





ADVANCES  
IN CHILD DEVELOPMENT  
AND BEHAVIOR

Volume 29

SOLUS

Robert V. Kail  
Hayne W. Reese

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AND BEHAVIOR

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ADVANCES  
IN  
CHILD DEVELOPMENT  
AND  
BEHAVIOR

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Volume 29



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## Preface

The amount of research and theoretical discussion in the field of child development and behavior is so vast that researchers, instructors, and students are confronted with a formidable task in keeping abreast of new developments within their areas of specialization through the use of primary sources, as well as being knowledgeable in areas peripheral to their primary focus of interest. Moreover, journal space is often simply too limited to permit publication of more speculative kinds of analyses that might spark expanded interest in a problem area or stimulate new modes of attack on a problem.

The serial publication *Advances in Child Development and Behavior* is intended to ease the burden by providing scholarly technical articles serving as reference material and by providing a place for publication of scholarly speculation. In these documented critical reviews, recent advances in the field are summarized and integrated, complexities are exposed, and fresh viewpoints are offered. These reviews should be useful not only to the expert in the area but also to the general reader.

The series is not intended to reflect the development of new fads, and no attempt is made to organize each volume around a particular theme or topic. Manuscripts are solicited from investigators conducting programmatic work on problems of current and significant interest. The editors often encourage the preparation of critical syntheses dealing intensively with topics of relatively narrow scope but of considerable potential interest to the scientific community. Contributors are encouraged to criticize, integrate, and stimulate, but always within a framework of high scholarship.

Although appearance in the volumes is ordinarily by invitation; unsolicited manuscripts will be accepted for review. All papers—whether invited or submitted—receive careful editorial scrutiny. Invited papers are automatically accepted for publication in principle, but usually require revision before final acceptance. Submitted papers receive the same treatment except that they are not automatically accepted for publication even in principle, and may be rejected. The use of sexist language, such as “he” or “she” as the general singular pronoun, is not acceptable in contributions to the *Advances* series; the use of “they” as a singular pronoun is incorrect. Use of the phrase “he or she” (or the like) is acceptable.

We acknowledge with gratitude the aid of our home institutions, Purdue University and West Virginia University, which generously provided time and facilities for the preparation of this volume. We also thank Barbara Younger-Rossmann for her editorial assistance.

Robert V. Kail  
Hayne W. Reese

# THE SEARCH FOR WHAT IS FUNDAMENTAL IN THE DEVELOPMENT OF WORKING MEMORY

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- A. DEFINITION AND DESCRIPTION OF WORKING MEMORY
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## I. Introduction

### A. DEFINITION AND DESCRIPTION OF WORKING MEMORY

Given the vast storehouse of one's knowledge, a mechanism is needed to hold a limited amount of especially relevant information in a privileged state for a short time. That mechanism, or collection of mechanisms (Cowan, 1999a), is generally implied when investigators speak of working memory. Although definitions of working memory vary dramatically from one investigator to another (Miyake & Shah, 1996), they all share a core idea (e.g., Baddeley, 1986). To carry out just about any cognitive task, a limited amount of information must be kept available temporarily. For example, comprehension logically requires some access to the information from early in a sentence, in some form, to be held until it can be integrated with information from later in the sentence, resulting in a coherent linguistic and semantic interpretation. Similarly, problem-solving logically requires access to data, premises, and so on until they can be integrated to produce a solution. Developmental differences in working memory, thus defined, certainly must play an important role in the growth of intellectual and scholastic abilities. In the present chapter, the development of working memory between the age of 7 years and adulthood is examined, largely on the basis of some of our own cognitive developmental studies.

The information in working memory, presumably, can come from the outside world but it also can include information from long-term memory that becomes activated as a result of the task context and the individual's attempt to carry out the task (Cowan, 1993, 1995, 1999a). Part of the difficulty in defining working memory is that it is not confined to a specific set of tasks; almost any cognitive task can involve the temporary activation of information that is needed for the response (Shiffrin, 1993). The question then becomes how one can logically identify and characterize the basic mechanisms that are used to activate information, and hold it temporarily, across such a wide range of cognitive situations. That question is compounded by the difficulty of understanding the development of working memory, given the need to compare basic mechanisms fairly across children of different ages, who are at different performance levels.

### B. EMPHASIS ON ELEMENTARY OPERATIONS

When the title of this chapter was first formulated, we drew inspiration from an earlier work by Posner and McLeod (1982) entitled "Information Processing Models—In Search of Elementary Operations." That work nicely set the stage for our analytic investigation as follows (Posner & McLeod, 1982, p. 478):



In a criticism of cognitive psychology, Newell (1973) suggested that there are few common principles emerging from myriads of often dichotomous distinctions. Newell's remedy . . . is the construction of complex information processing models that might eventually simulate a wide range of human mental activity. The reverse emphasis, and the one explored in this chapter, is that detailed studies of particular task configurations will lead to the identification of fundamental operations that can be used to characterize the human mind.

A search for such elementary operations is, we believe, the most important initial route for an understanding of working memory. However, we also think that we have learned enough in the past few years to hazard a guess at a type of information processing model, as well. Because such a model can make it easier to think about empirical results, we first describe the model, under I.C. Then we introduce, for comparison, the status of the field of working memory development, under I.D., and an aspect of developmental methodology and metatheory that we emphasize, under I.E. After that, under Part II, we pursue this analytic approach to indicate how parts of our model have been examined and which ones remain to be confirmed.

### C. A MODEL OF PROCESSING IN WORKING MEMORY TASKS

The present theoretical framework is based on a range of supporting evidence (see Cowan, 1988, 1993, 1995, 2001a) beyond the scope of the present chapter. In this framework, nodes from the memory system are automatically activated by incoming stimuli, although this automatically activated portion of memory consists mostly of physical features, i.e., sensory memory. This sensory memory decays (and is degraded through interference from other stimuli) within a matter of seconds unless it becomes the focus of the participant's attention. Once in the focus of attention, additional processing of the sensory information occurs and more categorical features related to the stimulus become activated. (Once they leave the focus of attention, these categorical features also suffer from interference or decay.) The focus of attention is limited in capacity and the rate at which activated nodes can be retrieved into the focus of attention also is limited. Presumably, these limits are important because deliberate recall can occur only on the basis of the current contents of the focus of attention.

Although this description is incomplete, it highlights the importance of three basic processing parameters for which we have invested considerable effort in order to find valid measures that could be used in developmental studies. These three parameters are the capacity of the focus of attention, the rate of retrieval of activated information into this focus, and the rate of decay of information from sensory memory. These are illustrated in Fig. 1.

The brief sketch of processing shown in Fig. 1 leaves a number of finer points to be discussed.

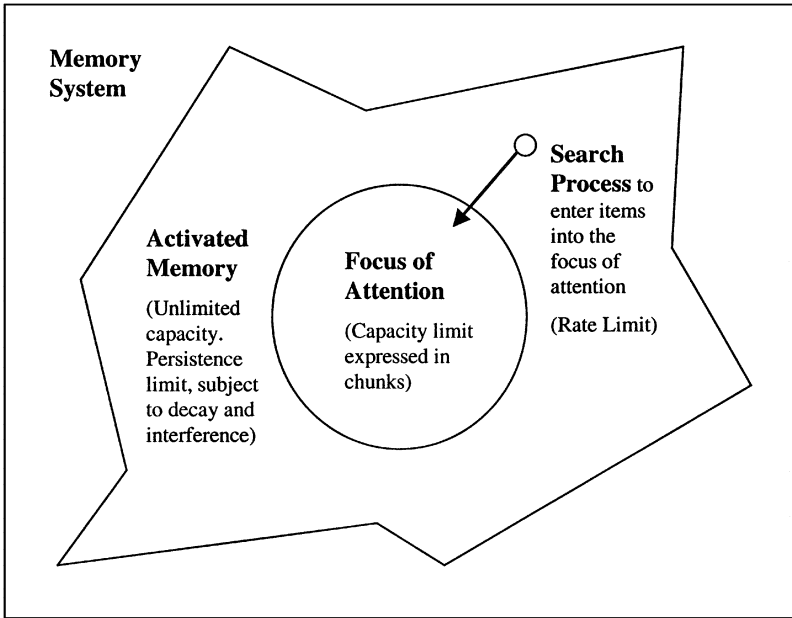


Fig. 1. A graphic depiction of various components of the memory system and their relation to the working memory limits we discuss. Activated memory and the focus of attention together form the working memory system according to this view.

### 1. Feature-Binding Processes

One particularly important point is that working memory must contain more than the activated or attended information from long-term memory. If that were all, no new information could be learned or recalled. Working memory must keep track of which elements are activated at the same time, which ones were activated after which other ones, and so on. In other words, the binding between activated features must be saved. Although Cowan (1988, 1995, 1999a) has often been cited to the effect that working memory is just the activated portion of long-term memory, the later two references actually cautioned otherwise. Cowan (1995, p. 101; 1999, p. 89) proposed that new links between concurrently activated elements also can be formed and stored in memory, with the assistance of attention. These new links are involved in the preservation of serial order and serial position information and other episodic information, as well as in the combination of elements or features to form novel objects. Such a role of attention is compatible with the role assigned to it by the feature conjunction model (e.g., Treisman, 1987).

### 2. New Long-Term Storage

Additionally, we suggest that, after attended sets of features are grouped into objects (i.e., chunks), only about four of these objects can be held in the focus of

attention at once (with the number subject to individual differences and age differences). However, once associations between items are formed (whether strongly enough to create discrete, multi-item chunks, or more weakly to form some more complex structure), the associative structure can be saved in long-term memory. Later, these new structures can be reactivated in a manner similar to preexisting information in memory.

### *3. Focal-Attention Zoom Lens*

In a theoretical review, Cowan (2001a) proposed that normal adults' average capacity of the focus of attention is about four unconnected chunks. However, several commentaries on that review suggested that sometimes the focus of attention can cover as little as one chunk. McElree and Doshier (2001) described research from a probed reaction time procedure in which response accuracy was examined for cases in which a list was presented, followed by a probe that matched any one item in the list or did not match any items, a procedure like that of Sternberg (1966). In their revised procedure, however, a variable response deadline was given. Such deadlines can reveal the speed of memory retrieval, or "retrieval dynamic," that is the function of accuracy increasing as the response deadline grows more lax. The results showed a faster retrieval dynamic for the most recent list item than for previous items, which did not differ from one another. This pattern could be explained on the basis that only the last item actually was in the focus of attention and therefore could be recalled without first having to be retrieved from some other portion of the memory system outside of attention. Moreover, Usher, Haarmann, Cohen, and Horn (2001) described a cognitive model in which the focus of attention could zoom from one to four depending on the task circumstances. In the response to commentaries, Cowan (2001b) tentatively accepted this view that the focus of attention can vary between a more intensive mode and a wider mode.

As in Usher's model, the limit of breadth is about four chunks. In Usher's model, this capacity limit occurs because the representations of different chunks overlap. Without such overlap, important cognitive functions such as generalization would be impossible. With such overlap, the model is unable to represent more than four chunks simultaneously. Cowan (2001a) and some of the other commentaries discussed a related neural representation in which each item in the focus of attention is represented by simultaneously pulsing feature detectors for the various features in the object. Multiple objects must pulse at different moments to avoid confusion between them but all objects in attention must pulse at a certain minimal rate to stay active. With too many objects in attention at once, the objects' features become temporally confused with one another. This places an upper, but not a lower, limit on how much can be in the focus of attention at once. Presumably, the fewer the number of simultaneously held stimulus objects (or chunks), the less the chance of confusion between them. Also, with fewer chunks from the stimulus set in the

focus of attention at one time, it should be easier to carry out intensive processing by incorporating other chunks from long-term memory.

#### 4. *Processing in Serial Recall*

We now show how these theoretical claims about processing apply to one relatively simple task, the serial recall task, given our reliance on this task in the present chapter.

*a. Attention and Formation of New Associative Structure.* New associations can be formed quickly to assist performance even in short-term recall. In a simple task in which a list of items (e.g., digits) is to be recalled, one need not assume that the participant holds all of the items in the focus of attention at once. Instead, a newly formed, active structure may be held automatically as the participant focuses attention on only a portion of the structure at a time to recall it.

*b. Attention and Phases of Processing.* Such a process solves another problem, which is the following. If attention leads to the grouping of items into chunks and adults can hold up to about four chunks at once in the focus of attention, then why does the response protocol in short-term serial recall include delays, both in children (e.g., Cowan, 1992) and in adults (Hulme *et al.*, 1999; Tehan & Lalor, 2000)? Moreover, if the chunks can be independent, how does the participant know which one to recall first, second, and so on? The zoom feature of attentional capacity, described above, can help to explain all of this. Perhaps one must focus attention entirely on a chunk in order to recall it overtly (e.g., to pronounce a word from a stimulus list), rather than spreading attention across all of the chunks simultaneously.

Thus, the list recall process would have several phases, as illustrated in Fig. 2. In the first, during input of the list, the scope of attention would vacillate. It could zoom in for the complete encoding of a presented item (*item encoding*) and zoom out again to encompass several recently activated items in order to form new associative links between them or between items and serial positions (*item binding*). In the next, *preparatory* phase, the attentional focus would spread out in order to get an overview of the entire, newly formed associative structure of the list. In the *search and output* phase, attention would typically be narrowed to a single chunk (group of items) every time it was about to be recalled. During the interword pauses between words in a response, a narrow focus of attention could scan the associative structure to determine which item to recall next; or, alternatively, the focus could zoom out to look at the list and find out which one to recall next and then zoom in to execute recall of the selected item. In either case, an assumption of a correlation between list length and the amount of associative structure or material to be searched correctly predicts the finding that longer lists result in longer interword pauses (Cowan, 1992; Cowan *et al.*, 1994, 1998, 1999; Hulme *et al.*, 1999; Tehan & Lalor, 2000).

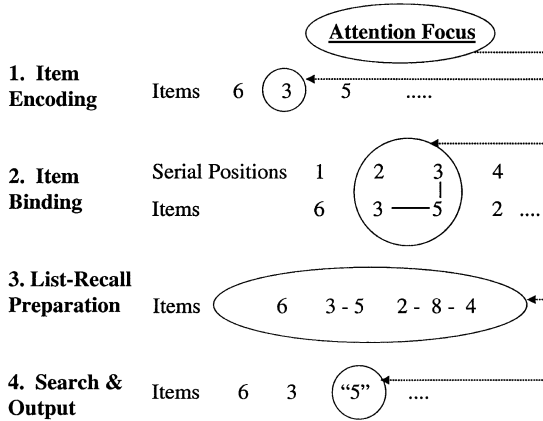


Fig. 2. An illustration of how the scope of the focus of attention (depicted as a circle or ellipse) might change from one phase of a memory trial to another. The depicted trial involves the serial recall of digits. Attention may focus on a single item during its encoding and then zoom out to allow an associative binding between nearby items and between an item and its serial-position context and in again to encode the next item and so on. At the end of the list, it may zoom out further to reload the series of chunked items into the focus of attention in preparation for recall, which may allow the creation of a more organized, overall mental scheme for the list before it is recalled. The process of recall may require that the focus of attention zoom in again, a requirement that could account for the well-known phenomenon of output interference.

*c. Involvement of Retrieval and Decay Rates.* Whenever an item could not be rehearsed, for example during the overt recall of another item, the unrehearsed item would tend to be forgotten over time. We broadly refer to that forgetting as decay, without specifying its exact nature. The amount of decay may be related to the absolute amount of time that has passed without rehearsal or, alternatively, to the amount of time relative to the interitem intervals, a loss of distinctiveness of the most recent items with the passage of time (Cowan, Saults, & Nugent, 1997, 2001; Nairne, Neath, Serra, & Byun, 1997). In any case, faster retrieval of information (because of faster control of the focus of attention or other, unknown factors) limits the amount of time during which decay can take place. Thus, in a serial recall task, the capacity of attention, the short-term memory search or retrieval rate, and the decay rate all could come into play in determining performance. Cowan (2001a,b) discussed the application of the framework to other tasks.

#### D. THE STATUS OF THE FIELD OF WORKING MEMORY DEVELOPMENT IN RELATION TO THE PRESENT APPROACH

Before summarizing research on development of working memory parameters, we want to convey briefly what progress has been made in other research on the development of working memory. The present approach is similar to conventional

approaches in some ways and different in other ways, and these similarities and differences must be described and put in the correct context.

### *1. Working Memory as a Distinct Research Area*

Some theorists consider memory to be just one type of problem for which the child must find a cognitive solution. Witness, for example, an article in which the possible demise of memory as a research area was proclaimed (Kuhn, 2000). This general approach to memory would not suffice to explain working memory. If one is dealing with the boundless well of information that the individual has learned over a lifetime, then the structure of information in the memory representation may be of similar importance for any type of cognitive task, mnemonic or otherwise. However, for any of these tasks, assuming that a limited amount of information becomes temporarily accessible (as the concept of working memory seems to imply), one can discuss certain fundamental information-processing limits: how quickly a limited amount of information moves into a temporarily accessible state, how much information can become accessible in this way concurrently, and how long it stays accessible. If information accessibility is limited in this manner, as we believe, these limits are important to understand apart from the knowledge structure for a particular task.

### *2. Approaches to Working Memory Development*

*a. Modular Approach.* Another key point concerns the procedures for examining working memory and their application to developmental research. The approach initiated by Baddeley and Hitch (1974) and elaborated upon enormously since that time (e.g., Baddeley, 1986) delineates certain hypothetical structures of working memory referred to as a central executive, a phonological loop, and a visuospatial sketchpad. The emphasis has been on learning how these components work, with a subsidiary emphasis on learning how the components mediate important types of learning (Baddeley, Gathercole, & Papagno, 1998; Gathercole & Baddeley, 1993). Some investigators have applied the same type of theoretical analysis to an understanding of developmental change (e.g., Henry, 1991; Hitch, Halliday, Dodd, & Littler, 1989; Hulme & Tordoff, 1989).

*b. Psychometric Approach.* In contrast to the modular approach initiated by Alan Baddeley and his colleagues, another approach has used more complex, holistic working memory measures that capture more of the variance of complex scholastic abilities tests (Daneman & Carpenter, 1980; Daneman & Merikle, 1996), presumably because they require both the processing of information and the storage of information during that processing. Researchers have attempted to analyze these complex working memory tasks into their basic components, both by examining the performance of high- and low-span individuals on various other, more narrowly

defined cognitive tasks (Engle, Conway, Tuholski, & Shisler, 1995; Conway & Engle, 1994) and by using structural equation models to isolate the source of variance within the complex working memory tasks that accounts for general intelligence (Engle, Tuholski, Laughlin, & Conway, 1999b). Some investigators have applied that type of task to an understanding of developmental change also (e.g., Hitch, Towse, & Hutton, 2001; Towse, Hitch, & Hutton, 1998).

Both of these approaches in the field (modular and psychometric) combine analytic experimental work and correlational work, though the balance of these two research emphases differs for the two types of approach, with more correlational work in the psychometric approach. Within the psychometric approach, the debate concerns whether individual and age differences in working memory stem from differences in the use of attention and inhibition or from rates of retrieval and forgetting. In the first camp, one would place theoretical views holding that the critical variable is the control of attention (Engle *et al.*, 1999b) or the use inhibition (Hasher, Stolfus, Zacks, & Rypma, 1991). In the second camp, one would place views holding that the critical variable is the speed of processing (Kail, 1992; Kail & Salthouse, 1994; Salthouse, 1996) or the additional forgetting that can occur over time as a result of slower processing and responding (Hitch *et al.*, 2001; Towse *et al.*, 1998). The former view has been taken to imply that attention is shared between processing and storage and that working-memory limits stem from difficulty doing this sharing, whereas the latter view has been taken to imply that attention switches back and forth between storage and processing (see Hitch *et al.*, 2001).

### 3. *The Present Approach Compared to the Others*

*a. Comparison to the Modular Approach.* The present approach illustrated in Fig. 1 borrows from both the modular and psychometric approaches, but adds something new. From the modular approach, it borrows the assumption that working memory results from an interaction between active attentional processes and passive memory-storage mechanisms and borrows the notion that we need to isolate, identify, analyze, and characterize these mechanisms. In the present approach, no distinction is drawn between phonological and visuospatial subsystems because we still do not know the best taxonomy. We do not know, for example, whether memory for nonverbal sounds or tactile sensations can be considered part of either of these stores. We do not know if memory for, say, spatial arrays of words must engage two separate, phonological and spatial subsystems or one integrated system. In the present approach, we circumvent such questions by simply referring to all such memory, whether physical or categorical in nature, as memory activation. Similar dynamic principles may apply to various types of activation, for example similar parameters of decay and of interference, modulated by the extent to which subsequent stimuli share similar features (Cowan & Saults, 1995; Nairne, 1990).

Baddeley (1986) spoke of passive memory stores as if they did not undergo developmental change in the forgetting rate. This was a parsimonious account because it allowed him to attribute developmental change entirely to the efficiency with which mnemonic processing can be carried out before the passive memory is lost (cf. Case, Kurland, & Goldberg, 1982). However, we have shown subsequently that passive memory at least for acoustic information is lost more quickly in younger children (Cowan *et al.*, 2000; Keller & Cowan, 1994; Gomes *et al.*, 1999; Saults & Cowan, 1996).

Unlike the approach of Baddeley (1986), we also consider that the attentional process itself has storage capability. Baddeley (2000) has modified his account to include an episodic short-term buffer that depends on attentional processes for its input; so he may not differ from us much on this score. He has conjectured that his episodic buffer has the capacity limit that we ascribe to the focus of attention (Baddeley, 2001). He has suggested that his buffer cannot consist entirely of the activated portion of long-term memory as it also must include newly formed links between active concepts and, although he has contrasted that with the Cowan model, Cowan (1995, 1999a, 2001b) actually made a similar point.

*b. Comparison to the Psychometric Approach.* From one strain of the psychometric approach, we borrow the notion that the control of attention is important (Engle *et al.*, 1999a,b). We differ from this psychometric approach in focusing on basic parameters that have difficulty-insensitive measures and are related to our own simple modeling framework (illustrated in Fig. 1). Borrowing from another strain of the psychometric approach, we also emphasize the importance of processing rates (Kail & Salthouse, 1994; Towse *et al.*, 1998). However, we have questioned the claim that a central, global processing rate controls performance quality. Instead, we have found separate, uncorrelated processing rates for memory search versus phonological processing operations (Cowan *et al.*, 1998).

We do not deny the importance of controlled attention but have concentrated our research instead on examining the limit in the capacity of the focus of attention in chunks. This may prove to be closely related to controlled attention, in which case it could provide a better defined type of measure of attentional processing limits than has been used in the psychometric approach. However, if such a correlation is not found, we still would hold that understanding attentional capacity limits is important in order to carry out an analysis of the demands of any particular task. (See Halford, Wilson, & Phillips, 1998, for theoretical work on how processing limits can account for developmental limits in the performance of various cognitive tasks.)

An open question in the psychometric subfield is the extent to which working memory processes are *modular*, i.e., divided into separate components for separate domains of stimuli. According to some views, one process or mechanism may account for all that is important and interesting in working memory: most notably, the



quality of controlled attention (Engle *et al.*, 1999a) or general processing capacity (Daneman & Merikle, 1996; Just & Carpenter, 1992). According to other views, distinct pools of capacity exist for specific areas of processing such as linguistic processing (Waters & Caplan, 1996) or spatial processing (Shah & Miyake, 1996). The present approach is an intermediate one. We propose only one processing capacity limit, namely the limit in the focus of attention, which is general across modalities; but processing within activated memory may be susceptible to interference that depends on the similarity between stimuli, thus allowing for apparently modality-specific and materials-specific resources. One must know about the decay, interference properties, and search rates, not just attentional capacity, in order to know how well tasks can be carried out (Cowan, 1995, 1999a).

#### E. DIFFICULTY-INSENSITIVE MEASURES OF DEVELOPMENTAL CHANGE

##### 1. Overview

A well-known, key epistemological problem that must be confronted in the field of cognitive psychology is that one cannot be sure how an observed measure (e.g., a pattern of proportions correct or reaction times across conditions of an experiment) can be interpreted to provide an estimate of an underlying factor of theoretical interest. This problem is compounded in the field of cognitive development, where one must find estimates of the factor that can be compared fairly across age groups. In the present case the problem is how to estimate a capacity limit, a search rate limit, or a decay rate (three parameters of special interest according to Cowan, 1995, 1999) from data collected across list lengths or retention intervals in immediate-memory experiments. We maintain that it is both possible and useful to derive absolute values for theoretically fundamental parameters at each age. This is in contrast to the usual approach (which we term a *relative-measurement approach*) in which the research focus is on relative differences between age groups on relevant tasks without any indication of the underlying, absolute values of parameters producing these age effects.

Potential concerns with this usual, relative-measurement approach are twofold. The first is a psychometric one: the results must be expressed in a manner such that the conclusions are not specific to the performance level of the individual or group. For example, suppose that decay of memory is observed across retention intervals and one wishes to determine if age groups differ in the amount of decay. The magnitude of decrement across retention intervals is likely to depend on the initial level of performance at the short retention interval. If performance is good initially, this well-learned memory may be more resistant to decay than a memory representation that is poorer initially. If older children perform at a higher level at short retention intervals than younger children do, an age difference in decay across retention intervals is not interpretable (because it could be an artifact of a stronger initial memory in the older children rather than a true decay

difference). A common solution to this sort of problem is to adjust the level of difficulty of the stimuli individually until each participant (or each group) is similar in the proportion correct at a short retention interval and then to observe decay (e.g., Keller & Cowan, 1994). More generally, the solution to such problems in developmental comparisons has often been to adjust the stimuli until the main effect of age disappears to determine whether there remains an Age  $\times$  Condition interaction that could be taken to indicate age differences in the process of interest (e.g., Massaro & Burke, 1991).

Given that type of solution to the measurement problem, however, one may wonder if the differences in stimuli across age groups make the developmental comparison difficult to interpret theoretically. In order to get the same level of performance at all ages, the adjustments in stimuli may lead to different sorts of limitations in performance for different age groups. For example, in a task requiring the comparison of two tones with a variable intertone interval, suppose for the sake of argument that performance can be based on either of two representations: a precise representation that decays quickly or a less precise representation that decays more slowly (e.g., sensory and categorical representations). In order to achieve equivalent performance at a particular, short intertone interval, the older participants have to be given tones that are less discriminable (Keller & Cowan, 1994). We do not know why this is the case but perhaps it is simply because younger children make more random errors, thus requiring easier comparisons to reach the same average level of performance. The stimulus adjustment might force older participants to rely most often on the more precise, unstable representation in order to hear very subtle differences between tones, whereas younger children's performance could be based more often on the less precise but more stable type of representation. That discrepancy in processing modes would lead to an underestimation of the stability of the memory representations in the older children relative to the younger ones.

The second concern with the relative-measurement approach is that it may be difficult to construct a defensible line of argument as to how a behavioral measure can be interpreted theoretically. The question is whether the observed differences across conditions reflect the process of interest or whether they instead reflect the intervention of some other, nuisance variable of lesser interest. For example, if one is interested in the duration of a sensory form of memory and its development, one wants to be able to know whether an observed age difference in forgetting over time is indeed due to differential sensory memory forgetting or whether it might instead reflect the better use of rehearsal, or better sustained attention across retention intervals, in older children; these being nuisance variables in the context of an investigation of sensory memory stability. Although many previous investigators have addressed these sorts of problems (e.g., Chapman & Chapman, 1978; Faust, Balota, Spieler, & Ferraro, 1999; Salthouse & Kausler, 1985), we believe that the field can still use additional, practical suggestions. In this regard, we make use

of various findings from the cognitive literature and point out that solutions to the psychometric and theoretical problems may converge. If one finds a means to identify the theoretical factor of interest, it should be possible to derive that factor similarly from results based on more than one level of difficulty of the stimuli.

Thus, the existence of a derived result that is stable across levels of difficulty of the stimuli can lend support to the argument that the result is theoretically meaningful and that it can be compared validly across age groups, for the same stimuli. In order to highlight such results and the methods underlying them, we suggest the term *difficulty-insensitive measures*. These, simply put, are measures that yield the same result across varying levels of task difficulty.

The advantage of difficulty-insensitive measures for developmental research is that they estimate the absolute values of parameters of information processing. They can yield conclusions about developmental change that are specific in magnitude and that do not depend upon the level of stimulus difficulty. This is in contrast to the usual tool of a group  $\times$  condition interaction, which typically varies in magnitude depending on the difficulty level of stimuli.

Few difficulty-insensitive measures have been found in developmental research; but there has not been much of a concerted search for these measures. In cognitive psychology, at least, two such exemplary parameters are rather well known. The *whole-report limit* described by Sperling (1960) is a limit in how many items can be recalled from an array (about four) which does not vary with the size of the array. It serves as an estimate of the capacity limit of working memory that has been confirmed in a variety of other work (Cowan, 2001a). The *memory search slope* described by Sternberg (1966) occurs in a procedure in which a probe is to be judged present in or absent from a recently presented set of items in memory and represents the slope of a linear increase in reaction time that occurs as a function of the number of items in the set held in memory. This slope reflects the amount of time it takes, per item, to search through the mental representations of items and does not vary with the exact list lengths presented, provided that the participant can retain the list. For example, the same slope would be obtained in experiments using List Lengths 1–4 or using List Lengths 3–6.

For both of the examples mentioned, there are remaining questions about exactly what processes these constant parameter values reflect (i.e., capacity of a visual store versus capacity of the focus of attention; serial versus parallel search of memory). Nevertheless, the difficulty-insensitive measures provide windows onto important processes that can be compared across individuals. Even without knowing all of the details of processing, an individual's profile of parameter values could be described. Also, when more is understood about the interpretation of the parameter values, more will consequently be known about the individuals whose values have been measured.

What essential properties of a measure would tend to make it difficulty-insensitive? One possibility is that the underlying parameter reflects a key

bottleneck in performance. Thus, in the procedure of Sperling (1960), performance is limited by some constant amount of output, presumably reflecting a constant limit in how much can be held simultaneously in working memory. Another possibility is that the parameter reflects a fixed process that can be used repeatedly on a trial, depending on the stimulus set. Thus, in the procedure of Sternberg (1966), it may take a certain, fixed amount of time to search for each item in a list, with the number of covert searches to take place on a trial dependent on the list length.

The studies used as examples here will be explained more fully within the theoretical framework illustrated in Fig. 1, which included three processing mechanisms: *a capacity limit*, presumably in the contents of the focus of attention; *a retrieval rate*, presumably in bringing material from activated memory into the focus of attention; and *a decay rate* for activated information outside of attention (in the case of our studies, sensory information; though we assume that categorical information also can be in this activated memory). As mentioned above, these three mechanisms are central to the authors' view of working memory and therefore have been the basis of a great deal of our developmental research.

## 2. *Storage Capacity of the Focus of Attention*

The first parameter of processing to be considered is the capacity of the focus of attention. We have examined it using both attended but briefly presented visual arrays and ignored, spoken lists. In neither case can attention be used to group items into higher level chunks.

*a. Visual Arrays.* In one key study, Sperling (1960) presented brief spatial arrays of characters for partial or whole report and found that, although partial report (if cued quickly enough) allowed almost all of the items in the array to be recalled, the whole-report limit was about 4 characters. This whole-report limit remained fixed as the number of characters in the array ranged from 4 to 12. Initial interpretations focused on the possibility that the rate of extracting information from the sensory memory of the array, during the few hundred milliseconds while the sensory memory lasted, was the limiting factor for whole report. However, this interpretation is at odds with the finding that a much longer extraction period (several seconds) leads to a comparable whole-report limit in the auditory modality (Darwin, Turvey, & Crowder, 1972) and the finding that, in a procedure in which only one decision must be made on every trial (Luck & Vogel, 1997), a very similar recall limit of about 3.5 items can be derived (Cowan, 2001b; Cowan, Saults, & Fristoe, in preparation). Cowan (2001a) and Cowan, Nugent, Elliott, Ponomarev, and Saults (1999) interpreted these whole-report limits as reflecting a capacity limit coming into play when sensory information must be transferred to the focus of attention in order to allow the creation of categorical codes for the characters in the array, before they can be recalled. The amount of information that can be included in the focus of attention may be limited. This, in turn, places an identical

limit on how many items can be recalled, regardless of the size of the array (at least, within the range of 4–12 items).

The unit for this capacity limit presumably is the *chunk* of information, where a chunk comprises a group of items that, for one reason or another, has close mutual associations and is only weakly associated with other items in the stimulus field (Miller, 1956; Simon, 1974). For briefly flashed arrays like the ones Sperling (1960) used, grouping processes are limited and the chunk size is assumed to be the individual item (Cowan, 2001a). Thus, the whole-report limit can be viewed as a difficulty-insensitive estimate of the capacity of working memory in chunks. In adults, the limit is about four chunks.

Cowan (2001a) proposed that what is critical for the observation of a difficulty-insensitive measure of memory capacity is that the items presented are highly familiar and unassociated (and hence are individual chunks) and cannot be subjected to memorization processes that result in larger groups or chunks being formed at the time of presentation. Without such memorization processes, each item remains an isolated chunk in memory, so that the number of items recalled reflects the number of chunks recalled. Presumably, difficulty-insensitive measures of capacity can be obtained across memory set sizes (list or array sizes) because the capacity is limited to a fixed number of chunks.

Convergent findings come from a wide variety of procedures. One contribution of Cowan (2001a) was to organize findings into a taxonomy that helped to make clear the situations in which the presented items are single chunks in memory and, therefore, in which capacity limits (in terms of chunks recalled) could be estimated (in terms of items recalled). Four such situations were identified. First, in some situations the amount of information presented at one time overloads attention so that grouping cannot be carried out. The procedures of Sperling (1960), Luck and Vogel (1997), and Cowan *et al.* (1999) are good examples of this. Second, in some situations grouping processes are prevented directly, forcing the participant to rely on each item as a separate chunk and to hold the chunks in attention rather than a passive source. Studies in which rehearsal is discouraged (e.g., Waugh & Norman, 1965) or blocked (e.g., Murray, 1968) or in which the materials are not rehearsable (e.g., Glanzer & Razel, 1974) are of this type. Third, performance discontinuities often occur when the materials begin to exceed attentional capacity. The best known such discontinuity is the finding that when an array of objects is presented and the participant must report how many there are, rapid subitization is possible for up to about four items in parallel, whereas items over four must be counted serially (Mandler & Shebo, 1982). Other examples include (a) the ability to track up to about four objects moving through the visual field in different directions at once (Pylyshyn *et al.*, 1994); and (b) the absence of proactive interference in adults only for sets of up to four items presented at once, but proactive interference for larger sets (Halford, Maybery, & Bain, 1988). Fourth, and finally, there are indirect effects of capacity limits. Recall from large categories occurs in bursts

of up to about four items at a time, both in immediate recall (e.g., Ryan, 1969) and in long-term recall (Broadbent, 1975, estimated three, whereas Graesser & Mandler, 1978, estimated five). Even when experts can recall many more items than normal, the recall protocol shows answers coming in bursts of about four at a time (e.g., Ericsson, Chase, & Faloon, 1980). Also, mathematical models of cognitive processes typically use a working memory with a limit of four slots, presumably because such a model works well (Kintsch & van Dijk, 1978; Raaijmakers & Shiffrin, 1981). A reading of Cowan (2001a) and the following commentaries offers many potential reasons why a capacity limit of about four items works well, though we do not yet know which of these reasons have merit.

*b. Spoken Lists.* Some investigators have presented present auditory arrays that probably were too complex to allow rehearsal or chunking, a condition that allows capacity to be estimated (Darwin *et al.*, 1972; Rostron, 1974; Treisman & Rostron, 1972). Cowan *et al.* (1999) extended the logic further by showing how capacity limits could be estimated even for spoken lists in which only one item was presented at a time. To prevent chunking, a demanding distracting task was developed that did not create any acoustic interference (matching pictures with names that rhymed). When this distracting task was played during the presentation of lists of random, spoken digits and no response was required to most such lists, recall of the spoken lists that were occasionally probed were limited, in adults, to about 3.5 digits recalled in the correct serial position. This estimate, which is very similar to the whole-report limit described above, was obtained with lists of varying length. Presumably, all digits were automatically active in memory throughout the experiment but the binding between a digit and its serial position within the list occupied a slot as an “item” or chunk in the attentional, capacity-limited store. (This binding presumably occurs only if attention is turned to the sensory memory of the last list before it fades away.) Thus, in this method, attention was turned away from the auditory stimulus during its presentation to prevent grouping so that we could observe the limits in attentional capacity if attention was applied to the stimulus only at one point in time, when recall was probed.

### *3. Rate of Retrieval into the Focus of Attention*

The second parameter of processing, the rate of retrieval of information into the focus of attention, has been investigated using both probed recall and the timing of serial recall.

*a. Probed Recall.* Another key study in cognitive psychology was that of Sternberg (1966, 1969). Given a target list to be remembered on every trial, the task was to indicate as quickly as possible, via a button-press, whether a probe item was in the list. Mean reaction times increased linearly as a function of the number of items in the list. The slope of the reaction time function across list

lengths was taken to indicate how long it took to search each item in the list to find an item identical to the probe. Sternberg considered the search process to be serial but subsequent investigators have suggested that the search actually could be parallel (Ratcliff, 1978; Townsend, 1976). In any case, the linear search function is not in question. The slope of the search function is the same when one increases from one to two items, two to three, three to four, and so on up to six items. In that sense, the slope is a difficulty-insensitive measure of the rate of mental search through the list.

*b. Pauses in Spoken Recall.* Cowan (1992) examined memory span in 4-year-old children and measured the duration of several segments of responses for errorless trials: (a) the silent preparatory interval between the end of the stimulus list and the beginning of the response, (b) the duration of each word in the response, and (c) the duration of each silent interword pause between words in the response (recorded as 0 if there was no such pause). The mean interword pause increased as a function of the list length, which suggested that children searched through the entire list to select the item to be spoken next. The longer the list was, the longer the search took. Subsequent research established the same phenomenon for older children (Cowan, 1999b; Cowan *et al.*, 1994, 1998) and adults (Hulme, Newton, Cowan, Stuart, & Brown, 1999; Tehan & Lalor, 2000).

Other aspects of the findings show further similarities between the probe reaction time and interword pause time measures. In particular, neither is affected by the duration of stimulus words (Cowan *et al.*, 1994; Chase, 1977; Clifton & Tash, 1973), suggesting that an abstract node is searched, not a phonological representation as in the word length effect in serial recall (Baddeley, 1986; Baddeley, Thomson, & Buchanan, 1975). Neither shows primacy effects, or enhanced recall of the first few list items, although the probe reaction time measure sometimes shows recency effects, or enhanced recall of the last few items (e.g., McElree & Doshier, 1989; Monsell, 1978; Ratcliff, 1978). Moreover, at least in children's recall of up to about five items, interword pauses are flat across serial positions except for a slight shortening at the last serial position (Cowan, 1992; Cowan *et al.*, 1998). If participants were able to eliminate each item from the search process after it was recalled, the pauses should have become steadily shorter across serial positions of the recall process, but that did not appear to occur. For longer lists in adults, longer pauses probably occur between some items in the response because the items are grouped together (Anderson & Matessa, 1997), albeit group boundaries may occur at different locations for different individuals. Those intergroup boundaries cannot, it appears, be seen clearly within shorter lists.

Unpublished evidence from the data set of Cowan *et al.* (1998) show that the interword pauses form a difficulty-insensitive measure of the underlying search process. Most children in the first, third, and fifth grades had pauses for lists of two, three, and four spoken digits and the pauses show a nearly perfect linear increase

within that range in all groups. That is to say, the increase in the pauses between two- and three-digit lists is the same as the increase between three- and four-digit lists. This difference represents the amount of time to search for a single extra item in the list, and this per-item search time is a difficulty-insensitive measure of the retrieval rate.

#### 4. *Sensory-Memory Decay Rate*

The third parameter of processing to be described is the decay rate of one type of automatically activated memory, namely sensory memory. A difficulty-insensitive measure of sensory memory cannot yet be identified with confidence equivalent to what we have suggested for capacity and retrieval speed. However, a possible measure is inspired by the early studies of sensory memory, conducted not only by Sperling (1960) and Darwin *et al.* (1972) but by many others (for reviews see Broadbent, 1958; Coltheart, 1984; Cowan, 1984, 1988, 1995; Crowder, 1976; Di Lollo & Dixon, 1988; Massaro & Loftus, 1996; Nairne 1990; Penney, 1989). The literature shows that we have a rich and vivid, but short-lived, memory of the sensation arriving in any particular modality, which tends to be overwritten by subsequent stimulation in the same modality (especially if physical features of the subsequent stimulus are similar to those of the to-be-remembered stimulus). The memory for sensation can be divided into two types, presumably in any modality: a brief mental afterimage that lasts only 1/5th to 1/3rd of a second and is perceived as a continuation of sensation and a longer memory for sensation that is perceived instead as a vivid recollection for up to about 20 s (Cowan, 1988, 1995). To examine the latter, longer memory without encountering sensory interference, one needs to test performance on the last stimulus in a list. The list length must be varied to demonstrate that the memory is difficulty-insensitive (i.e., yielding the same measurements regardless of the list length). If the stimuli can be retained in memory as labels, one must provide a powerful distracting task to prevent such labels from being formed so that the participant can only rely on sensory memory as opposed to memory for categorical labels; yet the distracting task should be in another modality so as not to cause sensory interference.

Perhaps no extant data meet all of these requirements. However, some relevant data come from a developmental study by Cowan, Nugent, Elliott, and Sauls (2000). In that study, attention was directed toward a silent task in which pictures were matched on the basis of rhymes while random lists of spoken digits, presented at a 2/s rate, were ignored. Occasionally, a change in the computer screen display indicated that the participant should use the number keypad to recall the digits in the most recent spoken list. The retention interval between the end of the target list and the recall cue, filled with a continuation of the rhyming game, lasted 1, 5, or 10 s. The list was always as long as the longest list that the participant had recalled without error in a previous task, in which he or she had paid attention to the digits (which we refer to as the participant's *maximal span*). We thus have



ignored-digit recall data for only one list length per participant, namely the participant's maximal span.

Although difficulty insensitivity can only be examined properly with multiple difficulty levels in the same participant, we can show that a measure of decay, the proportion decrement in the last serial position over retention intervals, is at least not very sensitive to performance level differences within an age group. Sufficient data to examine this exist only among the youngest group in the study, the second-graders (those with a span of 4,  $N = 7$ ; span of 5,  $N = 8$ ; and span of 6,  $N = 6$ ). Among these children, after a 1-s retention interval, the proportion correct at the last serial position depended heavily on the span: it was .82, .63, and .46 for children with a span of 4, 5, and 6, respectively. Yet, the ratio of the score after a 5-s retention interval to the 1-s score (indicating the proportion of memory remaining after 5 s) was similar in the three span groups: 0.52, 0.55, and 0.55 for children with a span of 4, 5, and 6, respectively. Thus, regardless of span among these children, the half-life of memory for the last list item in this memory-for-ignored-speech task was about 4 ( $= 5 - 1$ ) s.

### *5. Application of Difficulty-Insensitive Measures to Development*

In sum, so far we have seen that certain measures remain fixed as one changes the array size or list length: the number of items that can be recalled from a complex array or an unattended list, the rate of retrieval of information for recall, and (we suspect) the rate of decay of unattended acoustic information in the absence of acoustic interference. Having such measures is important for cognitive research because they provide stable estimates of processing parameters that are not highly dependent on the particular difficulty of materials. They are doubly important for developmental comparisons because different age groups show different overall levels of performance (see also Cowan, 2000; Cowan, Saults, Nugent, & Elliott, 1999). With difficulty-insensitive measures, developmental comparisons of data patterns are possible that are both (a) measured at the same overall performance level across age groups and, simultaneously, (b) measured using the same stimulus sets across age groups. That possibility, if extended and verified, represents an exciting opportunity for developmental research. It leads to the possibility of estimates of the quantity of change in basic processing mechanisms with development.

## **II. Evidence of Developmental Change in Processing Parameters of Working Memory**

Having discussed the theoretical framework, including three parameters of working memory and how they can be measured, we now describe evidence of their development.

## A. CAPACITY LIMITS

1. *Preliminary Evidence from a Spatial Array Task*

Working memory performance, even on the simplest tasks, clearly increases with age in childhood. However, why that change takes place is not clear. Researchers have been equivocal about whether there is a change in the capacity of working memory (e.g., Case, 1995; Pascual-Leone, 1970) or just a change in how well a fixed capacity is used (e.g., Case *et al.*, 1982; Kail, 1990). To address this issue, we examined capacity in developmental studies using measures for which the number of chunks can be estimated, inasmuch as each stimulus is a familiar chunk and the conditions discourage additional chunking, as explained by Cowan (2001a).

In an unpublished study (Cowan, Fristoe, Elliott, Sauls, Brunner, & Lacey, in preparation), we looked for evidence that the type of working memory needed to retain an array of color squares, like that examined in adults by Luck and Vogel (1997), may change with age in childhood. The method was nearly identical to that of Luck and Vogel. Each trial consisted of an array of 4, 6, 8, or 10 randomly placed color squares and then another array that was identical to the first or differed in the color of one square. A single cue (a white circle) surrounded one square in the second array. If a color had changed, this cue surrounded the changed color. The task was just to indicate whether that square had changed color between the two arrays or had remained unchanged. Any particular color could occur more than once in a single array so the participant had to encode not just the presence or absence of each color, but also the binding between the color and its spatial location in the array. In theoretical terms we assume that all of the colors become more or less activated in memory across trials but that the binding between colors and locations is subject to a more severe capacity limit.

We evaluated the results with a variation on a simple formula devised by Pashler (1988). To estimate an individual's memory capacity  $k$ , we assumed that out of  $N$  items in the first array on a trial,  $k$  of them were present in working memory. Thus, as a result, the right answer would be known on  $k/N$  of the trials. On the remaining  $(N-k)/N$  of the trials, we assumed that the participant guesses "yes, there was a change" with a probability  $g$ . Then it follows that hits  $H = k/N + [(N-k)/N]g$  and correct rejections  $CR = k/N + [(N-k)/N](1-g)$ , the latter differing from Pashler. Combining these equations, it can be shown that  $k = N(H + CR - 1)$ . This rough-and-ready estimate appears to have some validity in that it resulted in constant estimates of the capacity limit across array sizes, provided that the array size was larger than the capacity (which is necessary to avoid ceiling effects in the more capable participants, i.e., compression of the range of results).

For 56 adults the capacity estimates were, for set sizes 4, 6, 8, and 10, respectively, 3.15, 3.77, 3.84, and 3.80. For 61 fourth-grade children they were 2.28, 2.26, 2.39, and 2.36. These means are rather stable across set sizes, except for set size 4 in adults. Given that some adults actually had a capacity below 4 and others

had a capacity above 4, this small set size leads to a ceiling effect. Otherwise, the method is a difficulty-insensitive measure of capacity.

## 2. Evidence from a Serial Recall Task

*a. Introduction.* At least since the article by Miller (1956), the limit in short-term memory capacity has been considered a major aspect of human thought. However, the “magical number seven” that Miller observed results from a complex processing system in which stimuli are grouped together, rehearsed, and partly memorized to the point that one cannot tell how many independent ideas or “chunks” are concurrently occupying the short-term memory faculty. Obtaining measures of the number of independent chunks has been difficult, for example, in short-term serial recall. Cowan, Nugent *et al.* (1999a) investigated this issue developmentally with an ignored-speech procedure modeled after that of Sauls and Cowan (1996), but with only one retention interval and with each participant receiving ignored lists of four different lengths. The rationale was that one can prevent rehearsal and memorization by presenting items one at a time and diverting attention away from them. This seemed better for developmental research (because it is simpler) than the usual means of preventing these processes, which has been by presenting items in a complex spatial or temporospatial array (Darwin *et al.*, 1972; Luck & Vogel, 1997; Sperling, 1960). In both cases, though, an indication that one has succeeded in preventing the formation of higher order chunks is that the number correct does not change with the size of the array or list and matches other estimates of capacity (Cowan, 2001a). Given that pattern of responding we assume that, from the large amount of information in sensory memory, the independent, unrehearsed items that can be drawn into the short-term memory faculty (presumably, into the focus of attention) are limited to a fixed number.

*b. Basic Method of Cowan et al. (1999a).* To investigate capacity using ignored speech we tested 72 participants in all: 24 in each of 3 age ranges (Grade 1, Grade 4, and adult). After elaborate training and familiarization procedures, each participant carried out an auditory memory task and a visual distracting task, both separately and jointly. In the distracting task, some standard names of various pictures of common nouns were learned in advance and practice was given. Each display consisted of four pictures at the corners of the computer display (e.g., *tail*, *boy*, *hat*, and *rock*) and a central picture whose name rhymed with one of the peripheral pictures (e.g., *mat*). The task was to use the computer mouse to select, as quickly as possible, the peripheral picture with a name that rhymed with that of the central picture (e.g., *hat*). Upon completion of that response, the central picture changed and the participant was to answer again. Thus, the pace of the task was self-adjusting. As we explain shortly, this primary task was reasonably effective in keeping attention away from the spoken words during their presentation.

Before each of these tasks, each participant received an aurally presented span test with a spoken response. Then, in the auditory-memory-alone task (serving as an “attended-speech control” for a subsequent, ignored-speech condition), lists of spoken digits were presented at a rate of 0.5 s/digit and were to be recalled in the presented order using the numerical keypad. The developmental difference was no larger with a keypad response than with a spoken response in the span test, and therefore we concluded that the keypad played no role in the developmental findings. (The same was true in Cowan, Nugent *et al.*, 2000.) In the auditory-memory-alone task, lists were presented through headphones at four lengths: the longest length that the participant had repeated correctly in the span task (which we term “span length”) and the three adjacent, shorter lengths (span-1, span-2, and span-3). A child managing to repeat one five-digit list correctly in the span test, for example, would receive five-, four-, three-, and two-digit lists in random order in the auditory memory tests.

The visual task was carried out alone in two test segments and also, most critically, in a dual task while spoken lists of digits were to be ignored. These spoken lists were presented at a fast, two-per-second rate and occurred with randomly mixed silent periods of 1, 4, or 7 s between lists. A to-be-ignored series continued for 45 to 100 s and then the visual task was interrupted with a response screen indicating that the participant was to use the keypad to recall the last spoken list, which had ended 2 s previously. The response screen included one empty box for each of the numbers that had occurred in the list, so the participant knew the list length. After the participant responded, a new set of pictures appeared and the primary task resumed. After the dual task session, the visual-alone task and then the auditory-memory-alone task were presented again.

*c. Adequacy of the Distractor Task.* Cowan, Nugent *et al.* (1999a) showed that memory for ignored speech yielded estimates of capacity that are constant across list lengths, yet change with age, as explained further below. The constancy of estimates across list lengths presumably was obtained because recall was based on information transferred, just after the response screen appeared, from a large-capacity sensory memory representation of the list to a limited-capacity focus of attention. There was no prior opportunity to convert the sensory memory to larger chunks of information before recall, so each retrieved item remained a separate chunk in the focus of attention and the number of items that could be retrieved therefore was determined by the capacity limit. That is the same interpretation given by Cowan (2001a) to procedures in which information must be gleaned from a rapidly presented, simultaneous array of characters, again producing a capacity estimate that is constant across set sizes (e.g., Sperling, 1960).

An alternative interpretation of the ignored-speech memory results, however, is that there actually is no memory for “ignored” speech per se and that the memory that we observed depended upon attention diverted from the primary, visual task. Such an interpretation would invalidate our measure of capacity. However,

countering this interpretation are several strong arguments that depend largely on data collected in three developmental studies with the rhyming task (Cowan, Nugent *et al.*, 1999a, 2000; Saults & Cowan, 1996). The patterns of performance for attended-speech and unattended speech trials differ considerably and the ignored-speech memory capacity estimate converges with results from very different, and varied, methods of estimating capacity (Cowan, 2001a). As a further argument against the attention-diversion hypothesis, shifts of attention to the speech channel, though they may occur occasionally, cannot account for several critical features of the results that we have obtained:

1. The auditory stimuli are highly repetitive, irregular, and presented every few seconds but cued for recall only every minute or so. The subjective impression is that it is almost impossible to train attention on the channel to be ignored while performing the visual task, just as one would expect from habituation of the orienting response (e.g., Sokolov, 1963; Cowan, 1988).

2. In all three studies, we have recorded the primary task reaction times and accuracies, and have included *primary-task-alone* control test phases just before and just after the ignored-speech session. These measures invariably show that, for each age group, performance in the initial primary-task-alone phase is nearly identical to primary task performance during the immediately following, first block of ignored speech; and although performance improves during the ignored-speech task, primary task performance during the last block of ignored speech is nearly identical to primary task performance in the immediately following, primary-task-alone phase. Thus, speech does not appear to shift attention away from the primary task. Reaction times decrease across age groups, as expected, but visual trials were self-paced and thus occurred commensurately faster in the older age groups.

3. In two studies, to test for possible trade-offs between tasks, we have examined within-age correlations between mean performance on the primary task and mean memory for ignored speech. These correlations are very small (and nonsignificant) for children and positive for adults. Neither result is consistent with the suggestion that participants trade off performance on the two tasks, which should produce a negative correlation. Similarly, the correlation between the primary task and memory performance on a trial-by-trial basis *within* an individual, in memory for ignored spoken lists (Cowan, Nugent *et al.*, 2000), is near zero for first- and fourth-grade children and is significantly different from zero in adults, but in a direction in which trials with better primary task performance also go along with better auditory memory. Perhaps adults in a more alert state can do both tasks better because alertness facilitates the process of retrieving information from sensory memory. At any rate, there is no evidence of a trade-off between tasks.

4. Finally, in all age groups, the pattern of forgetting (Cowan, Nugent *et al.*, 2000) was not what would be expected if the spoken digits were attended.

Initial and final serial positions showed considerable forgetting across retention intervals. That differs from retention across filled intervals in *attended* speech tasks, in which the good performance in the initial serial positions (primacy effect) remains stable across retention intervals (Jahnke, 1968). Thus, the typical pattern caused by attention is absent for the ignored lists. Moreover, the *age difference* in forgetting across retention intervals is restricted to the final serial position of the list, the only one at which there are no subsequent sounds to interfere with sensory memory (Crowder & Morton, 1969). Covert strategies of monitoring the ignored channel would have led to the prediction of an age difference more extensively across the list positions (and a trade-off between tasks).

*d. Results of the Memory Task of Cowan, Nugent et al. (1999a).* In the method of scoring used for the auditory memory task, credit is given only for items recalled in the correct serial position. The underlying assumption is that all nine digits become activated in memory, given that the response set consists only of these same digits. What actually constitutes an “item” in this task, therefore, is the association between items and serial positions in the list. These associations, or “bindings,” form an episodic record of the trial. The number correct is taken to reflect the capacity of the focus of attention.

The pattern of responding in the memory tasks is shown in Fig. 3. The dashed lines indicate memory for attended speech, which increased across list lengths

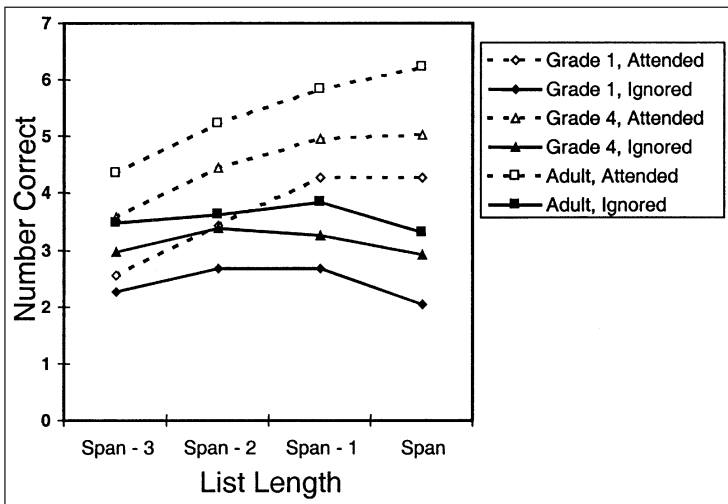


Fig. 3. Mean number of correctly recalled digits from attended lists (dashed lines) and unattended lists (solid lines) as a function of relative list length for participants in three age groups (graph parameter). Notice that the number correct is fixed across list lengths for the unattended lists, indicating a capacity limit that increases with age. Adapted from Cowan et al. (1999a).

(x axis) for all age groups (graph parameter). In contrast, the solid lines indicate memory for ignored speech, which was rather constant across list lengths. The age differences in the levels of these solid lines, which were significant, indicate that the capacity of memory increased with age. Also, the fact that the age differences in the attended-speech control condition were about the same size as age differences in the ignored-speech condition (true especially between Grades 1 and 4) suggests that age differences in span do not stem mainly from attention-demanding processes taking place during the reception of the list (e.g., rehearsal), in contrast to what is commonly assumed. (Rehearsal accounts were questioned also by Cohen *et al.*, 1985; Dempster, 1981; and Huttenlocher & Burke, 1976.) If attention during reception had played a major role, then age differences should have been substantially larger in the attended- than in the ignored-speech condition.

*e. A Difficulty-Insensitive Measure of Memory Capacity for Spoken Digits.*

The data shown in Fig. 3 illustrate that performance, measured as the number of items recalled in the correct serial position, was not affected much by the number of items in the list. In that figure, however, as in the experiment carried out by Cowan, Nugent *et al.* (1999a), the range of list lengths was adjusted according to the participant's ability in the attended-speech condition. Cowan, Nugent *et al.* also found a similar pattern when the data in the ignored-speech condition were categorized according to the absolute list length. Lists of four, five, and six items appeared in the data sets of most participants. A plot of the number correct for these list lengths, and for span-length lists, reveals that the developmental trend was approximately the same regardless of the list length (Fig. 4). This difficulty-insensitive developmental trend strengthens the evidence that the capacity changes across ages and

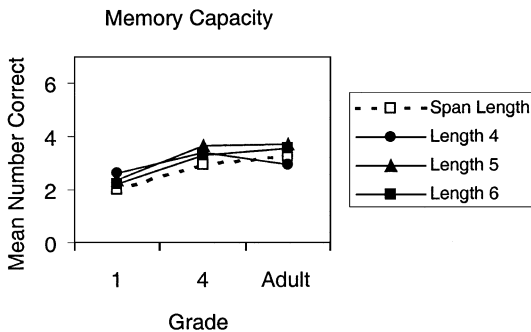


Fig. 4. Mean number of correctly recalled digits from unattended lists as a function of age for several list lengths (graph parameter) from the same data set as in Fig. 3. The irrelevance of list length for the developmental function shows that this is a difficulty-insensitive measure of capacity. After N. Cowan, J. S. Saults, L. D. Nugent, and E. M. Elliott (1999b), *The microanalysis of memory span and its development in childhood*, International Journal of Psychology, 34, 353–358. Copyright 1999, International Union of Psychological Science.

does not simply appear that way because of some complex interaction between the stimulus conditions and ability levels at different ages. The capacity measure is presumably difficulty-insensitive because, for these unattended spoken digits, capacity is limited to a fixed number of digit-to-serial-position bindings regardless of the number of digits present in the list.

## B. RETRIEVAL RATES

### 1. Introduction

The full understanding of performance in any memory task must take into account both the level and the rate (or timing) of performance. Yet, few studies of immediate recall have used timing measures because of the considerable tedium of measuring this timing. We have found it rewarding to do so. Cowan (1992) timed 4-year-old children's responses to correctly repeated lists, using a computer-based speech waveform editor to obtain the duration of each segment in recall in what may be the first such study of span recall timing. Neither the durations of *preparatory intervals* between the stimulus and response lists nor the durations of *words* in the responses provided a clear indication of the ability level of a child. However, durations of the *interword pauses* between words in the response did. As mentioned above, children with a higher span repeated lists of a particular length with shorter interword pauses in their responses. Cowan *et al.* (1994) found that a given list was repeated with longer interword pauses in 4-year-olds than in 8-year-olds.

The processes taking place during the pauses did not appear to include verbal rehearsal, inasmuch as the pauses were no different for lists of monosyllabic versus multisyllabic words (Cowan *et al.*, 1994), whereas covert verbal rehearsal would have been expected to take much longer for the multisyllabic words (Baddeley, 1986). However, the pauses within a particular individual's recall increased as a function of the list length and remained relatively constant across serial positions in the list. This suggested that the pauses reflect a sort of memory search process in which the entire list plays a role during each pause, during which the participant searches throughout the list for the word to be recalled next (not necessarily in a serial manner; for a parallel model see, for example, Ratcliff, 1978).

### 2. Findings of Cowan, Wood *et al.* (1998)

Cowan, Wood *et al.* (1998) reported results of a study of the timing of spoken recall in a digit span task in first-, third-, and fifth-grade elementary school children ( $N = 24$  per age group). This study focused on correlations between span and timing measures and demonstrated that age effects do not necessarily show the same pattern as individual differences. To see this, one must distinguish between the preparatory interval in recall (the relatively long silent period between the end of a stimulus list and the beginning of the first word in the response) and the



interword pauses (the typically shorter periods between words in the response). Within correct recalls at a particular list length, older children had markedly shorter preparatory intervals. Nevertheless, preparatory intervals were completely unrelated to span across all 72 children. (The age differences were not large enough to force that correlation.) In contrast, the interword pauses both decreased with age and correlated with memory span.

Cowan, Wood *et al.* also examined children's ability to repeat digits rapidly. Baddeley (1986) and others have found that this type of measure correlates with memory span. Most previous measures of rapid-speaking ability have involved the repetition of a small set of items over and over. However, we worried that such a measure confounds the time needed for speaking with the time needed for planning each cycle of the repetition. Therefore, we used a rapid-speaking measure in which the children simply counted from 1 to 10 once on each trial as quickly as possible and a measure in which a short list of one to four randomly ordered digits was presented for repetition once on each trial following a start signal (a tone) so that the planning period is separable from the speaking period. The same list was presented for six trials in a row in order to examine the role of memory in the rapid-speaking task, but essentially the same correlation between speaking rate and memory span emerged in each of the six repetitions despite large practice effects across repetitions. Digits span was correlated with tasks of counting 1–10 and repeating two-, three-, and four-digit lists.

Various authors have suggested models in which memory development can be traced to a change in the global rate of processing, which in turn is assumed to influence the rate of processing of various specific skills (e.g., Kail & Park, 1994; Kail & Salthouse, 1994; Fry & Hale, 1996). If that were the whole story, then there should be substantial correlations between interword pause measures and rapid-speaking measures, given that part of each measure would reflect a common global rate of processing. However, Cowan, Wood *et al.* (1998) found no correlations between these two measures, which picked up different portions of the variance in digit span. (The mean of 12 correlations was .07.) Together in a latent variable model presented by Cowan, Wood *et al.*, in which the two types of processing rates both are influenced by age and both contribute to span independently, they accounted for 60% of the total variance in span and 87% of the age-related variance in span. This model contained three latent variables: short-term memory retrieval duration, rapid-speaking duration, and span. The path coefficient from age to short-term memory retrieval duration was  $-.42$ ; from age to rapid-speaking duration,  $-.30$ ; from short-term memory retrieval duration to span,  $-.41$ ; and from rapid-speaking duration to span,  $-.49$ . These paths were significant but the path from age directly to span was nonsignificant (.17) within this model. Correlation between disturbances for the two latent variables for different kinds of rates was near zero, showing that they are unrelated. This model fit significantly better than a model with only one latent variable encompassing all of the rate measures. Thus, individuals

have different ability profiles, reflected in the two types of unrelated rate measures, that can result in equivalent memory spans.

The model was verified in a second experiment with 180 adults, using a different measure of rehearsal rate (covert repetition of the alphabet or the numbers 1–10 with the participant manually marking the beginning of each cycle of rehearsal) and memory-search tasks modeled after Sternberg (1966), in place of interword pauses, to measure short-term memory retrieval. These two types of measures correlated with span but not with each other and together picked up 30% of the adult variance. Thus, the pattern is not a fluke and has considerable conceptual validity.

In the simple model of Cowan, Wood *et al.* (1998), the two latent variables were identified as retrieval rate and rehearsal rate, concepts that seemed theoretically most reasonable at the time. However, we have subsequently questioned the popular notion (Baddeley, 1986) that the rapid-speaking rates reflect rehearsal. Various studies indicate that rehearsal develops late in the elementary school years (e.g., Flavell *et al.*, 1966; Henry, 1991; Ornstein & Naus, 1978). Cowan (1999b) carried out a reanalysis of the Cowan, Wood *et al.* (1998) data focusing on within-age patterns and found that the rapid-speaking rates correlated with memory spans within Grade 1, but not within Grades 3 or 5. This difference cannot be attributed to a greater sensitivity of correlations in Grade 1 because a very different pattern was obtained for interword pauses, which correlated with memory span in Grade 5, but not in the younger grades. The correlation between rapid-speaking rate and span at such a young age suggests that this rate reflects a verbal ability that is functional in first grade, such as the ability to plan or retain phonological materials (Gathercole & Hitch, 1993), rather than cumulative rehearsal.

The following analysis focuses on the durations of interword pauses and not on the durations of phonological processes. The evidence reviewed above provides assurance that these interword pauses reflect a specific retrieval process rather than a fully general speed of processing. As discussed above, the pauses increase with the list length but do not depend on the length of individual verbal stimuli and are uncorrelated with rapid-speaking ability.

Interword pauses that have been observed in various studies appear to be rather uniform across serial positions of the list (e.g., Cowan, Wood *et al.*, 1998). One might have expected that pauses would differ across serial positions if participants grouped the list items and repeated them with a timing indicative of the grouping boundaries (Anderson & Matessa, 1997). Perhaps that would be the case with adults, or with relatively long lists in children capable of recalling them correctly, although there still would be the problem of individual differences and list-specific differences in where group boundaries are placed. For the lists of digits that most of our children have recalled successfully, namely the two-, three-, and four-item lists, we have found no evidence of grouping. We have asked second-grade children about their recall methods and they make little or no mention of grouping, unlike adults, who usually report some type of grouping strategy. Therefore, the interword

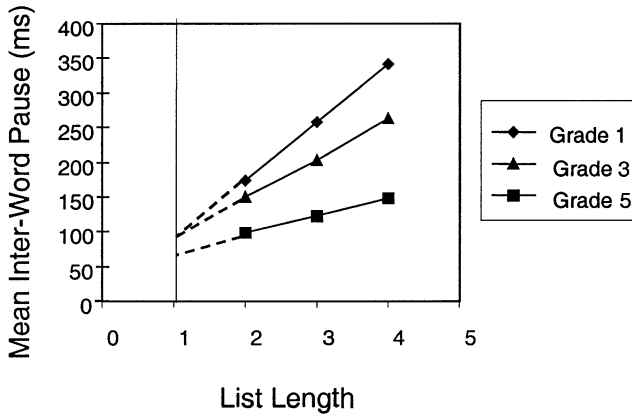


Fig. 5. Interword pauses as a function of list length for three age groups (graph parameter). From the data set of Cowan, Wood et al. (1998)

pauses for these list lengths appear to be relatively pure indices of a retrieval time with little contribution of grouping processes.

Figure 5 shows the interword pauses as a function of age and list length, for all children capable of correctly repeating lists of these lengths. This figure shows a very orderly pattern in which the  $y$  intercept of the performance function differs little with age but the slope of retrieval, as a function of list length, decreases systematically across age groups.

Figure 6 plots the same data in a different manner, with age group on the  $x$  axis and list length as the graph parameter. This allows the addition of a relative list

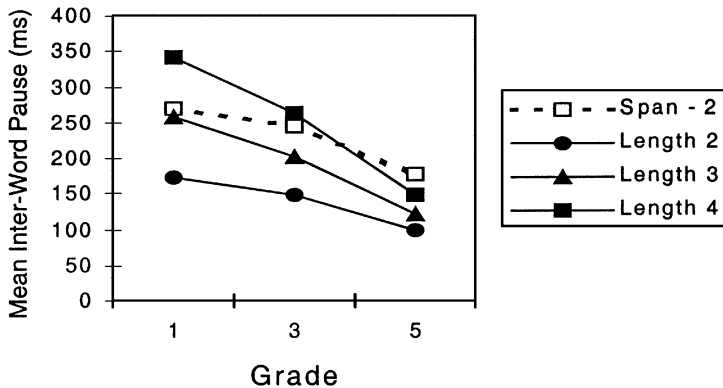


Fig. 6. Interword pauses as a function of age group for several list lengths (graph parameter), from the same data set as in Fig. 5. After N. Cowan, J. S. Saults, L. D. Nugent, & E. M. Elliott (1999b), *The microanalysis of memory span and its development in childhood*, International Journal of Psychology, 34, 353–358. Copyright 1999, International Union of Psychological Science.

length; only Length Span-2 included enough trials to form stable means. This figure shows that interword pauses per se are not a difficulty-insensitive measure inasmuch as they shorten across ages to an extent that strongly depends on the list length.

### 3. Supplementary Results: A Difficulty-Insensitive Measure of Retrieval Rate

Although interword pauses do not form a difficulty-insensitive measure, the results shown in Fig. 5 suggest that the slope of the search function is difficulty-insensitive. Thus, the amount of change in pause durations between two- and three-item lists, for any age group shown in the figure, is nearly identical to the amount of change between three- and four-item lists. That per-item increase or search slope can be interpreted as the speed of memory search, analogous to Sternberg (1966).

Given that the intercepts of the functions shown in Fig. 5 are small in absolute terms and differ little between groups, the search slope is by far the most important factor determining the duration of interword pauses. Consequently, one can get a nearly difficulty-insensitive measure by taking each mean pause duration shown in Fig. 6 and dividing it by the list length. The result is plotted in Fig. 7. Notice that, in contrast to Fig. 6, this per-item pause amount does approximate a difficulty-insensitive measure. The resulting measure changes with age in about the same way regardless of the list length. If the measure is taken as an estimate of the memory-search rate, the estimate clearly is similar to what has been found in studies of the development of memory search using probe-recognition procedures (e.g., Keating, Keniston, Manis, & Bobbitt, 1980).

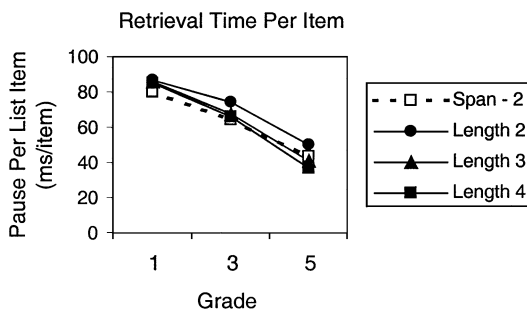


Fig. 7. Pause per list item, calculated by dividing the mean pause by the list length, for three age groups (graph parameter). From the same data set as Figs. 5 and 6. Notice that this derived measure is approximately difficulty-insensitive; the small, similar intercepts shown in Fig. 5 are necessary for this difficulty insensitivity to emerge. After N. Cowan, J. S. Saults, L. D. Nugent, and E. M. Elliott (1999b), *The microanalysis of memory span and its development in childhood*, International Journal of Psychology, 34, 353–358. Copyright 1999, International Union of Psychological Science.

### C. DECAY RATES

#### 1. Introduction

According to the theoretical framework of Cowan (1988,1995), various parameters of processing are interrelated. An example is the relation between rates of retrieval and decay. The relation depends on the description of short-term memory retrieval as a process in which information is drawn from an automatically activated source into the focus of attention. Given that the automatically activated memory representation of a stimulus is short-lived, the ability to retrieve information from that representation depends not only on the retrieval rate, but also on how long the activated representation lasts and how soon it is accessed.

#### 2. Findings

Saults and Cowan (1996) used an ignored-speech procedure to examine the forgetting function in children in Grades 1 and 3 and adults. Instead of digit lists, the stimuli were randomly presented repetitions of four isolated spoken words: *bee*, *tea*, *bow*, and *toe*. (These four words were helpful because they permitted a separate assessment of memory for consonants versus vowels, though the results were similar for both types of speech sound.) The participant played a silent computer game while ignoring random repetitions of these words presented through headphones with 1, 5, or 10 s between words. Most ignored presentations were never tested. However, occasionally (every few minutes), the computer game would suddenly be replaced by a response screen consisting of pictures of the four spoken words. At that point the task was to select the picture corresponding to the spoken word that had been presented last, 1, 5, or 10 s ago (the retention interval), presumably based on the sensory memory trace that can be lost during this time between the spoken word presentation and the recall cue.

Cowan, Nugent *et al.* (2000) considered that the developmental increase in memory persistence observed by Saults and Cowan (1996) might be attributed to differences in the effective memory load imposed by isolated words. For example, an isolated word is two items below span for a child with a span of three words, but four items below span for a child with a span of five words. We consequently adjusted the list lengths so that each child was tested with spoken lists of digits at a length equal to his or her own span (defined as the longest list that could be recalled, given that an integer value was needed). Participants were second- and fifth-grade children and adults. Lists were presented at a 0.5-s-per-item rate to maximize list continuity in sensory memory. The silent computer rhyming game of Saults and Cowan (1996) was again used for the primary task in the ignored-speech trials. Attended-speech trials, administered both before and after the ignored-speech trials, showed no loss of information about the spoken lists across retention intervals and no age differences. For ignored speech, averaged across all serial positions,

the auditory memory data showed a steep forgetting function across retention intervals, but no significant age difference in this forgetting function.

An age difference was revealed when performance at each serial position was examined separately. The expectation from previous research was that sensory memory should be most clearly revealed at the end of a list (e.g., Balota & Engle, 1981) because the last serial position is the only one not followed by additional acoustic stimuli that can cause interference with sensory memory. These analyses showed no age difference in forgetting except, as expected, in the final serial position. To illustrate this pattern in a simplified manner, Fig. 8 shows memory for ignored speech across retention intervals for just three of the serial positions. Although for the two groups of children the first and last serial positions were at similar levels of performance after 1 s, these serial positions show very different patterns across retention intervals. This difference was absent at the first serial position (left panel), as in all of the medial serial positions (e.g., middle panel), but was very clear in the final serial position (right panel). At this position, as shown in the figure, the adults were above the children at all retention intervals so that their forgetting functions could not be adequately compared to the children. However, the data clearly show that forgetting of list-final items was more severe in the younger children than it was in the older children. This result is the same as Sauls and Cowan (1996) found for isolated words. Again, the primacy effect shown for ignored lists (Fig. 8) differs from *attended* lists with a filled retention interval (Jahnke, 1968), which show substantial forgetting in the recency portion of the list but not in the primacy portion.

The findings lead to important points about age differences in memory. If those differences resulted primarily from the covert use of strategies during the presentation of lists that were supposed to be ignored, then these age differences would be expected to show up in the primacy portion of the serial position function, given the usual assumption that rehearsal strategies are used most at the beginning of a list (e.g., Atkinson & Shiffrin, 1968; Rundus, 1971). The occurrence of the age difference in forgetting in the final serial position only (see Fig. 8) appears to confirm the suggestion that what develops here is the persistence of auditory sensory memory or some other form of passively held memory activation. (Primacy effects in all age groups at a short retention interval can be attributed to the distinctiveness of items at either end of the list; see, for example, Nairne *et al.*, 1997.)

We have not yet conducted a study to examine directly whether the age difference in decay rate is difficulty-insensitive, although preliminary indications are encouraging. What is necessary to design a difficulty-insensitive measure is to formulate an objective rule that makes sense and that yields the same estimates of the magnitude of age-related change across a range of difficulty levels (i.e., in our studies, list lengths or set sizes). In the case of decay rate, the rule is to examine the proportion correct at the final serial position. If performance at

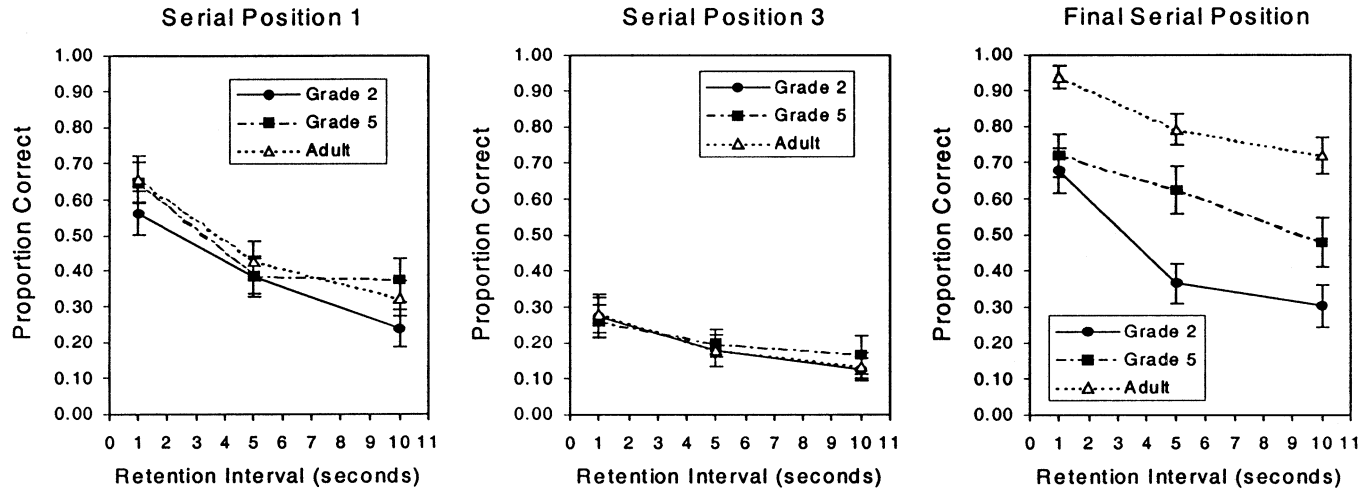


Fig. 8. Loss of memory for unattended digits within a list across retention intervals, selected here for illustrative purposes for Serial Position 1 (left-hand panel), Serial Position 3 (central panel), and the final serial position (right-hand panel) from the data set of Cowan, Nugent et al. (2000). Within each panel, age group is the graph parameter. Age differences in decay rates were obtained only at the final serial position.

this serial position turns out to be independent of the list length, the result performance will be difficulty-insensitive. If not, it may be necessary to formulate a more complex function to isolate the part of final-serial-position performance based on a sensory memory that is independent of list length, such as the proportion decrement in performance across retention intervals (see above).

### III. Conclusions, Observations, and Speculations

Working memory is a complex system of processes that retain information temporarily in the service of the performance of various cognitive tasks. Thus, Hulme and Roodenrys (1995, p. 374) aptly remarked that, in cognitive tasks such as language comprehension and mental arithmetic, “. . . it is obvious that a wide array of memory processes will be operating. Working memory is a convenient shorthand to refer to these processes and their functional importance.”

We have suggested that the development of this complex performance can be understood better by breaking it down into basic processes that can be studied in detail. One difficulty that complicates such an approach is that individuals' basic processes can be identified not from a single data point, but only from a *pattern* of results across several conditions. One typically is faced with an unfortunate choice between comparing children's patterns of performance across ages on comparable stimuli, but at different levels of performance, or on stimuli that are not comparable because they have been individually adjusted to match performance levels. Neither option may yield a fully interpretable developmental comparison. We have suggested, though, that difficulty-insensitive measures might be derived, using theoretical considerations, for at least three basic types of parameters of working memory: capacity limits, retrieval rates, and decay rates. For these measures, which presumably reflect the underlying processes of interest, estimates of developmental change can be obtained that are stable across a range of difficulty levels of the stimuli.

Nevertheless, a number of important questions remain unanswered. We end by examining these questions and giving tentative answers to them.

#### A. ARE THERE TRULY DIFFICULTY-INSENSITIVE MEASURES OF WORKING-MEMORY PARAMETERS?

We have manipulated difficulty level in a very specific way, by altering the lengths of lists or the set sizes of arrays of to-be-remembered stimuli. Difficulty could be manipulated in other ways. For example, word frequency and word length both influence the level of recall and one could ask whether the three parameters we have examined are constant across levels of difficulty defined by such manipulations as opposed to manipulations of list length.



Answering this question is not easy. One first must ask whether any particular manipulation of difficulty preserves the conditions under which the parameter estimate theoretically can be derived. For example, the capacity parameter can be derived only if each item is an independent, single chunk of information. Recall of nonwords is poorer than the recall of words but that difficulty manipulation does not preserve the appropriate conditions, inasmuch as each nonword (or, say, a word with which the participant is unfamiliar) may be represented in memory as a collection of subitem parts rather than as an integrated, lexical item or single chunk.

Another possible scenario is that a parameter estimate could change with a change in the difficulty of the stimulus set because that parameter underlies the change in difficulty. Once more a word/nonword distinction is relevant. Hulme *et al.* (1999) found that interword pauses are shorter for lists of words than for lists of nonwords. One possibility is that this difference occurs because nonwords are not single, integrated units in memory (as mentioned above), in which case the effective list length is higher than the nominal list length and is unknown. Even if each nonword were, in some sense, a recently stored single unit in memory, the time needed to make contact with such nonword units in memory might be longer than the time needed to make contact with real words because of insufficient long-term memory support for the nonwords. This would be expected to affect memory-search time, altering the durations of interword pauses; and it would be possible that this difference in memory-search time could cause a difference in memory span. As another example, if stimulus items differed in their consonants but not their vowels in an unattended-speech procedure, this should increase the amount of memory decay relative to a situation in which vowel variation was included (Cowan, Lichty, & Grove, 1990). The poorer performance with no vowel variation could indeed be attributed to the decay of sensory information in the sense that less redundant, more fragile sensory information is available to work with in the first place.

What is one to conclude given such examples? Essentially, if a manipulation (such as list length) produces difficulty-insensitive measures, these measures can be used to make developmental comparisons. However, many factors can cause a manipulation to fail to produce difficulty-insensitive measures, and the existence of such cases does not invalidate the logic of difficulty-insensitive measures in general.

#### B. WHAT ARE THE RELATIONS BETWEEN THE STUDIED WORKING-MEMORY PARAMETERS?

One simplistic view would be that the capacity, retrieval, and decay parameters that we have observed are three independent influences on recall. We would caution that they may not be independent from one another. Perhaps not all of the parameters are causally related to memory; one might be causal and another

a noncausal correlate of the first. We have not yet examined this question directly but certain evidence may have a bearing upon it.

Cowan (1998) suggested that capacity contributes to memory span, whereas retrieval speed may not and may instead be another consequence of capacity. The finding underlying that proposal was that the mean interword pauses in serial recall were the same in 4- and 8-year-olds when examined at each age for span-length lists. However, the same pattern does not necessarily hold up in older children. Figures 6 and 7 show that pauses within responses for lists of length (span-2), or 2 below maximal span, seem to speed up across age groups from third to fifth grades. From the same data set (Cowan *et al.*, 1998, Experiment 1), we found that pauses within responses for lists of length (span-1) were longer for 22 children with a maximal span of 5 ( $M = 341$  ms,  $SD = 186$ ) than for 34 children with a maximal span of 6 ( $M = 279$  ms,  $SD = 179$ ). (More complete data, for longer lists within this experiment, were not estimated, partly because there are few trials for maximal-span-length lists.) Thus, adjusting list length for ability does not eliminate the speed differences in recall. Another relevant consideration is that Cowan (1999b) found that fifth-grade (10- to 11-year-old) children had shorter interword pauses than third-grade children, even among a subgroup with spans matched across ages.

These results suggest that interword pauses and the retrieval rates that they estimate are, at best, indirectly related to memory span. If capacity were the cause of memory span changes, we would predict that interword pauses would not be directly related to capacity measures either. The predominant role of capacity is reasonable inasmuch as Cowan, Nugent *et al.* (1999) found a fairly strong correlation between memory for attended digits and memory for ignored digits,  $r = .52$ . We have not yet examined direct correlations between difficulty-insensitive measures of retrieval rates and difficulty-insensitive measures of memory capacity, so we cannot definitively say whether they are independent.

Although we are proposing that retrieval rates do not directly influence spans, they may have an indirect influence. For example, sufficiently rapid retrieval rates may permit the use of a more mature strategy such as grouping of items together in memory, though rapid retrieval would not guarantee that the mature strategy would be used (Cowan, 1999b).

Capacity, retrieval rate, and decay rate all seem to change with age. For this reason, theoretically speaking, they must be correlated with one another; but it is unclear if the correlations would persist with age partialled out. Even if the measures were correlated within an age, more work would be needed to determine the paths of causality.

### C. WHAT ARE THE BASES OF DEVELOPMENTAL CHANGE IN THESE WORKING-MEMORY PARAMETERS?

One could make a case for either biological or environmental factors leading to age changes in the parameters we have examined. Regarding biology, it has been

proposed that frontal-lobe structures underlie working memory (for reviews see Engle, Kane, & Tuholski, 1999a; Nelson, 1995). However, the type of mechanism that may be reliant on the frontal lobe is the control of attention. Less certain are the biological structures that underlie the parameters of working memory that we have examined. Cowan (1995) provided rationales for the proposal that the focus of attention (and hence, by implication, its capacity) depends heavily on the inferior parietal areas, whereas decay of sensory information probably depends on the sensory cortical areas. Retrieval speed may depend on language-production-related parts of the frontal lobe.

Regarding environmental factors, one could argue that the greater familiarity with stimulus materials accumulated across ages in childhood underlies age differences in measured parameters. Less familiar materials could result in a lower capacity, longer retrieval times, and faster decay than more familiar materials. We have only one piece of evidence contradicting that interpretation at present. Cowan, Nugent *et al.* (1999a) noted that children receive much more exposure to the digits 1–3 than to the digits 7–9, yet there were no differences at any age in the recall of digits 1–3 versus 7–9. Perhaps, when very familiar materials are used, there is a ceiling level beyond which familiarity plays no role. Given that the target items in the studies discussed above were digits (or, in one case, simple colors to be matched), familiarity probably played only a small role, if any, in these results. Thus, the present results are at least promising as potential behavioral indices of biological, neurological change in working memory systems.

#### D. HOW SUCCESSFUL ARE THESE WORKING-MEMORY PARAMETERS IN ACCOUNTING FOR HIGHER LEVEL COGNITION?

Daneman and Carpenter (1980) and Daneman and Merikle (1996) suggested that the complex span tasks, in which processing and storage requirements are imposed simultaneously, are much more successful than simple span in accounting for various measures of achievement and aptitude because they tax both processing and storage components of working memory. Complex span tasks are more successful, but the reasons are not yet clear. Engle *et al.* (1999a) suggested that the storage plus processing requirement taxes the ability to control attention, whereas Towse *et al.* (1998) argued that, at least in children, it is the longer duration for decay, not task difficulty, that is important in complex span tasks.

More complex span task results may correlate with achievement and aptitude measures well because they reflect a variety of simpler skills, each of which contributes a smaller but at least partly nonredundant correlation with achievement and aptitude tests. If a simpler, more basic parameter is found to correlate with complex tests, therefore, it is in principle more impressive.

We do not yet have tests of the relations between the difficulty-insensitive measures and tests of intellectual achievement or aptitude. However, Mukunda and Hall (1992) provided some important evidence that has been largely ignored in this

debate. Their meta-analysis examined 11 different measures of short-term memory for stimulus order and the relation of these measures to achievement and aptitude measures. The overall relation of achievement and aptitude tests with forward digit span (among 108 experiments) was modest,  $r = .20$ . The correlation of such tests was higher with reading span (among 21 experiments),  $r = .33$ , and counting span (among 4 experiments),  $r = .30$ , as other working-memory theorists have noted. However, differing from what working-memory theorists have suggested, it was even higher for running memory span (among 21 experiments),  $r = .34$ . The highest relation was found among 9 experiments in which a list of nine digits was presented and a probe indicated whether the first, middle, or last three digits were to be recalled. For these three recall probes the correlations were  $r = .23$ ,  $.19$ , and  $.45$ , respectively. Notice that the condition in which the last three digits are to be recalled—the one in which a large correlation with achievement and aptitude tests was found—is similar to what occurs in running memory span. Because running span (or, alternatively, long lists of a fixed length) may make it impossible to keep track of where one is in the list, items cannot be chunked together and recall may therefore estimate the memory capacity (Cowan, 2001a).

Thus, the memory capacity parameter may be important for success on applied tests of achievement and aptitude. We do not yet understand the causal paths between memory capacity, controlled attention, and decay. A large capacity may make it easier to control attention, thus accounting for performance on both complex span tasks and running memory span tasks (and, presumably, on other tests of capacity such as the ones described in this chapter). Theoretically, the converse is also possible: better control of attention may allow better performance on capacity tasks. Specifically, perhaps participants with better control of attention are able to use attention to do some helpful encoding of items in long lists or in unattended lists, whereas other participants cannot do so and must rely only on a sensory memory of the list items. We find this to be an important question to be examined in future research.

#### E. WHAT ARE THE IMPLICATIONS FOR OTHER MODELS OF WORKING MEMORY AND ITS DEVELOPMENT?

The present finding of developmental change in three parameters of information processing related to working memory clearly is consistent with the theoretical framework offered here (depicted in Fig. 1). However, it does not necessarily rule out versions of other, popular modeling frameworks, some of which are even compatible with the present approach and complementary to it. It does place constraints on what must go into models of working-memory development. We examine this for four distinctly different approaches: (1) versions of Alan Baddeley's model of working memory; (2) general processing-speed approaches; (3) M-space models; and (4) the approach promoted by Randall Engle and his colleagues, in which

emphasis is placed on the efficiency of controlled attention. We then will suggest (5) that the most important application is a metatheoretical and methodological one: that the field would be well-served if other theorists were to search for difficulty-insensitive measures of the parameters important for their models.

### 1. *Baddeley's Working-Memory Models*

One no longer can maintain a model in which all parameters except one remain fixed. In the hypothesis of developmental change in verbal working memory offered by Baddeley (1986), the change was attributed solely to an increase in the rate of rehearsal processes with development in childhood. According to that notion, if rehearsal were blocked, no developmental difference should be observed. Yet, developmental differences in capacity were observed in situations in which the stimuli were unattended at the time of their presentation (e.g., Cowan, Nugent *et al.*, 1999a).

Baddeley (1986) assumed that the rate of decay of phonological memory stayed constant across ages, in contrast to what Cowan, Nugent *et al.* (2000) found for the final serial position of a list. However, it would be possible to advocate a developmental change in decay rate without requiring a change in the basic components of Baddeley's model, just a change in one assumption about development in the model. This is especially easy to imagine given that Gathercole and colleagues (e.g., Gathercole *et al.*, 1992) have considered the quality of information in phonological memory to be an individual-difference characteristic that is related to later vocabulary development in childhood. Auditory memory decay could account for the individual differences in their task (in which spoken nonwords of varying lengths are to be repeated) and for developmental changes in this task.

Moreover, the discrepancy regarding storage capacity may not apply to a more updated version of Baddeley's view. According to Baddeley (2001), a newly specified component of working memory, the episodic buffer, could be limited in the number of chunks that can be held at any moment. That chunk limit possibly could change with age.

### 2. *The General Processing-Speed Model*

It has been suggested that developmental change might be accounted for by an increase in a general speed-of-processing parameter (e.g., Fry & Hale, 1996; Kail & Salthouse, 1994; Salthouse, 1996). This hypothesis is not necessarily inconsistent with the finding that there are developmental changes in the capacity, retrieval rate, and decay rate. After all, we have not ruled out the possibility that all of these parameters depend on speed of processing. The faster information is processed, the more information might be kept active at once (Baddeley, 1986). However, the notion that a speed of processing is general seems at odds with the finding that retrieval rate and articulation rate are separate and uncorrelated with one another, even though both of these rates are correlated with memory span

(Cowan *et al.*, 1998) and begin to relate to memory span at different times in child development (Cowan, 1999b).

What this type of finding indicates is that one cannot rely on a one-dimensional notion of normal developmental change in working memory. Instead, one must adopt the notion of different individual profiles in development. One child might do fairly well in a memory span task because he or she has a fast retrieval rate, even though the articulation rate is relatively slow. Another child might do equally well because of a fast articulation rate (allowing rehearsal or some sort of covert phonological coding), even though retrieval is slower. This notion of individual profiles will be even more important if there prove to be only weak correlations between capacity, retrieval, and decay rates, in which case they all could contribute to different individual styles of cognition related to working memory.

### 3. *M-Space Models*

Pascual-Leone (1970) presented a complex model that depends primarily on a capacity limit to explain developmental differences. In this model, the number of storage slots or “M-space” was said to increase with development in childhood, allowing more data storage and, consequently, increasingly complex problem solving. One might assume that the present evidence of retrieval rates or decay rates falls outside of the model but that is not the case. The model allowed for differences other than M-space. Pascual-Leone (2000, p. 143) stated, for example, that “Perhaps as a function of real time, the activation weight  $W$  of schemes will decay when they are outside of the M-space. . . This mechanism might exist, but it would be very hard to separate experimentally from the previous two [interruption and inhibition of irrelevant schemes, and interference between schemes].” (For further details, see also Burtis, 1982; Morra, 2000.)

The present approach does differ from Pascual-Leone’s approach in the particular value offered for capacity. In his commentary upon Cowan (2001a), Pascual-Leone (in press) suggested that the true estimate in adults is about seven chunks and that Cowan’s estimate of approximately a four-chunk capacity in adults does not allow room for operations needed in the task. Cowan (2001b) replied that, in the types of tasks used to measure capacity, the assumption was that the tasks have become automatic ( Shiffrin, 1988) and therefore do not require capacity. However, both views agree that capacity can increase with age.

Robbie Case is usually credited with the notion that it is not necessary to propose an actual change in M-space with age in childhood. Instead, it could be that operational schemes become more efficient as the child matures and therefore release more and more space that can be used for data storage, resulting in the observed increase in M-space. (Later writing suggests that Case actually favored a theory in which capacity does change; see the review by Case, 1995.) We believe that the present evidence does support a true change in capacity. In the task of Cowan, Nugent *et al.* (1999), described in detail above, participants ignored the sounds

while carrying out a silent computer task and then, at the time of the memory test, attended to nothing but the sensory memory representation of the last ignored list. There was no manipulation of information and the only operation necessary was to use the keypad to record the items in this list. We demonstrated that there was no developmental difference in the effects of using a keypad as opposed to a spoken response and that differences in the familiarity of the digits probably could not account for the developmental difference. Developmental differences also have been obtained in our laboratory using the procedure of Luck and Vogel (1997), in which the participant simply must compare two fields of colored spots presented in succession and determine if one color (at a cued location) has changed. Again, this task does not seem to have the operational complexity and novelty of the tasks that have been used to examine M-space. An alternative account of the discrepancy is that the M-space tests used by Pascual-Leone and Case allowed for some degree of chunking or memorization of the stimuli. This is the same explanation that Cowan (2001a) offered for why the ordinary memory span reaches about 7 items in adults. Without the notion of chunking and memorization, it would appear that the M-space theorists would have to postulate that memory span indicates an M-space of 10 items or more in adults!

Kemps, de Rammalaere, and Desmet (2000) and several following commentaries compared the theories of Baddeley and Pascual-Leone. Kemps *et al.* obtained data that favored Baddeley's theory in some ways (in the need for a developing phonological loop component) and Pascual-Leone's theory in other ways (in the increase in visual memory that could not be accounted for through the improvement of rehearsal speed or the phonological loop). This type of approach suggests a limit to how much parsimony can be espoused and that a reliance on more than one basic parameter may be necessary to explain developmental change and individual differences. Given the difficulty in selecting among established theories on the basis of the complexity of the evidence (as seen in Kemps *et al.* and following commentaries), we believe that it makes sense to investigate the basic parameters, as we have been doing, and the relations between them, as we have just started to do, before settling on an overall model of working memory and its development.

#### 4. Engle's Controlled-Attention Approach

As noted above, Engle and his colleagues (Engle *et al.*, 1995, 1999a, 1999b) have shown unequivocally that working memory depends quite a bit on the quality of the control of attention. They have not extended this work to childhood development but such an extension would be easy to imagine, given ample evidence that the neurological tissue underlying the executive control of attention continues to develop throughout childhood (Rabinowicz, 1980; Yakovlev & Lecours, 1967).

In the present approach, there is no attempt to deny or reduce the importance of the control of attention in working memory. However, the question of whether

one of our parameters that changes with age actually may relate to attentional control is inadequately resolved. Tuholski, Engle, and Baylis (2001) provided one type of evidence that capacity and attentional control are not related. They examined working memory tasks and also subitizing, the ability to determine how many objects are in a field by processing the objects rapidly, in parallel. It is typically found that people can subitize (as opposed to counting the objects) only if there are four or fewer objects. Tuholski *et al.* obtained very little variability among individuals in this task and little difference between high versus low working memory span individuals. However, commentaries following Cowan (2001a) suggest that subitizing limits may occur for reasons unrelated to capacity *per se*. Thus, studies like that of Tuholski *et al.*, but using other measures of capacity, are needed. As mentioned already, one measure that appears to reflect capacity, running memory span (Cowan, 2001a), may have a correlation with complex tasks as high or higher than working memory span tasks have (Mukunda & Hall, 1992). In short, the issue of the relation between attentional control and capacity is not yet clear.

For someone taking the attentional-control position, a fundamental issue for future research is whether attentional control is an ultimate, basic cause of individual differences or is a product of some other, more basic mechanisms. One possibility that cannot be dismissed is that early differences in capacity, occurring before children have very sophisticated means of strategic attentional control, eventually produce lasting differences in attentional control. Alternatively, the concepts of capacity and attentional control could be solely independent. Capacity appears to be related to performance on simple span tasks at  $r = .5$  or higher (Cowan, 2001a), but it is not yet clear if capacity is related to higher level tests of aptitude or achievement.

##### 5. *Future Applications of the Difficulty-Insensitive Measurement Approach*

This chapter provides only a beginning toward the enterprise of finding difficulty-insensitive measures that can serve as quantitative estimates of parameters of processing. One limitation of the work so far is that it has defined the difficulty level in terms of the number of items to be recalled. It remains to be proven that the developmental estimates are stable across different types of materials, although Cowan (2001a) did show stability for the capacity parameter across a wide variety of procedures in adults.

It seems likely that the three difficulty-insensitive measures that have been examined here are not the same ones that will be important for other investigators. What is critical is for other investigators to find a way to obtain difficulty-insensitive measures of whatever parameters are most important for their approaches. That should not be too difficult for approaches in which a quantitative approach already is used, such as the M-space hypothesis (Pascual-Leone, 2000). For such an approach, simply manipulating the memory-set size could test difficulty insensitivity.



In Alan Baddeley's approach, the limit on how much can be recalled (amounting to how much can be said in about 2 s) is a type of difficulty-insensitive measure of articulatory rate; it emerges similarly for lists of short and long words (Hulme & Tordoff, 1989; Schweickert, Guentert, & Hersberger, 1990). However, these studies show that the constant is not applicable to phonologically similar words in the same way. Schweickert *et al.* took this as evidence for an effect of the phonological similarity of materials on the decay rate, thus advocating an interaction between two potentially difficulty-insensitive parameters (decay rate and articulatory rate). However, difficulty-insensitive measures of other parts of Baddeley's model may not have been derived or considered in much detail.

For central executive processes (Baddeley, 1986) or attentional control (Engle *et al.*, 1999a, 1999b), the concept at first seems too complex to be separated into basic parameters. However, Miyake *et al.* (2000) suggested that attentional control is not a unitary concept, but rather a combination of several partly independent mechanisms including mental-set shifting, information updating and monitoring, and inhibition of prepotent responses. Working with such concepts, if they do prove to be independent, one might be able to derive difficulty-insensitive measures of each mechanism.

Last, we acknowledge that the notion of difficulty insensitivity may only apply within certain bounds. As an example, we do not know if the forgetting rates for visual and auditory sensory information are identical, although Cowan (1988, 1995) argued that they may be; the often-seen difference between auditory vs visual memory may reflect better temporal vs spatial encoding, and forgetting rates for simple materials appear to be quite similar. For certain parameters, however, it may be necessary to specify the materials or situations to which the parameter estimates apply. As a simple example, one cannot talk of a threshold intensity for detecting a tone without specifying the frequency of the sound for which hearing is to be measured. Similarly, we might end up having to speak of the capacity limit as applicable to various materials generally but not to materials that can be processed by a special linguistic module, should it exist (Caplan & Waters, 1999), or, say, of a memory-updating process that depends on the quality of the corresponding long-term memory representation of the materials to be updated.

Nevertheless, such constraints only help to define what appears to be a powerful approach to understanding developmental change: an approach in which, at different points in development, difficulty-insensitive measures of theoretically important processing parameters are derived. Such measures not only help us describe developmental change, they help us quantify it.

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# CULTURE, AUTONOMY, AND PERSONAL JURISDICTION IN ADOLESCENT–PARENT RELATIONSHIPS

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## I. Introduction

The balance between autonomy and authority is very much on the minds of parents. Consider the following responses about autonomy and authority, obtained through semistructured interviews with African American mothers of middle adolescents:

We don't have to talk about the limits. We just talk about his newfound freedom within the limits. Things that he thought he couldn't do or things that he's not sure as to how far he can go. . . you want to make sure that you have parameters for your children. You want to make sure that, number one, they understand that you trust them, but you want them to understand where the line stops. How far that can go. Once you have the security of knowing that they really do know and they respect those limits, then you leave it up to them to keep those limits in place or to explore them further. . . Then you step back and really let him do things. (mother of a 14-year-old African American male)

Just because he is 16 doesn't absolve me of my responsibility [to set limits]. Because as children, I believe they need guidance. Even adults sometimes still need someone to guide them. And if I am not doing that, then he may become another statistic. Kids committing crimes. . . So I try to be James's friend as well as his mother.

*How do you decide when to be firm and set limits?:* It all depends on the issue. Some fights are worth fighting. Some are not. You just let it go. I try not to stress myself out too much about things that won't have a final impact on his life. . . some things like the way he dresses I don't think that has an impact. . . I encourage [independence] because there's no guarantee that I am going to be around. I encourage respectful independence. . . Because as I indicated earlier, I believe he needs to be a free thinker. And I try to stop thinking for him so much. . . he should be allowed, within limits, to decide who his friends would be. . . what clothes he will wear. . . what job he's going to work. . . But he also should understand that he's still a kid. . . And 'til I'm gone, he'll still be my baby. (mother of a 16-year-old African American male)

I guess the hottest issue in our house is the issue of freedom. And the freedom to—she thinks she should have more freedom to do whatever she wants to do. I think that's part of getting older—the need to have freedom. . . we think it's important that freedom comes with responsibility. . . We believe that the scripture has a lot to say about life and how we should live our lives. And so that really informs how we set guidelines for her. . .

*Do you encourage her independence?:* Well, I think it's sort of an ambivalent feeling because in one sense you want her to be independent, but in another, you don't want her to become so independent that she feels like she can be rebellious. . . So it's like you want to strike a harmonious balance where she knows that being independent is good, but it's also good to be interdependent and to never feel like because you have enough money, you can be on your own and be self-relying and never depend on anyone else. . . We all need other people, and we need other people's advice and fellowship and friendship, and that's important. . . And I think we want her to be independent but receptive and teachable. (mother of a 14-year-old African American female)

Each of the mothers just quoted asserted the importance of allowing adolescents some independence, but they also maintained the importance of parental limits. Indeed, these brief excerpts illustrate how mothers coordinated their beliefs about

their adolescent's developmental needs for independence with their beliefs about the ongoing need for rules and guidelines and their needs to sustain connections with family and friends, preserve links to cultural and religious traditions, and respect parental authority.

This chapter provides an integrative theoretical framework and supporting empirical evidence for understanding these issues. The chapter focuses on the interplay between autonomy and authority as conceptualized in my research and in the research and theorizing in cultural and developmental psychology. The chapter begins with a description of several divergent perspectives on the role of culture in development. This research suggests that researchers need to treat individuals' orientations toward autonomy and authority as heterogeneous within cultures rather than considering individuals to have homogeneous orientations that vary across cultures. This claim is elaborated by considering the findings from several different lines of research. First, I discuss research on adolescent–parent conflict. A theoretical perspective for understanding adolescents' and parents' divergent views of conflict is presented, and research examining adolescents' and parents' interpretations of conflict using diverse samples of adolescents and parents is discussed. Next, investigations that have examined children's and parents' beliefs about autonomy and authority are reviewed and related to broader developmental and cultural concerns with these issues. The chapter concludes with an examination of current conceptualizations of autonomy drawn from culture theories and research on adolescent development.

## II. Cultural Views of Autonomy and Authority

### A. INDIVIDUALISM AND COLLECTIVISM

The issues of autonomy and authority described in the examples above—framed in somewhat different ways—have been central in recent debates about the role of culture in development. For instance, in one currently popular characterization, cultures have been described in terms of the global dimensions of individualism and collectivism (e.g., Markus & Kitayama, 1991; Markus, Mullally, & Kitayama, 1997; Shweder, 1990; Shweder, Goodnow, Hatano, LeVine, Markus, & Miller, 1998; Triandis, 1995). According to this view, individualistic cultures like those in the United States, most of Europe, Australia, and New Zealand promote a view of the self as separate from others and from the larger collectivity and as autonomous and bounded. Individualistic cultures are said to stress self-sufficiency, the attainment of personal goals, autonomy, and detachment from others. Elaborating further, Markus and Kitayama (1991; see also Marcus *et al.*, 1997; Shweder *et al.*, 1998) have proposed that individualistic cultures promote the development

of independent construals of the self. This entails a view of the self as separate from the social context, unique, and valuing the achievement of personal goals, needs, and rights. Individualistic societies are said to emphasize the autonomous self at the expense of collective goals.

Some social commentators have gone further, viewing this trend toward individualism as an alarming symptom of societal disintegration. For instance, in *Habits of the Heart*, sociologist Robert Bellah and his colleagues (see Bellah, Madsen, Sullivan, Swidler, & Tipton, 1985) have asserted that mainstream American society is embracing a form of radical individualism that is characterized by isolation, separation, and a focus on personal fulfillment over the needs of the larger community.

In contrast, collectivist cultures, which are seen as the norm worldwide and as predominating in much of Asia, South America, and Africa, are described as oriented toward authority, tradition, and duty and as stressing interdependence and harmony in interpersonal relationships. Collectivist cultures also promote interdependent construals of the self, which are described as entailing connectedness with the social context, indirectness in social interactions, a focus on statuses, roles, and relationships, and a concern with fitting in and promoting others' goals (rather than promoting personal goals). Thus, collectivist cultures are said to stress the subordination of individual goals to the needs of the larger group or society. In contrast to individualistic cultures, collectivist cultures are said to stress more harmonious social relations, resulting in the accommodation of the individual to society.

These distinctions between individualism and collectivism have been crystallized in a recent synthesis that describes essential differences in how cultures define relatedness to others (Rothbaum, Pott, Azuma, Miyake, & Weisz, 2000). According to Rothbaum *et al.* (2000), individuals' biological predisposition toward relatedness is interpreted through different cultural lenses, which lead to different developmental pathways. One pathway emphasizes individuation. Predispositions toward relatedness come into conflict with the needs for separation and autonomy; this is termed the path of generative tension. In contrast, the other lens emphasizes the accommodation of the self to others; this is termed the path of symbiotic harmony.

## B. HETEROGENEITY IN CULTURAL ORIENTATIONS

These descriptions have usefully focused attention on the ways that individuals in different contexts actively construct meaning from their social interactions. However, they have been criticized as providing an overly broad, even stereotyped, view of culture; some have questioned whether cultures really are quite as monolithic, homogeneous, internally consistent, and externally distinctive in their orientations as these views suggest (Harkness, Super, & Tijen, 2000; Hermans & Kempen, 1998; Nussbaum, 1999). Indeed, Strauss (2000) has noted

that while such dichotomous characterizations are gaining increasing prominence among developmental psychologists, they have been overwhelmingly rejected by the majority of cultural anthropologists, who have become wary of “stark ‘great divide’ contrasts” (Geertz, 1994, p. 3) that lump all of Asia, Africa, and Latin America into a single category and then compare the “West versus the rest.” In response, some researchers have acknowledged that although individualism and collectivism represent ideal types, in actuality cultures may vary along a continuum (Greenfield & Cocking, 1994). Different cultures may strike different balances between individualism and collectivism, with elements of both evident to varying degrees in different societies (Killen & Wainryb, 2000).

Others have gone further and have proposed that cultures should be characterized in terms of the heterogeneity of orientations of individuals within cultures. One type of heterogeneity has been described as arising from the particularity of individuals’ social positions and locations (both physical and social) within societies. Differences in ethnicity, gender, social class, education, religion, and ideology all have been proposed to lead to different social experiences, which in turn, may have different psychological effects (Harwood, Scholmerich, & Schulze, 2000; Strauss, 2000). In this view, the notion of culture can be parsed into smaller cultural communities that share some sets of common characteristics, leading to similarities in orientations among its members. This perspective leaves intact the notion of a dominant cultural orientation but calls into question how broadly that orientation can be applied. Thus, heterogeneity results from the many ways in which societies (and individuals within societies) differ and are stratified. This approach has left unresolved the potentially problematic issue of how broadly or narrowly to define a cultural community, which can be based on special interests (like playing soccer or following the Grateful Dead), as well as on broader social categories like ethnicity or gender. Recognizing that such pluralism can potentially lead to an endless proliferation of cultural communities, proponents of these views also uphold the notion that there are some overriding intrasocietal similarities in patterns that result from the shared economic, political, and social environments (Strauss, 2000).

Another approach to defining heterogeneity, and the one adopted here, is to locate the source of heterogeneity within individuals rather than societies. Proponents of this approach have proposed that individuals across cultures develop heterogeneous orientations that entail the coexistence of different kinds of concerns (Killen & Wainryb, 2000; Nucci & Turiel, 2000; Turiel, 1998, *in press*; Turiel & Wainryb, 2000; Wainryb, 1997). As the examples at the outset of this chapter illustrate, individuals—in any culture—may value autonomy while at the same time stress the importance of maintaining traditions and group goals; they may be collectivist in some situations and individualistic in others and may seek the fulfillment of personal goals (although perhaps covertly), even while upholding society’s demands for conformity.

This position has developed from two very different sets of observations. One is an emerging trend in cultural anthropology away from viewing cultures in terms of their coherence and consistency (and uniform orientations, such as those implied by individualism or collectivism) and toward viewing cultures in terms of their diversity, oppositions, and conflicts (Abu-Lughod, 1993; Holloway, 1999; Nussbaum, 1999; Strauss, 1992). A number of anthropologists have begun to describe individuals within cultures, including traditional ones, in terms of their conflicts, struggles, and attempts to transform social practices or how cultural understandings “may be conflicting, contested, and resisted by members of society” (Holloway, 1999, p. 61). In elaborating this argument, cultural psychology has been said to have focused too much on individuals in dominant positions to the neglect of individuals in subordinate positions (Turiel, 1999; Turiel & Wainryb, 2000). In turn, the focus on individuals at the bottom of the social hierarchy has revealed that what are seen as dominant cultural orientations may be questioned or contested by those not in power (Nucci & Turiel, 2000; Turiel & Wainryb, 2000). Thus, several recent ethnographic accounts have described in detail the covert processes that women in traditional societies, including women in Moroccan harems (Mernissi, 1994) and in polygeneous Bedouin societies (Abu-Lughod, 1993), have used to subvert their subordinate positions and attain desired goals.

Another source of support for this notion of heterogeneity comes from research on the development of children’s social judgments. Researchers from what has come to be known as a social domain approach (Nucci, 2001; Smetana, 1995b; Tisak, 1995; Turiel 1998, 1999, in press) have proposed that children develop different forms of social knowledge and that these are constructed from the multifaceted nature of children’s social experiences. Research from this perspective, elaborated in more detail in this chapter, has provided extensive evidence that children develop differentiated forms of social understanding. These include concepts of justice, rights and welfare (moral concepts), understandings of society, including hierarchical roles, duties, authority, and normative expectations (conventional concepts), and concepts of self, including a focus on personal goals, entitlements, autonomy, and fulfillment. These concepts may be applied in different situations or coordinated in individuals’ judgments about the same situation; because the social world is complex and entails shifting meanings and contextual variations, these concepts also may be in conflict in individuals’ judgments.

### C. SOCIAL REASONING IN CULTURAL CONTEXTS

These two lines of research—the ethnographic anthropological research and the psychological research on individuals’ social reasoning—have converged in studies of individuals’ social reasoning in different cultural contexts. The result has been an attempt to shift the discourse on culture from focusing on unitary and global cultural orientations (like individualism and collectivism) to a more differentiated

view that takes into consideration the heterogeneity and diversity of orientations within cultures. In this chapter I describe a program of research that has benefited from this convergence of evidence. Although attempts to examine how cultural meanings are subverted and contested have focused primarily on the subordinate role of women and their attempts to challenge cultural practices, this view can be fruitfully applied to an understanding of parent–adolescent relationships as well. As a topic, adolescent–parent relationships may seem somewhat removed from the types of concerns with cultural orientations just considered. Indeed, relatively few connections have been made between the developmental literature on adolescent–parent relationships (which has focused primarily on American youth and, until relatively recently, on mainstream, middle-class youth; see Graham, 1992) and theorizing and research about cultural orientations. But the nature of adolescent–parent relationships and how those relationships are conceptualized bear on the above-mentioned cultural issues in several interesting ways.

First, an obvious but frequently ignored fact is that, like relationships between men and women in traditional societies, parent–child relationships are hierarchical, with parents in dominant positions and children in subordinate roles (but see Hartup, 1989; Piaget, 1932; and Youniss & Smollar, 1985; for an explicit consideration of this issue). Of course, this is as it should be, at least in early development; a prolonged period of dependency is necessary to ensure young children’s survival and, more broadly, for children to acquire the norms, values, and expectations of society (LeVine, 1974). But modern society has prolonged the transition into adulthood well beyond the point when biological and cognitive maturity is attained. Indeed, some theorists have proposed to extend the period of youthful dependency beyond adolescence and to consider young adulthood as a distinct developmental stage (Arnett, 2000). Moreover, American society is ambiguous about when the transition from the subordinate status of childhood to the more mutual status of adulthood has been achieved, as indicated by the staggered timing for conferring the legal status of adulthood (e.g., the legal ages for driving, drinking, the draft, and voting). This extended delay in achieving adulthood and the attendant subordinate status of adolescents in hierarchical relationships with parents is fraught with many of the same tensions and contradictions noted by cultural anthropologists focusing on those in subordinate positions in more traditional cultures.

Furthermore, as with the anthropological research, most of the theorizing and research on socialization has been conducted from the top down. That is, the focus has been primarily on parents’ rules, values, expectations, and disciplinary strategies. Insofar as children’s perspectives have been considered, the focus typically has been on compliance and the situations that facilitate it. But as Nucci and Turiel (2000) have noted, individuals “in subordinate positions in the social hierarchy do not necessarily share understandings about all cultural practices with those in dominant positions” (p. 131). How children conceptualize situations of noncompliance and divergences between children’s and parents’ perspectives in these situations

have received scant research attention, although researchers have recognized recently that children often do not share parents' goals (Grusec & Goodnow, 1994). More systematic research from the child's perspective would help redress this imbalance and might illuminate children's and parents' differing goals in situations where they conflict and the implications of these situations for children's development. As described in detail in the following section, this was the goal of my research on adolescent-parent conflict.

### **III. Morality, Social Convention, and Adolescent-Parent Conflict**

#### A. SURVEY STUDIES OF ADOLESCENT-PARENT RELATIONS

My interest in studying adolescent-parent conflict did not initially stem from a concern with the types of issues just raised. Rather, my interest was piqued by what seemed like unresolved contradictions in researchers' interpretations of the research evidence bearing on adolescent-parent relationships. During the 1970s, the focus of much of this research reflected concerns arising at that time about "the generation gap" and adolescent alienation from adult society (as well as persistent questions arising from psychoanalytic theory about the normative nature of storm and stress). The 1960s and 1970s in American culture were a time of significant societal change and disruption, including student revolts on campus, youthful opposition to the Vietnam War, and significant societal debate and struggles over civil rights. Researchers at that time were primarily concerned with whether adolescents were rejecting parents' moral, religious, and political values and creating a distinct and separate youth culture. In the language of some cultural theorists, youth seemed to be determined to create their own, distinctive cultural community, and this was not viewed by adults as a welcome turn of events.

In contrast to the notion of a generation gap, however, the results of several large-scale survey studies conducted at the time revealed a great deal of consistency between parents and adolescents. As Offer (1969) summarized, "Adolescents of this generation do not rebel against the entrenched important values of the parents' generation" (p. 186). However, numerous researchers did find persistent evidence of conflict over more everyday issues, like doing homework, when to go out, choice of clothes, and hairstyle (Douvan & Adelson, 1966; Kandel & Lesser, 1972; Offer, 1969; Rutter, Graham, Chadwick, & Yule, 1978). For instance, based on the results of an epidemiological study of parents and teachers of the entire population of 2303 adolescents on the Isle of Wight in Great Britain, Rutter (1980) concluded that there were "minor disagreements or clashes between parents and adolescents on mundane day-to-day issues involving hair length, clothes, music, and time to be in at night" (p. 33). Researchers generally viewed the issues as mundane, minor, or trivial and dismissed the findings as unimportant, although



quite notably, parents did not. As Offer (1969) stated, “At this stage the parents of our adolescent subjects did not regard their sons’ behavior as trivial. For instance, the great majority of the parents say that the early adolescent years (twelve to fourteen) are the most difficult time they have in raising their children” (p. 187).

#### B. ADOLESCENT–PARENT CONFLICT RECONCEPTUALIZED

I believed that these findings could be understood within the framework of social domain theory. Rather than viewing all of society’s rules and standards as unitary (as was the case with social learning theory accounts of social development) or as becoming increasingly differentiated through development, as Piaget (1932) and Kohlberg (1969) had asserted in their structural-developmental theories of moral development, social domain theory has proposed that from early ages onward, children have a differentiated understanding of adult rules and standards.

More specifically, Turiel (1983) has hypothesized that children differentiate between concepts of justice (morality) and concepts of society and social convention. According to Turiel, children’s understanding of morality and social convention develop in tandem because they emerge from different types of social experiences. Some social interactions (such as hitting or hurting others) have intrinsic consequences for others’ welfare and rights, leading to the development of prescriptive moral judgments about how individuals ought to behave toward each other. In this view, then, morality pertains to concepts of welfare (harm), justice (comparable treatment and distribution), and rights. In contrast, other social interactions may pertain to more arbitrary regularities and routinized social interactions, such as when to say “please” and “thank you”. According to social domain theory, regularities in forms of social interaction lead to children developing an understanding of social systems, social organizations, and social conventions that is separable from their understanding of morality. Conventions are the arbitrary and consensually agreed-on rules and uniformities that serve to coordinate social interactions in different social contexts. As reviewed extensively elsewhere (Killen, McGlothlin, & Lee-Kim, in press; Nucci, 2001; Smetana, 1995b, 1997; Turiel, 1983, 1998), the findings from more than 85 studies are consistent with these propositions. From early ages onward, children have been found to differentiate morality from social convention using theoretical criteria drawn from formal descriptions of the domains.

From the lens of social domain theory, then, researchers expected to find adolescent–parent conflict over moral issues (which were equated with important or serious issues), but instead found that adolescent–parent conflict occurred over social-conventional issues (which were seen as more trivial or unimportant issues). But according to social domain theory, differences between social conventions and morality are not merely quantitative differences in the seriousness of violations or in the importance of issues (see Tisak & Turiel, 1984; for an experimental test of this

assumption); rather, they are seen as qualitatively distinct concepts that have their origins in different social interactions, follow different developmental trajectories, and serve different developmental functions. In turn, this suggested that researchers may have been too dismissive of the findings on adolescent–parent conflict because they lacked an adequate conceptual framework to understand them.

This insight led to a program of research to examine adolescents' and parents' interpretations of their disputes, using the framework of social domain theory. As the above discussion suggests, I hypothesized that adolescent–parent conflict would occur over the social conventions of the family. In an initial study (Smetana, 1989), a sample of 102 primarily middle- and upper middle-class European American adolescents and their married parents (as well as a small additional sample of divorced mothers and adolescents; see Smetana, Yau, Restrepo, & Braeges, 1991) were interviewed separately to obtain their interpretations of their conflicts. In semistructured clinical interviews, adolescents and parents generated lists of everyday conflicts in their relationships and then justified their perspectives on these disputes (see Smetana, 1988b, 1989; for a fuller description).

Consistent with the findings of earlier investigations (Douvan & Adelson, 1966; Kandel & Lesser, 1972; Montemayor, 1983, 1986; Rutter *et al.*, 1978), the research revealed that adolescent–parent conflicts were over the everyday issues of family life, such as doing the chores, getting homework done, choice of clothes and hairstyles, and when to be with friends. More importantly, my hypothesis that adolescent–parent conflict occurs over the social-conventional rules and standards of the family and society turned out to be only half right. An analysis of parents' justifications for conflicts revealed that, as expected, mothers and fathers reasoned about conflicts primarily as social-conventional issues. As described in more detail in Smetana (1988b, 1989), parents justified conflicts by appealing to the need for social coordination in dividing responsibilities around the home, by focusing on the need for social conformity (and the negative consequences of nonconformity), by invoking family and cultural norms and standards, and by appealing to parental authority. Approximately 50% of parents' responses pertained to these types of social-conventional justifications, with the remainder of their responses divided among moral, pragmatic, psychological, and prudential justifications. Thus, as expected, conflict (at least for parents) was primarily over the social-conventional—not moral—issues of the family.

Although parents primarily viewed conflicts in conventional terms, the more surprising finding at the time—and in retrospect surprising only because my initial hypotheses primarily considered parents' perspective and thus were more consistent with a top-down focus—was that adolescents did not. In contrast to my hypotheses, adolescents primarily justified their perspectives on conflicts by appealing to personal jurisdiction. That is, adolescents claimed that the issues causing conflict were unimportant or inconsequential (“it doesn't matter” and “it's no big deal”), that their behavior was acceptable or permissible (“it's okay,”), that

their choices were a reflection of their identity or individuality or were an aspect of their personal expression, or that the issues should be personal choices (“it’s my decision,” “it should be up to me,” and “it’s my room”). When asked to reflect on the conflicts from their parents’ positions (referred to as counterarguments), adolescents clearly understood but rejected their parents’ conventional positions on disputes.

One interpretation of these findings is that adolescents’ appeals to personal jurisdiction reflect the individualistic orientation of American culture, with its focus on personal goals, individual rights, and personal agency. Indeed, based on the results of a single study comparing American and Japanese adolescents, Rothbaum *et al.* (2000) have asserted that adolescent–parent conflict is prototypical of the generative tension that characterizes relatedness in the United States and other Western cultures. Adolescents’ appeals to personal jurisdiction also can be seen as reflecting the hedonistic desires for personal fulfillment or the selfish achievement of personal needs and goals that Bellah *et al.* (1985) view as endemic to American culture, with its overly individualistic orientation. The findings are also consistent with Marcus and Kitayama’s (1991) description of independent construals of the self. Indeed, in describing the cultural features of the American self, Marcus *et al.* (1997) have stated the following:

choice—picking one’s favorite, having it your way, the availability of a wide variety of styles, favors, colors, and so on—is central to many domains of U.S. life. Choice is important because it allows people to serve—to manifest their individuality, to express themselves, to be active agents who control their own actions. Choosing involves knowing, revealing, and making good on one’s constituting preferences and attitudes. (p. 24)

Marcus *et al.*’s (1997) statement appears to be an apt description of our European American adolescents’ assertions of personal choice in situations of conflict with parents. Indeed, the mere fact that conflicts arose between parents and adolescents can be seen as a reflection of the individualistic orientation of American society and debates about whose rights should predominate. But there is evidence to suggest that this conclusion may be premature.

Most models of socialization posit that through a variety of processes, parents mold children to acquire the rules, values, and standards of adult society. Culture theories typically have adopted similar views of how children acquire culturally valued beliefs, scripts, attitudes, and behaviors (see Shweder *et al.*, 1998, for a review). Although the specific processes that lead to internalization of cultural scripts may vary in minor ways, culture theories generally assert that internalization occurs through children’s guided participation in sociocultural activities.

But the findings from my research are inconsistent with this account—and with the general claims about American individualism. They are inconsistent because, although appeals to personal jurisdiction prevailed in our European American middle class families, these claims primarily characterized adolescents’ but not

parents' responses (although in other contexts, as the interviews at the outset of the chapter illustrate, parents do endorse an arena of personal jurisdiction for their children). As just noted, parents' social-conventional justifications reflected their attempts to obtain conformity to the norms, standards, and conventions of the family and the culture, to become more responsible members of the social unit, to subordinate their own personal desires to the needs of the group, and to respect the hierarchical structure of the family and the authority of the parents. All of these concerns can be seen as much more in line with a collectivist than an individualistic orientation!

Furthermore, to paraphrase Much and Shweder (1978), parents are the local guardians of the social and moral order, and as such, their task is to transmit the important values, attitudes, and beliefs of the culture and to mold children's behaviors to fit those beliefs and values. And the values that the parents in my initial study (Smetana, 1989), as well as in subsequent studies of European American middle-class parents (Smetana, 1995c; Smetana & Asquith, 1994; Smetana & Berent, 1993) enforced were conventional (societal) ones. To a lesser extent, parents also endorsed concerns with fairness and others' welfare (moral values), as well as concern with the child's safety and health (prudential values), but in the context of conflicts, they did not endorse the child's personal jurisdiction. In their counterarguments, parents articulated—but overwhelmingly rejected—adolescents' desires for personal choice and fulfillment, reasserting, instead, their conventional views of disputes.

Indeed, the findings for adolescents bear some surprising similarities to the descriptions of how women in traditional societies attempt to subvert the traditional and hierarchical social order and attain their desired goals (e.g., Abu-Lughod, 1993; Mernissi, 1994). These similarities are especially striking when adolescents' justifications in individual interviews and in face-to-face interactions are considered.

In one study (Smetana, Braeges, & Yau, 1991), justifications obtained in individual interviews were compared to the justifications offered in the context of a structured, videotaped family interaction task that focused on discussion and resolution of a conflict. Adolescents' appeals to personal jurisdiction, which predominated in individual interviews, were less evident in adolescents' discourse in the context of the structured family interaction task. Perhaps adolescents did not feel the need to express personal justifications explicitly when discussing a conflict with their parents because these arguments had been elaborated in detail in other contexts. The finding that parents' counterarguments perfectly mirrored adolescents' justifications bears this out to some extent.

However, adolescents were much more opaque in expressing their claims to personal jurisdiction in face-to-face interactions than in individual interviews and used more circuitous and less conflict-arousing strategies to attempt to win disputes.

For instance, adolescents focused more on the pragmatic and practical aspects of the situations (e.g., “I would take out the garbage, but it’s just that I’m usually at football practice when it needs to be taken out”) than they did in individual interviews. Thus, their use of subterfuge to attain their desired goals was reminiscent of the accounts of how others in subordinate positions in more traditional cultures achieve their goals (Abu-Lughol, 1993; Mernissi, 1994). It was also consistent with the indirectness in social interactions that have been attributed to individuals in collectivist cultures.

## IV. Culture and Adolescents’ Reasoning about Conflict

### A. CULTURAL CONTEXTS OF THE RESEARCH

Another type of evidence against the claim that adolescents’ appeals to personal jurisdiction are solely reflections of the individualism of American culture comes from three studies conducted more recently to examine adolescent–parent conflict in different cultural contexts. Two of the studies, conducted in collaboration with Jenny Yau, examined reasoning about conflict among Chinese adolescents. The first of these studies included a sample of 120 lower to middle-class Chinese adolescents in Hong Kong who ranged in age from 12 to 19 years of age (Yau & Smetana, 1996), and the second study entailed a comparison of 188 10- to 19-year-old lower to middle-class adolescents in Hong Kong and Shenzhen, China (Yau & Smetana, 2000). The third study focused on middle-class African American families and included 95 11- to 14-year olds and their families, who were followed longitudinally for 2 years (described in more detail in Smetana & Gaines, 1999).

Other researchers have described Chinese cultures as prototypically collectivist (Marcus *et al.*, 1997), and Chinese family life is seen as strongly influenced by Confucian values (Chao, 1995). Chinese families have been found to emphasize affiliation, cooperation, and harmony in interpersonal relationships (Chao, 1995) and children’s obligations to the family. They traditionally place greater emphasis on social and moral values than on personal values and competence in the service of individualistic goals (Rosenthal & Feldman, 1996). Acting in ways that are contrary to parents’ wishes may be seen as selfish and inconsiderate, as not demonstrating gratitude to parents, and as potentially leading to the family’s loss of face.

In contrast, researchers have viewed African American culture as strongly influenced by West African values, which include spirituality, the importance of extended kin networks, communalism, hierarchical family relationships, and harmony in interpersonal relationships. These cultural traditions have been maintained and yet transformed into a distinctively American pattern by the history of slavery,

the ongoing experience of oppression and racism, and the necessity to maintain an African American heritage while adapting to majority culture (Boykin & Toms, 1985; Garcia Coll, Meyer, & Brillon, 1995; Parke & Buriel, 1998).

As these brief descriptions suggest, many of the characteristics ascribed to African American culture, such as the value placed on communalism and harmony in interpersonal relationships and the strongly hierarchical family structure, with the demand for obedience and respect toward elders, bear strong similarities to the characteristics ascribed to Chinese culture. Indeed, these descriptions suggest that at least in some ways, African American families may be more similar to Chinese families in Hong Kong than to the European American families with whom they share a wider cultural milieu.

In all three of these studies, participants were administered a semistructured clinical interview similar to the one employed with European American families (Smetana, 1989). As with the earlier research, the goal of the interview was to examine adolescents' and parents' interpretations of their disputes through analyses of their justifications. In line with those who have advocated employing within-group designs and studying ethnic minorities or cultural groups on their own terms (McLoyd, 1998; Phinney & Landin, 1998), each of these studies was conducted as an independent investigation that focused primarily on examining within-group differences and processes. Conflicts between parents and adolescents occurred relatively frequently in all the contexts studied, although contexts varied in the numbers of conflicts generated, the intensity of disputes, the types of issues that led to conflict, and in particular, the ways conflicts were resolved.

## B. PERSONAL JUSTIFICATIONS IN CULTURAL CONTEXTS

Of interest here are the findings pertaining to justifications. The findings from all three studies largely replicated the research on middle-class European American youth. Appeals to personal jurisdiction predominated in each of the cultural contexts studied, accounting for approximately 50% of adolescents' responses (with the remaining responses divided in similar ways among other justification categories). Age differences in the samples and differences in the types of conflicts observed can account for the small cross-cultural variations that were observed. Moreover, adolescents' appeals to personal jurisdiction increased as they got older, a finding that may be seen as surprising if one were to assume that with age, children become more socialized into the norms and standards of their culture. Appeals to personal jurisdiction increased proportionately with age in the cross-sectional analyses of Chinese adolescents (from 29% among 5th graders to 50% among 10th and 12th graders in Hong Kong and China; Yau & Smetana, 2000) and in the longitudinal analyses of middle-class African American adolescents (from 45% in early adolescence to 54% in middle adolescence). Therefore, the findings challenge the

notion that adolescents' appeals to personal jurisdiction reflect the individualism of American culture. These responses were observed in widely different cultural and ethnic contexts that have been described as prototypically collectivist, oriented toward interdependent construals of the self, and focused on modes of relatedness that emphasize symbiotic harmony.

## **V. The Personal as a Domain of Knowledge**

My interpretation of these findings is in line with recent theorizing and research from social domain theory, which has asserted that children develop an understanding of self and others as psychological systems that is distinct from concepts of morality and social convention (but must be considered within those broad frameworks). The personal domain has been defined as the set of actions that individuals consider to be beyond the realm of justifiable social regulation and moral concern (Nucci, 1996, 2001; Nucci & Lee, 1993; Nucci & Turiel, 2000). Unlike moral and conventional issues, personal issues are not subject to considerations of right and wrong, but rather are seen as pertaining to preference and choice regarding issues such as control over one's body, privacy, and choice of friends or activities. The right to make autonomous decisions is described as an aspect of the self that forms the boundary between the self and the social world.

### **A. CHILDREN'S CONCEPTS OF PERSONAL ISSUES**

A growing number of studies have provided support for these propositions. In several recent studies that concerned children's judgments of personal issues (in primarily European American middle-class samples), children ranging from 3 to 18 years of age have been found to primarily categorize personal issues as up to the individual (rather than as acts that are right or wrong). These judgments were found to be based on children's justifications that the action's consequences only affect the actor or that the acts are personal matters that should be the actor's own business (Killen & Smetana, 1999; Nucci, 1981; Nucci, Guerra, & Lee, 1991; Nucci & Weber, 1995). In addition, several observational studies of social interactions regarding personal events have provided evidence that personal concepts emerge through tacit communications and negotiations with adults regarding opportunities for choice and personal preference (Killen & Smetana, 1999; Nucci & Weber, 1995). Finally, appeals to personal prerogatives and personal entitlements have been observed in a number of different cultures, including Brazilian children from varying regional and social classes (Nucci, Camino, & Sapiro, 1996), Israeli Jewish and Druze Arab children, adolescents, and adults (Wainryb, 1995; Wainryb & Turiel, 1994), Indian adolescents and adults (Miller, Bersoff, & Harwood, 1990), and Colombian preschool children (Ardila-Rey & Killen, 2001),

although cultural (Miller *et al.*, 1990) and social class (Nucci *et al.*, 1996) variations have been observed.

In my view, the findings from my research on adolescent–parent conflict must be located with this theorizing and research on the personal as an epistemological and developmental social knowledge domain. Appeals to personal jurisdiction reflect adolescents' attempts to claim an arena of personal discretion and choice and thereby to assert a subjective sense of agency and construct a coherent self-identity. As described in more detail in subsequent sections, a great deal of research from the social domain perspective has confirmed in more theoretically specified ways what researchers interested in the generation gap found a half-century ago. Adolescents do not reject parental conventions in toto; in fact, they uphold most parental and societal values and social conventions and view themselves as obligated to conform to most social norms. Rather, adolescents are attempting to coordinate their beliefs about the legitimacy of (culturally variable) social conventions and the validity of moral prescriptions with a desire to stake claims to areas of self-regulation and personal control that are required or desired to become an independent adult in their cultural setting. Moreover, the research indicates that appeals to personal jurisdiction are not solely a developmental manifestation of adolescence; rather, the above-mentioned research indicates that they emerge in early childhood (although disputes over personal jurisdiction may take on new meanings and increased intensity during adolescence). Furthermore, the similarities in justifications found among mainland Chinese, Hong Kong Chinese, European American, and African American adolescents suggest that adolescents' desires for greater autonomy over issues in the personal domain reflect basic developmental processes.

Social domain theorists have proposed that claims to personal choice and personal prerogatives are part of an attempt to instantiate a subjective sense of agency. Nucci and Turiel (2000) have elaborated that this experience of agency is composed of two aspects. One is an awareness of oneself as an initiator of action. At a deeper and more fundamental level, agency entails the sense of the self as a unique and bounded individual entity, or what William James (1899) described as an awareness of the "I," that aspect of the self that organizes and interprets experiences as reflective awareness of one's agency, continuity, and distinctness. Individuals' attempts to assert personal prerogatives and control areas of conduct provide opportunities for self-expression, developing an identity, and expressing needs for privacy.

## B. CULTURAL VIEWS OF SELF AND PERSONHOOD

At a general level, culture theorists agree that notions of self and personhood (Damon & Hart, 1988; Geertz, 1975) and a sense of agency (Markus & Kitayama, 1991; Miller, 1997) are basic human concepts. Culture theorists are sensitive to the universal existence of notions of self and agency. They have given more emphasis,



however, to the extent to which agency is embodied in culturally variable forms, particularly in representations of the self as an individual (Miller, 1997) and in how definitions of personhood vary across cultures (Geertz, 1975; Markus & Kitayama, 1991; Shweder & Bourne, 1984). Thus, for instance, some culture theorists have asserted that the sense of self as a bounded, discrete social being is a peculiarly Western construction (Geertz, 1984). They have proposed that how the sense of agency becomes expressed and the contexts in which it is expressed (Miller, 1997) are culturally variable (for a fuller description of the different positions taken by culture theorists, see Miller, 1997; Nucci & Turiel, 2000; Wainryb, 1997.)

In contrast, social domain theorists have asserted that notions of the personal are grounded in underlying psychological realities that are applicable cross-culturally (Killen & Wainryb, 2000; Nucci, 1996; Nucci & Turiel, 2000; Wainryb, 1997). All cultures treat some issues as fundamentally within the boundaries of the self and personal agency because the establishment of an arena of personal freedom and notions of human agency are necessary for the formation of the self and the development of the social individual and, thus, are seen as fulfilling basic psychological needs (Nucci, 1996; Nucci & Lee 1993). There are universal dimensions of the personal domain, along with cultural variations in the boundaries that constrain or define the personal domain (Nucci 1996; Nucci & Lee 1993; Smetana, 1995b), and, thus, what is considered to be under the individual's personal jurisdiction. Although individuals in all cultures develop personal concepts, they are elaborated in cultural contexts that define their scope. Despite cultural variations as to the content of the personal domain, the evidence suggests that there is a great deal of overlap across cultures in the types of issues that are treated as personal and up to the individual to decide.

### C. CULTURAL AND ETHNIC VARIATIONS IN ADOLESCENTS' BEHAVIORAL AUTONOMY

Further support for this assertion has been obtained in recent research examining adolescents' and parents' expectations regarding the timing of behavioral autonomy (Feldman & Quatman, 1988; Feldman & Rosenthal, 1990; Feldman & Wood, 1994; Fuligni, 1998). Adolescents and parents have been asked to indicate the appropriate ages at which they believe that adolescents can engage in a variety of activities; this has been seen as assessing the desired pacing of behavioral autonomy. Because cultural values are seen as influencing beliefs about the appropriate timing of behavioral autonomy (Goodnow & Collins, 1990), several recent studies have compared autonomy expectations among adolescents and parents from different cultures or ethnicities.

The types of items chosen to assess adolescents' and parents' timetables for behavioral autonomy typically have been chosen on an ad hoc basis, and little attention has been paid to defining the types of issues over which behavioral

autonomy may proceed. Interestingly, however, most of the available research has focused on items that from the social domain perspective might be considered to fall under the personal category (for instance, when adolescents should be able to decide about choice of clothes, hairstyles, how to spend their own money, how to keep their bedroom, and when they can prepare their own dinner) or that can be seen as including a mixture of personal and prudential issues (when they can decide to smoke cigarettes; drink coffee, beer, or wine; or have sex) or a mixture of personal, conventional, and prudential issues (e.g., how late teenagers can come home at night and when they can go out on dates).

This research has indicated that European American adolescents and parents generally expect to attain autonomy at earlier ages than do adolescents and parents of other ethnicities or cultures. This finding has been observed among American adolescents from European, Chinese, Filipino, and Mexican backgrounds (Fulgini, 1998); Asian American adolescents and parents (Feldman & Quatman, 1988); African American adolescents and parents (Smetana & Daddis, 2001); and adolescents from Hong Kong (Feldman & Rosenthal, 1990). Nevertheless, across contexts, and with the exception of behaviors like drinking and drug use, which some parents condone as inappropriate at any age, adolescents and their parents expect that individuals will become behaviorally autonomous with respect to these issues by the end of adolescence or early adulthood. This is consistent with the notion that a central developmental task of adolescence is to become a self-governing individual.

As I have proposed elsewhere (Smetana, 1995a), variations in the conceptual boundaries between the personal and the conventional domains may be directly related to the occurrence of adolescent–parent conflict. That is, overt, expressed conflict may be more frequent or more intense in cultures that view the individual as exercising personal jurisdiction over a broader range of issues than in cultures where the boundaries of the personal domain are drawn more restrictively or where those boundaries are more selectively applied to individuals in subordinate positions.

For instance, parent–child relationships are more hierarchically structured in Chinese cultures than in mainstream American society; filial piety and respect for elders is strongly stressed (Chao, 1995). Accordingly, adolescents in Hong Kong appeared to have fewer overt conflicts with their parents and rated these conflicts as less intense than did adolescents in upstate New York. Nevertheless, they expressed the same desires for personal jurisdiction as did their European American counterparts. Thus, cultures may vary in the intensity of disputes (and what parents and adolescents fight about), but not in its fundamental meaning to the child. Indeed, in cultures that draw the boundaries of the personal domain very restrictively, such as among the Druze Arabs living in Israel, those in subordinate positions (such as Druze Arab women) may desire more control over personal issues. However, they view decisions not to oppose the existing conventional order and to express their

desires for more personal jurisdiction as more appropriate or more pragmatically wise (Wainryb & Turiel, 1994).

Conflict also may be greater in cultures (such as mainstream American culture) where adolescents clearly have transitional status in society and where the boundaries between the personal and the conventional are sometimes ambiguously defined. This suggests that overt, expressed conflict may be more muted in some cultures than in others and that conflict resolutions may vary depending on how hierarchical relationships are defined and how power is distributed. However, viewing appeals to personal jurisdiction as an aspect of personal reasoning rather than as reflective of American individualism suggests that adolescents' appeals to personal jurisdiction serve a more universal developmental function.

## **VI. Mothers' Beliefs about Children's Personal Freedom**

Although my research indicated that parents rejected adolescents' claims to personal jurisdiction in situations of conflict, other research has indicated that parents do endorse an arena of personal control as important for their children's development. Consistent with hypotheses about the cross-cultural relevance of personal concepts, in several recent studies conducted in diverse cultural and ethnic contexts, investigators have examined mothers' beliefs about granting children an arena of personal freedom. These studies have employed a similar set of interview questions to investigate the types of issues that mothers (and fathers in Smetana & Chuang, 2001) in different cultures or ethnicities believe should be personal for the child, the criteria for deciding when an issue should be personal, and their justifications for allowing independent decision making. As described in more detail in Table I, the samples for these studies included European American and African American mothers, Chinese mothers from Taiwan and the Peoples' Republic of China residing in North America, Japanese mothers in Tokyo, and Brazilian mothers from two different regions and social classes in Brazil. Cultural norms and values are widely viewed as influencing parental beliefs (Goodnow & Collins, 1990). Therefore, these studies examining maternal beliefs in different cultures or ethnicities are especially useful in determining whether appeals to personal jurisdiction reflect more culture-specific individualistic orientations or whether they reflect the heterogeneity in reasoning found among individuals in different cultures or subcultures.

### **A. MOTHERS' EVALUATIONS OF CHILDREN'S INDEPENDENT DECISION MAKING**

Mothers in each of these studies were first asked whether there were issues that they believed should be up to the child to decide. In all samples except one,

TABLE I  
Description of Study Samples of Mothers' Concepts of Children's Personal Domain

Study	<i>N</i>	Culture	Social class	Children's <i>M</i> ages	Independent variables <sup>a</sup>
Nucci and Weber (1995)	20	European-American	Middle	3 and 4	
Nucci and Smetana (1996)	40	European-American	Middle	5 and 7	Age groups
Yamada (2000)	64	Japanese from Tokyo	Middle	3-4 and 5-6	Age groups
Chuang (2000)	40	Taiwanese-Canadian	Middle	6-8	Acculturation level
Xu (2000)	72	Chinese (from the PRC) residing in the US	Middle	5-8 and 9-12	Age groups, length of residence in U.S. (>2 years, 2-5 years)
Smetana and Chuang (1999)	95	African American	Middle	13 and 15	2-Year longitudinal
Nucci and Milnitsky Sapiro (1995)	120	Brazilian	Lower and Middle	6-8, 10-12, and 14-16	Social Class

<sup>a</sup>Gender differences were examined in all studies. PRC = People's Republic of China.

mothers responded affirmatively. Nucci and Milnitsky Sapiro (1995) found that the middle-class Brazilian mothers in their study believed that children of their child's age should be allowed to make decisions about some things. However, approximately half of the lower class mothers of 6- to 8-year-olds and 10- to 12-year-olds and one-fifth of the lower class mothers of 14- to 16-year-olds responded negatively to this statement, based primarily on concerns with the child's health or safety and, less frequently, with the child's developmental readiness. These concerns with children's health and safety were particularly evident for mothers of the youngest children, accounting for nearly three-quarters of their negative judgments about control over decision making and less than half of the negative judgments in mothers of early and middle adolescents. Therefore, delays in granting their children an arena of personal choice were related to lower class Brazilian mothers' assessments that their physical environments were less safe than for middle-class mothers.

As summarized in Table II, the studies reveal a great deal of similarity across samples in mothers' responses regarding the types of issues that they believed should be up to the child to decide. Consistent with theoretical descriptions of the personal domain (Nucci, 1996; Nucci & Turiel, 2000), mothers primarily indicated that children should be allowed to make independent decisions regarding choice of

TABLE II  
Issues (in Percentages) That Mothers Viewed as up to the Child to Decide

Issue	U.S.-White, N&W (1995)	U.S.-White, N&S (1996)	Japanese, Yamada (2000)	Taiwanese, Chuang (2000)	U.S. Chinese, Xu (2000)	U.S.-Black, S&C <sup>a</sup> (1999)	Brazilian, N&M (1995)
Clothes	28	28	15	29	24	28	22
Food	18	22	08	17	18	—	10
Activities/Play	27	22	30	28	15	21	23
Friends/Playmates	08	12	14	0	05	19	15
Routines	—	07	07	11	10	—	08
Harmless/Inconsequential	18	05	—	—	11	—	—
Homework	—	—	11 <sup>c</sup>	10 <sup>c</sup>	—	12	13
Other	—	05	14	05	10	19 <sup>b</sup>	11 <sup>b</sup>

<sup>a</sup>Means for Time 1 and Time 2 were combined.

<sup>b</sup>The Other category included Doing Chores (.04), Spending Money (.05), and Bedtimes/Curfew (.02) in Smetana and Chuang and Mobility in Nucci and Milnitsky Sapiro (1995).

<sup>c</sup>Coded as Learning Activities in Yamada (2000) and as School Activities in Chuang (2000); .03 pertained to college/vocational choices in Nucci and Milnitsky Sapiro (1995).

clothes, activities or play choices, and when and what to eat. Smaller proportions of responses endorsed independent decision making regarding choice of friends or playmates and control over routines. The similarity across samples is striking, particularly as some of the variation in responses appears to be due to sample differences in children's ages rather than in cultural characteristics.

For instance, decisions regarding choice of food (when and what to eat) may be more a salient personal issue in early childhood, when children first begin to express food preferences and parents first begin to grant children discretion over choice of food, than in adolescence, when these preferences have been firmly established and self-regulation over eating is routinely expected. Indeed, Nucci and Smetana (1996) found that in European American families, decisions over food choices were a more salient personal issue among mothers of 5-year-olds than 7-year-olds, and Nucci and Milnitsky Sapiro (1995) found that responses indicating that food was an issue of personal decision making declined from childhood to adolescence. Therefore, that African American mothers did not mention food as a personal issue (Smetana & Chuang, 1999, 2001) no doubt reflects the older age of this sample.

In contrast, only Brazilian and African American mothers mentioned homework as an issue for which independent decision making was permitted, and these were the only two samples that included adolescents. (Japanese and Taiwanese-Canadian mothers also permitted independent decision making regarding learning and school-related activities, but these mothers' responses focused less specifically on independent decision making regarding homework.) Children may not be granted personal discretion over when and how to do their homework until they

have demonstrated the developmental competence to make independent decisions in this arena. The responses indicate that mothers in these different cultures permitted independent decision making (except when the environment poses risks in doing so) regarding a constrained set of issues that are consistent with the theoretical definitions of the personal domain. Furthermore, the results in Table II suggest strong cross-cultural continuity in the types of issues that mothers describe as personal for their children (although the coding may have masked some within-category cultural differences, for instance, in the types of clothes or hairstyles that mothers view as personal for their child or the circumstances in which personal discretion over clothes may be granted).

#### B. MOTHERS' JUSTIFICATIONS FOR PERMITTING INDEPENDENT DECISION MAKING

Mothers in each of these studies also were asked to justify why these issues should be up to the child to decide. The results are presented in Table III. Appeals to develop the child's competence and autonomy (including establishing the child's control, developing a sense of individuality and independence, and helping to establish the child's uniqueness), foster the child's sense of agency or self-esteem, personal reasons, and assess developmental appropriateness or

TABLE III  
Mothers' Justifications (in Percentages) for Viewing Issues as Up to the Child to Decide

Justification category	U.S.-White, N&W (1995)	U.S.-White, N&S (1996)	Japanese, Yamada (2000)	Taiwanese, Chuang (2000)	Chinese, Xu (2000)	U.S.-Black, S&C <sup>a</sup> (1999)	Brazilian, N&M (1995)
Child competence	34	41	22	23	24	19	10
Foster autonomy	22	23	52	41	30	25	48
Agency, self, self-esteem	32	33	02	03	23	09	22
Personal	—	—	04	08	—	20	—
Developmentally appropriate	—	—	—	18	—	—	21 <sup>b</sup>
Natural consequences	07	—	02	—	—	—	—
Pragmatic	—	—	10	03	20	04	0
Parents' responsibility	—	—	—	—	03	06	0
Other	05	05	07	08	—	17	02

<sup>a</sup>Means for Time 1 and Time 2 are combined; there were few differences over time.

<sup>b</sup>These responses were coded in a Readiness category.

developmental readiness all can be seen as closely related, as they all pertain to aspects of the child's psychological or self-development. Across samples, these types of psychological reasons accounted for the vast majority of mothers' justifications for allowing independent choices, with proportions ranging from 73% among African American mothers (Smetana & Chuang, 1999, 2001) to 97% among European American mothers (Nucci & Smetana, 1996).

Another noteworthy outcome in Table III is cultural variation in the specific psychological reasons mothers used to justify an arena of personal choice for their children. Despite the description of both Asian and Brazilian cultures as prototypically collectivist (Marcus *et al.*, 1997), Taiwanese mothers varying in level of acculturation to Canadian culture, Japanese mothers in Tokyo, and both lower and middle-class Brazilian mothers emphasized autonomy as a justification for independent decision making. Indeed, appeals to their child's developing autonomy predominated in Taiwanese, Japanese, and Brazilian mothers' reasoning and appeared to be more frequent among these mothers than among mothers in the other samples. These findings stand in sharp contrast to the claim that expressing choices and manifesting individuality are solely expressions of individualistic cultures.

Justifications focusing on the need to develop the child's self-esteem, promote self-development, and provide a sense of agency were apparent to varying degrees in the different samples, but they appeared to be most prevalent (although not predominant) in the two European American samples (Nucci & Smetana, 1996; Nucci & Weber, 1995). Rather, European American mothers (in Nucci & Smetana, 1996) primarily justified independent decision making as important in fostering the child's competence. Wiley, Rose, Burger, and Miller (1998) have described European American middle-class mothers' disciplinary practices as focused on maintaining and enhancing children's self-esteem, whereas related investigations have found that Chinese mothers' narrative retelling of young children's transgressions focus more on inducing guilt and shame (Miller, Fung, & Mintz, 1996). The results presented in Table III are consistent with views of cultural differences in mothers' psychological justifications. The findings suggest that when justifying independent decision making, European American mothers may have a greater propensity than do other mothers to express explicit concern with enhancing the child's self-esteem. But this must be considered within the broader finding that mothers in each of these cultures viewed independent decision making as important in fostering autonomy, agency, competence, and self-reliance in their children.

Miller *et al.*'s (1996) and Wiley *et al.*'s (1998) conclusions were based on observations of mother-child interactions, whereas the cultural comparisons discussed here are derived from interviews (which tap maternal beliefs rather than practices). Therefore, explicit comparisons between the two sets of findings are difficult. Nevertheless, other findings from these studies are consistent with the view that European American middle-class mothers do not cast their children's misbehavior in more of a positive or ego-enhancing light than do mothers in other cultures. In four of the studies just discussed, mothers were asked to provide explanations for

TABLE IV  
 Mothers' Explanations (in Percentages) for Children's Motivations in Situations  
 Where the Child Resists Parents' Wishes

	U.S.-White (N&S)	Japanese (Yamada)	Taiwanese- Canadian (Chuang)	Chinese from PRC (Xu)
Selfishness/egocentrism	47	75	7	—
Establish personal boundary	21	28	38	12
Get attention	16	—	—	—
Express anger/emotions	8	—	13	—
Peer/media influence	8	—	4	—
Laziness	—	—	12	—
Limit testing/defiance	5	—	10	20
M approves of C behavior	—	—	—	22
Parent is bossy	—	—	—	17

their children's motivations in situations where they resisted what mothers asked them to do. Diversity characterized mothers' explanations of children's motivations for misbehavior. As shown in Table IV, roughly similar proportions of mothers in these four studies responded that their children were establishing personal boundaries (the much higher proportions of these responses among Canadian-Taiwanese mothers reported by Chuang, 2000, are most likely due to her expanded definition of this category).

Attributing the child's behavior to selfishness or egocentrism might be seen as reflecting a more sociocentric orientation, with its implied focus on accommodating to others' needs. The data presented in Table IV might be interpreted to mean that Japanese mothers were more likely than European American middle-class mothers to view their children's motivation as selfish or egocentric (75% compared to 47%). However, the data appear more similar when mothers' responses for children of similar ages are compared. Attributions of selfishness or egocentrism declined significantly from a high of 90% for Japanese mothers of 3- to 4-year-olds to 61% for Japanese mothers of 5- to 6-year-olds, a response frequency much more in line with American mothers' responses regarding their 5- to 7-year-olds. Moreover, attributions regarding the negative personality of the child were virtually absent from Chinese mothers' responses. Indeed, mothers from the People's Republic of China tended to view children's behavior in a positive light (Approval of child, 22%), parents' behavior in a negative light (Parent is bossy, 17%), and situations of resistance as Positive Learning Opportunities (6%). Therefore, in contrast to Japanese mothers, resistance to the mother's wishes appeared to be encouraged among Chinese mothers.



More comparative research would be needed to test whether these differences in justification and motivation responses across cultures represent statistically significant and, more importantly, culturally meaningful differences in responses. Although culture theorists have asserted that differences are substantive and reflect deep structure differences in cultural orientations, the overlap in justifications and motivation explanations among mothers in these different contexts suggests that differences may be more culturally variable stylistic differences in referring to the child's psychological development.

## **VII. Shifts and Discrepancies in Adolescents' Acceptance of Parental Conventions**

The research discussed in the previous sections indicates that mothers endorse an arena of personal discretion for their children, although they explicitly reject those claims in situations of conflict. Likewise, another body of research indicates that adolescents generally endorse adults' moral and social-conventional expectations and view their authority to regulate these issues as legitimate. A number of investigators have examined children's and adolescents' judgments regarding the legitimacy of parental (Fuligni, 1998; Smetana, 1988a, 1993, 2000; Smetana & Asquith, 1994; Tisak, 1986) and teachers' and principals' authority (Laupa, 1991; Laupa & Turiel, 1986, 1993; Smetana & Bitz, 1996) to make rules about hypothetical moral and conventional acts. The studies have yielded a consistent set of findings. From early childhood to late adolescence, children have been found to view moral and conventional issues as legitimately regulated by adults (except when they are asked to evaluate "immoral" requests, for instance, to steal, or the adults are depicted as lacking in authority on one of several dimensions). And, beginning in early childhood, children strongly endorse adolescents' obligation to obey adults' moral and conventional rules (although adolescents feel less obligated to obey parents' conventional regulations as they get older). Furthermore, these findings have been obtained in different cultural and ethnic contexts, including African American (Smetana, 2000) and European American middle-class families with adolescents (Smetana, 1988a, 1993; Smetana & Asquith, 1994); American adolescents from European, Chinese, Filipino, and Mexican backgrounds (Fuligni, 1998); and Korean children in Korea (Kim & Turiel, 1996).

The research on parental authority also indicates that judgments regarding the legitimacy of adult authority shift over the course of adolescence, as do the boundaries of adolescents' personal jurisdiction. Adolescents do uphold the legitimacy of most parental and cultural conventions. However, the results of both cross-sectional and longitudinal research indicate that with age, adolescents also are increasingly likely to claim certain types of issues, such as preferences for music, TV programs, clothes, hairstyles, activities, and friends as under their personal jurisdiction.

In contrast, both European American (Smetana, 1988a; Smetana & Asquith, 1994) and African American parents (Smetana, 2000) typically view these same issues as conventional and legitimately subject to their authority. These differences in adolescents' and parents' conceptions of parental authority lead to conflict. Adolescents' appeals to personal jurisdiction serve to increase adolescents' agency, or enlarge their sphere of personal action, and thus serve to increase their autonomy. The conflict between adolescents' appeals to personal jurisdiction over issues that parents consider to be social-conventional entails the renegotiation of the boundaries between parental authority and adolescents' authority over the self.

Adolescents and parents have different interpretation of conflicts because their competing goals lead them to focus on, or subordinate, different concerns (Smetana, 1988b, 1995a). As the examples at the outset of this chapter illustrate, parents' hierarchical relationships with their children and their perceptions of their parental role lead them to focus on socializing adolescents into societal rules and cultural conventions and to help them to acquire the culturally prescribed psychological competencies required by their society to lead productive lives. Mothers of children varying in age from early childhood to middle adolescence of different ethnicities and in diverse cultures do believe that those psychological competencies include developing an arena of personal choice and prerogatives, as the research in the foregoing section and the examples at the outset of the chapter indicate. But parents' decisions to grant children personal choice are affected by many factors. Prominent among these are parents' assessments of the environmental risks entailed in exercising those personal choices. At one extreme, this may lead parents to negatively evaluate any and all claims to children having arena of personal control, as was vividly illustrated in the findings for lower class Brazilian mothers. But these concerns arise in less extreme forms among most parents. For instance, similar concerns with safety—although for somewhat different reasons—also arose quite frequently among African American parents (Smetana & Chuang, 1999, 2001) and were an important criterion in their decisions whether to grant adolescents independence. Faced with an environment where racism and prejudice remain persistent and pervasive, African American mothers viewed a number of behaviors, such as wearing certain styles of clothes (e.g., looking like gang-bangers), driving in certain areas or at certain times of day, or being at the mall in large groups of teenagers, which might be relatively innocuous for adolescents of other ethnicities in the United States, as entailing significant safety risks for their children. This point has been made poignantly by Boyd-Franklin and Franklin (2000) in their description of how they prepared their African American adolescent sons for the risks of “DWB”—driving while Black. And Chinese adolescents in Hong Kong likewise reported that their parents' restriction of their personal choices often hinged on parents' perceptions of the risks to adolescents' safety in pursuing activities in the dense, crime-ridden, urban environment of Hong Kong (Yau & Smetana, 1996, 2000).

Parents' decisions to grant children personal choices are also integrally related to their assessments of adolescents' abilities and competencies (Nucci, Killen, & Smetana, 1999), and these assessments may be particularly variable and divergent during periods of rapid developmental change, such as during transitions to adolescence. The concurrent physical, social, and cognitive changes of early adolescence and the processes of adaptation to those changes make accurate assessments of adolescents' actual competencies a challenging task at best. The resulting discrepancies between children's developing competencies—or children's (over-)estimations of them—and parents' assessments of those competencies are likely to lead to conflict. Collins (1990, 1991) has described this elegantly in terms of how violations of expectancies serve to transform adolescent–parent relationships.

The developmental and social changes of adolescence typically lead to many new areas where limits must be renegotiated and where autonomy may be sought (or feared). American adolescents spend increasingly more time away from home without supervision, leading to parental concerns about monitoring, curfews, and involvement in problem behaviors (see Rothbaum *et al.*, 2000, for a discussion of how this differs in Japan). Transformations of adolescent friendships into cliques, crowds, and romantic relationships lead to increased parental concerns about peer group influences, dating, and premature sex, and the emerging ability to drive and work outside the home brings new opportunities and risks. All these social changes require parents to reassess (or assess in a new way) adolescents' competencies, which themselves are undergoing dramatic transformations due to the cognitive and physical changes of adolescence.

The research on adolescents' and parents' conceptions of parental authority indicates that adolescents view many risk behaviors, such as drinking alcohol, smoking cigarettes, using “soft” drugs like marijuana, when to have sex, and driving, as issues that should be under their personal discretion (Smetana & Asquith, 1994) or as “personal but foolish” (Nucci *et al.*, 1996). In contrast, parents nearly unanimously view these issues as prudential and pertaining to adolescents' health and safety and, therefore, as beyond adolescents' legitimate authority or developmental competence to decide (Smetana, 2000; Smetana & Asquith, 1994). Moreover, although parents increasingly view decisions about choice of friends, appearances, and TV programs, music, and video games as legitimately within adolescents' personal arena as adolescents get older, parents' judgments consistently lag behind those of adolescents.

The extent to which parents view these issues as personal for their adolescents may vary by culture or ethnicity. For instance, comparisons across studies suggest that African American middle-class parents (Smetana, 2000) are less likely to view these types of issues as personal for their adolescents than are middle-class European American parents (Smetana, 1988a; Smetana & Asquith, 1994). Differences may be due both to African American parents' traditional beliefs in

the importance of conformity to cultural and religious conventions and the value placed on respect for elders (Garcia Coll *et al.*, 1995; Parke & Buriel, 1998), as well as concerns with adolescents' safety due to the effects of racism. However, both large discrepancies between adolescents' and parents' judgments of what is personal for adolescents and longitudinal increases with age in the boundaries of personal jurisdiction were observed in African American families, much as they have been found (in cross-sectional studies) in European American families.

Thus, the research on adolescent-parent conflict and the related research on conceptions of parental authority suggest that changes in the boundaries of adolescents' personal jurisdiction may come "from the bottom up"; adolescents' claims to personal jurisdiction are followed over time by parents' granting greater personal control over those issues. Adolescents actively attempt to negotiate, resist, contest, and ultimately transform the boundaries of parents' conventional (and prudential) beliefs and practices into a broader arena of self-regulation, personal control, and autonomous functioning. These issues at the boundary of personal jurisdiction and legitimate parental authority thus constitute the dynamic region where the development of autonomy proceeds. Based on Vygotsky (1978), culture theorists have proposed that development in the "zone of proximal development" proceeds through children's guided participation in activities slightly beyond their competence (Rogoff, 1990; Wertsch, 1979). In contrast, the findings from my research suggest that children's active assertions of competence may provoke autonomy development by guiding parents to shift their views (Smetana, 1995a).

This discussion has focused primarily on adolescent-parent relationships. However, the transition from infancy to toddlerhood also entails a period of rapid developmental change and a great deal of research and theorizing about this period has focused on related concerns with children's autonomy, defiance, and compliance (Crockenberg & Litman, 1990; Erikson, 1958). These concerns are centered primarily on granting young children new areas of personal discretion. The development of personal concepts thus entails ongoing negotiations between children and their caregivers over what children claim to be personal and what adults view them as competent to control in their particular environmental contexts.

### **VIII. Autonomy from the Perspective of Research on Adolescent Development**

The studies on cultural orientations cited at the outset of this chapter and the research discussed here provide widely divergent and contradictory views regarding the nature of the self, the meaning of claims to personal jurisdiction, and the development of autonomy. Cultural theorists have asserted that notions of the autonomous self primarily characterize individualistic cultures, while a focus on group goals and interdependent construals of the self characterize collectivist cultures. Yet in the research presented here, adolescents varying in ethnicity and

from different cultures ranging from those typically described as individualistic to those seen as prototypically collectivist similarly appeal to personal jurisdiction in situations of conflict with parents. Likewise, children in a range of cultures develop concepts of personal choice, and mothers in these cultures endorse independent decision making as a means of developing the child's competence, agency, autonomy, and self-esteem. Autonomy is of concern to parents in cultures that have been considered collectivist as well as individualist. Some of the apparent contradictions between these two sets of findings may be due to confusions over the meaning and definition of autonomy. For many culture theorists, autonomy has been equated with an orientation toward individualism, uniqueness, and a sense of self as detached from others. However, whether autonomy is commensurate with individualistic values deserves more careful scrutiny.

Theorizing and research on autonomy development during adolescence have indicated that autonomy is a multifaceted construct. Autonomy most often has been defined as the process of becoming a self-governing person (Silverberg & Gondoli, 1996; Steinberg, 1990, 1999), but distinctions generally have been drawn between emotional autonomy, which refers to the process of individuating from parents and perceiving oneself as a responsible and mature individual who is less dependent on parents, and behavioral autonomy, which refers to the ability to make independent decisions (Steinberg, 1990, 1999).

Researchers studying emotional autonomy during adolescence have rejected the notion that autonomy necessarily entails distancing or separation from parents. Indeed, this notion has stemmed from earlier psychoanalytic theories, which have promoted the notion of adolescence as a period of normative developmental disturbance and adolescent–parent relationships as highly conflictive. In more recent research with European American adolescents and their parents, distancing and emotional separation from parents in the absence of maintaining connections is seen as an indication of maladjustment (Ryan & Lynch, 1989). Current conceptualizations (based primarily on research using European American samples) instead emphasize the importance of maintaining a balance between autonomy and relatedness to parents as necessary for healthy emotional autonomy (e.g., Allen, Hauser, Bell, & O'Connor, 1994; Grotevant & Cooper, 1986). Thus, cultural theorists' global descriptions of autonomy in individualistic cultures are not consistent with current theory and research regarding the nature of emotional autonomy development during adolescence. Whereas culture theorists view the balance between autonomy and relatedness as tipped toward autonomy in individualistic cultures and tipped toward relatedness in collectivist cultures, researchers studying North American (e.g., prototypically individualistic) adolescents view healthy autonomy as a balance between the two. And significantly, the parents of adolescents, and even adolescents themselves, view it that way as well.

From a cultural perspective, Kagitcibasi (1996) has asserted that emotional closeness or interdependence (or, conversely, separation) and agency are logically

and empirically distinct dimensions of autonomy that should not be confounded. She asserts that, whereas emotional separation and agency are characteristic of individualistic cultures, and emotional interdependence and lack of agency (heteronomy) are characteristic of collectivist cultures, some cultures, particularly those in transition, may endorse both emotional interdependence and agency, which she refers to as autonomy-relatedness. This account, with its more dimensional view of autonomy, provides an important advance over the way autonomy has been conceptualized in most culture theories. But it is problematic in its denial of agency to collectivist cultures. It also perpetuates the view of American culture as endorsing primarily separation, even as current research has characterized North American adolescents in terms of autonomy-relatedness (e.g., Allen *et al.*, 1994).

### **IX. Culture, Autonomy, and the Personal**

Thus, the research on emotional autonomy development during adolescence, as well as the research on behavioral autonomy discussed above, is in line with theorizing from the social domain perspective that establishing an arena of personal freedom is important for healthy psychosocial development. Rather than reflecting purely individualistic values, the research discussed here suggests that appeals to personal jurisdiction serve basic human psychological needs, although cultures may vary in the boundaries that define the personal domain, the specific types of issues over which personal jurisdiction is sought, and the ages at which personal jurisdiction over personal issues is deemed appropriate. Moreover, the research indicates that mothers in a variety of cultures view the development of an arena of personal discretion as a desired developmental goal because it helps to promote the child's psychological development.

The responses of African American mothers quoted at the outset of this chapter indicate that parents coordinate their beliefs about allowing independent decision making with their concerns about socializing children to uphold cultural, religious, and familial conventions. Parents draw boundaries to children's personal freedoms. Coordinations between what should be personal for the child and what should be subject to conventional regulation vary by culture, change with adolescents' increasing age, and are informed by parents' assessments of the context in which choices are to be made, the adolescents' competencies to make those choices, and parents' orientations toward parenting (Smetana, 1995c). As the examples from our interviews with African American mothers quoted at the outset of the chapter illustrate, these coordinations may be finely tuned and carefully considered. They also may be in conflict or remain uncoordinated.

Culture theorists and social constructionists (e.g., Shweder & Bourne, 1984) have viewed these different developmental tasks primarily in terms of cultural reproduction. Children's internalization of cultural norms and values and the

development of the self are seen as recapitulating societal constructs. From this perspective, adolescents' conflict with parents may be seen as indicating noncompliance, resistance to adult authority, and more generally, failures in internalization. In contrast, the evidence presented here suggests that acceptance of parental and cultural conventions and the construction of self and boundaries of personal jurisdiction constitute interrelated, dialectical, and constructive processes that entail children's attempts to redefine the hierarchical relationships of childhood into the more mutual relationships of adulthood. How children's and adolescents' claims regarding personal prerogatives and personal entitlements are coordinated with social conventions in different cultural systems, with their varying power relationships, hierarchical structures, and differentiated social roles, lead to cultural variations in these concepts and thus to heterogeneity both within and between cultures. As the research described here indicates, adolescents' negotiations, resistances, and challenges to parental authority are selective and developmentally functional in transforming parent-adolescent relationships and in constructing a coherent self. They also lead each generation to construct anew the social conventions of their society, leading to potential changes in cultural practices.

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# MATERNAL RESPONSIVENESS AND EARLY LANGUAGE ACQUISITION

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## I. Introduction

The acquisition of language constitutes one of the most remarkable and complex achievements of early childhood. In a span of approximately 2 years, the cooing, babbling infant develops into a relatively competent communicative partner, able to understand and express virtually hundreds of words and phrases. Although the order of children's language achievements is generally consistent, the first 2 years are characterized by enormous variation among children in their lexical, syntactic, semantic, and pragmatic abilities (Hoff-Ginsberg, 1991). These early individual differences in language are meaningful, often forecasting children's later cognitive-linguistic achievements and emergent literacy (e.g., Chall, Jacobs, & Baldwin, 1990; Bornstein & Haynes, 1998). From the dynamic systems view (Thelen & Smith, 1994), several emergent, interactive processes explain the course of language development, and variation among children in early language is explained by a confluence of factors, including affect, motivation, articulation, cognition, and *parenting*. In particular, children's experiences with language—notably their interactions with mothers who are verbally responsive to children's own initiatives and interests—exert telling effects on children's contemporary and future language achievements.

In this chapter, we review the body of evidence we have unearthed for the centrality of *maternal responsiveness* in children's language acquisition in the first 2 years of life. Our evidence is based on naturalistic observations of mothers and their young children. We begin by discussing concurrent and predictive associations



between the amount of verbal information mothers provide to their children and children's receptive and productive lexical development. We then revisit these associations, demonstrating the special relevance of mothers' responsive verbal interactions for their children's language gains. Next, we explore more deeply the lagged effects of maternal responsiveness for language acquisition by modeling the developmental onset of key language milestones (e.g., first words and vocabulary spurt). Our inquiry includes a content analysis, in which maternal responses to their children are characterized in terms of their targets (i.e., which behaviors of children mothers respond to) as well as their contents (i.e., how mothers respond). To illustrate the effects of responsiveness more concretely, we focus on the language acquisition of two children who experienced extremes of maternal responsiveness and augment these analyses by presenting their language diaries: one with a relatively unresponsive mother, and one with a highly responsive mother. This microgenetic portrayal captures the essence of our quantitative findings by characterizing individual trends that reflect those of the group. In the concluding section, the relevance of verbal responsiveness for children's language acquisition is considered in light of current theories on the social context of language development. We highlight the ways in which maternal responsiveness supports the limited, if still impressive, perceptual, cognitive, and social abilities that children bring to the task of learning language, and we speculate on why and how different forms of maternal verbal responsiveness become essential as children first master language.

## II. Children's Language Experiences

This chapter builds on social-pragmatic theories of early language acquisition that emphasize the role of expert partners in guiding children through the process of acquiring new symbolic forms (Bloom, 1993; Bornstein, 1985; Carpenter, Nagell, & Tomasello, 1998; Landry, Smith, Miller-Loncar, & Swank, 1997; Nelson, 1973, 1988; Woodward & Markman, 1998). This position is rooted in the writings of theorists such as Vygotsky (1962) and Bruner (1974, 1983), both of whom underscored the ways in which adults help children to extract meaning, assign interpretation, and infer intention from reciprocal interactions.

An impressive corpus of empirical research indicates unquestionable connections between children's verbal environments and their language achievements (e.g., Bloom, 1993; Hart & Risley, 1995; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Landry *et al.*, 1997; Nelson, 1973; Snow, 1986). The language children hear in their first 3 years is unarguably one of the most powerful predictors of their emerging linguistic competencies, oftentimes exerting enduring consequences for school readiness, literacy, and overall cognitive functioning (Chall *et al.*, 1990; MacWhinney & Bornstein, 2002). This body of research

has stimulated theoretical models on the origins of word learning and children's emergent language (e.g., Hollich, Hirsh-Pasek, Tucker, & Golinkoff, 2000), and it has advanced our understanding of the reasons why certain children lag behind their peers in early language performance. As a concrete example, circumstances of poverty have often been associated with cognitive and linguistic delays (e.g., Brooks-Gunn & Duncan, 1997; Hart & Risley, 1995; Kelly, Morisset, Barnard, Hammond, & Booth, 1996), and although the mechanisms underlying connections between poverty and language are appreciably complex, the home environment mediates links between poverty and children's outcomes, most significantly through its effect on the verbal environments of children (Bloom, 1998; Bradley, 1995; Brooks-Gunn & Duncan, 1997; Hoff-Ginsberg, 1991).

Our own early findings substantiated the role of children's language experiences in their language acquisition. In three longitudinal investigations, we documented the importance of mothers' verbal interactions and encouragement of infant attention for language and cognitive performance. In the first series of these studies, Bornstein (1984, 1985; Ruddy & Bornstein, 1982) identified associations between maternal didactic language and behavior in infancy and children's language and cognitive status at 12 months and at 4 years. For example, mothers who more often verbally or physically encouraged their children to attend to the environment (termed didactic encouragement) at 4 months had children with greater vocabulary sizes at 12 months and higher scores in psychometric IQ at 4 years.

A second investigation of 13-month-olds evaluated maternal didactic and social interactions in the home in relation to infant language at 13 months. The influence of maternal didactic activities related conditionally to maternal social activities and to the role of the infant in the interaction (Vibbert & Bornstein, 1989). In predicting children's noun comprehension, for example, when object-centered interactions were initiated and maintained by mothers, their toddlers showed linear gains in language skills to the degree that their mothers also engaged in social activities. By contrast, when toddlers initiated and maintained object-centered interactions more than their mothers, maternal social input was unassociated with language growth.

Some years later, we asked whether maternal didactic encouragement in infancy continues to predict children's emerging language over and above children's own contributions. To address this question mothers and children were assessed during naturalistic interactions when children were 5 and 13 months of age; language data were obtained from these naturalistic interactions as well as through maternal report. Children were also seen in the laboratory at 5 months where they were assessed for their information-processing ability. We found that mothers' verbal and physical didactic encouragement predicted children's language comprehension and production at 13 months after considering the significant contribution of infant information processing at 5 months (Tamis-LeMonda & Bornstein, 1989).

In short, despite our initial use of relatively crude (and on-line) assessments of maternal verbal and physical didactic interaction, these three study sets revealed that children's earliest language experiences influenced the course of their

language (and cognitive) growth apart from stability in children's own performance. A question that arose from these investigations concerned the deeper nature of these mother-child associations. That is, although the verbal information inherent in didactic communications is crucial to language (Huttenlocher *et al.*, 1991), these studies motivated us to ask about the ways that mothers convey information to their children, and whether indicators of verbal quality (i.e., responsiveness) predict children's language above mothers' amount of language. In the following sections, we define maternal responsiveness and review studies that demonstrate that children who frequently experience responsive verbal input appear to be afforded a special advantage in acquiring language.

### III. The Nature of Responsiveness

In the first 2 years, children's exploration of objects, play, vocalizations, and bids to mother constitute their frequent, prominent, generally communicative behaviors. The extent to which children engage in these activities varies substantially. Mothers too vary in their reactions to children, and in how much their own reactions are attuned to their children's initiatives. For example, a child holding up a doll might provoke various reactions, including a verbal response (e.g., "That's a doll, isn't it?" and "Is dolly hungry?"), reprimand or prohibition ("Put that down"), asynchronous comment ("Let's play with the blocks"), or silence. Even within this small and incomplete array of possibilities, we suggest that maternal reactions that are prompt, contingent, and appropriate to children's activities—here termed responsiveness—contribute in a fundamental way to explaining variation in children's language acquisition (Bornstein & Tamis-LeMonda, 1989).

*Promptness* refers to the timing of mothers' replies vis-à-vis their children's overtures. In our studies, we focus on maternal reactions that occur within 5 s of a change in children's behaviors. Data from numerous sources indicate that the temporal duration for various basic temporal events (e.g., lines of poetry, spoken sentences, breath cycles, and communicative movements) falls between 2 and 7 s (see Jaffe *et al.*, 2001, for discussion). Because events appear to be grouped into coherent wholes when they occur within this span (Jaffe *et al.*, 2001; Rovee-Collier, 1995), we reasoned that children would be more likely to link words to perceptual experiences when the two are temporally connected. To the extent that verbal responsiveness ensures temporal contiguity between auditory and perceptual experiences, children should be more prone to link sounds to meaning in memory within this temporal window. *Contingency* refers to the dependence of maternal reactions on child behavior. Contingent replies are ones that evolve out of moments of shared attention, bearing meaning to the child's initiative. A maternal reply may fall within a 5-s window, but may not be pertinent to anything the child has done. Indeed, maternal reactions that are asynchronous with child behaviors (e.g., saying "Look at the doll!" as a child reaches for a ball), even if prompt,

may actually interfere with the process of mapping words to referents, particularly during early stages of language acquisition (Tomasello & Farrar, 1986). *Appropriateness* refers to maternal replies that are conceptually and positively connected to the child's behavior. A mother who states, "You're feeding your bear" as a child directs a spoon to the mouth of a toy bear is providing constructive information, whereas a mother who admonishes "Put that down!" is not. This is so even though both reactions may be prompt and contingent.

In summary, three aspects of verbal stimulation—promptness, contingency, and appropriateness—lie at the heart of what constitutes responsiveness. Based on the conceptual importance of these three constructs, we speculated that responsiveness would be paramount in the first 2 years, when the start of children's own cognitive skills place enormous responsibility on mothers to scaffold learning and interpret the world so that meaning might be shared. Theorists have interpreted the relevance of verbal responsiveness in several ways (e.g., Bornstein, Tamis-LeMonda, & Haynes, 1999), including the notion that verbal responsiveness eases referent matching for children by decreasing situational ambiguity. Children who hear words that are congruent with their actions need not "guess" about adult reference or rely solely on natural constraints; rather, the adult has anticipated the child's intent (Nelson, 1988). We address potential mechanisms of action of responsiveness after reviewing empirical evidence on the role of verbal responsiveness for children's language development.

#### **IV. General Procedures for Studying Maternal Responsiveness and Children's Language Development**

In this section we provide a general overview to procedures we have used in our investigations of maternal responsiveness and child language. Past research from other laboratories indicates that mothers frequently respond to their children's initiatives and do so in developmentally appropriate ways. For example, mothers fine-tune the semantic and syntactic contents of their utterances to match their children's level of understanding (e.g., Clarke-Stewart, VanderStoep, & Killigan, 1979; Cross, 1978). Maternal speech that semantically matches children's speech, as one form of responsiveness, predicts children's linguistic abilities (Barnes, Gutfreund, Satterly, & Wells, 1983; Cross, 1978). In our research, we sought to extend these findings in a series of sequential, longitudinal studies with middle-class mothers and their first-born children.

##### **A. HOME VISIT PROCEDURES**

Dyads whom we recruited were visited in their homes every few months, where they were assessed on measures of object play, attention, language, and

interactions, starting when children were 2 months of age and extending through their 22nd month. These dyads were recruited from private pediatric groups in New York City. The various samples included between 24 and 120 children. Participants across studies came from relatively homogeneous, middle-class, intact households in which both mother and father had typically completed college.

In infancy, dyads were visited in their homes at 2, 5, and 9 months. In the second year, they were visited in their homes when children were 13, 17, and between 21 and 22 months of age. During all home visits, naturalistic observations of daily activities (e.g., feeding) and mother-child free-play were videotaped. During the free-play sessions, children and mothers were seated on the floor with a standard set of toys (e.g., doll, blocks, nesting set, teapot and cover, cups and saucers, spoons, telephone, and vehicle), and they were videotaped for 10 to 15 min. Mothers were asked to remain with their children and to do whatever was typical for them when they played with their children. They were told they could use any or all of the toys provided, but that the child's own toys should not be introduced. Most of the studies of responsiveness we describe are based on data coded from these free-play sessions.

At all ages, event-based coding systems were used to document the frequency of vocal and exploratory behaviors in children (e.g., vocalizing, bidding toward mother, looking at objects, and playing). The onsets and offsets of target behaviors were noted, and these target behaviors provided a starting point for classifying mothers' behavioral reactions.

Mothers' behaviors were also coded using event-based coding systems in which each maternal reaction to each child behavior was noted. These reactions could be responsive or could fall into other behavioral categories such as redirections, prohibitions, and ignoring. A maternal response was defined as a positive and meaningful change in the mother's behavior that was appropriate, temporally contiguous (i.e., within 5 s), and contingent on a change in children's own behaviors. As an example, if the child looked at a cup (target act = exploring) and the mother said "cup," the mother was credited with being responsive; similarly, if the child said "cup" (target act = vocalizing) and mother responded "Yes, that's a cup," she would be credited with responding. For each instance of responsiveness, coders noted what the mother was responding to (response target) and the precise nature of her response (response type). The categories of child behaviors, as well as maternal responses to these individual behaviors were all mutually exclusive.

From these data, frequency counts were obtained on infant target acts, mothers' responses to each target act, and the various types of responses (e.g., descriptions and questions). All measures in children and mothers varied substantially and showed meaningful developmental change. Interobserver reliabilities were conducted on all measures at the onset of each study after a period of extensive training, throughout the course of the study, and at the study's end. In general,

reliabilities were based on 15 to 25% of the observations in each sample, randomly selected. Kappa and percentage agreements were acceptable for all variables.

#### B. LANGUAGE ASSESSMENTS

Measures of children's language were obtained through maternal report and/or observations of actual child language from transcripts of the videotaped free-play sessions. Transcripts were coded for children's word types and tokens, semantic usage, and syntactic complexity (e.g., MLU) using the *Systematic Analysis of Language Transcripts* (SALT; Miller & Chapman, 1993). These observed measures of language were augmented with information from maternal interviews about children's language, based on the MacArthur Communicative Development Inventories (MCDI; Fenson *et al.*, 1994) as well as instruments developed in our laboratory. Overviews of our various interview procedures are described separately within each study.

#### C. SUMMARY

In sequential longitudinal cohorts of middle-class mothers and their children seen at various time points across children's first and second years we assessed multiple dimensions of maternal responsiveness, children's activities, and children's language. The various studies were designed to address several outstanding questions that form the basis of the next four sections: Does verbal responsiveness predict children's language above the amount of language to which children are exposed? Does responsiveness explain differences in the developmental onsets of children's language milestones? Are the effects of responsiveness global or specific? What is the magnitude of effects on language for children experiencing extremes of maternal responsiveness?

### **V. Does Responsiveness Matter above Total Amount of Language?**

A central aim of our studies has been to examine whether verbal responsiveness matters for children's early language acquisition, and if so, if it bears special relevance beyond the amount of language to which children are exposed. Maternal responsiveness might predict children's language acquisition by virtue of the sheer linguistic information it affords. Children who regularly encounter responsive language are provided with ample opportunity to associate meaning with verbal symbols: Mothers who verbally respond more often are likely to be talking more often as well (Hoff *et al.*, 2002). Consequently, the amount of language that children encounter may be fundamental (Huttenlocher *et al.*, 1991; Hart & Risley, 1992, 1995). However, we believe that maternal language is more meaningful

when it is promptly, contingently, and appropriately responsive to children's own verbal and nonverbal activities. This is not to say that amount of language is unimportant, but rather that a more comprehensive understanding of children's language experiences is offered by a focus on both language quantity (amount) and quality (responsiveness).

This proposition led us to reexamine our initial findings regarding the importance of maternal didactics by emphasizing not only how much didactic language children experience, but also whether mothers' messages matched the initiatives and interests of children. How verbally responsive are mothers to their children, and to what extent does verbal responsiveness per se contribute to variation in children's language acquisition? In the following section we address these questions, and advance the proposition that the promptness, contingency, and appropriateness of verbal information—its responsiveness—contributes uniquely to language, even after considering the amount of language mothers produce.

#### A. VERBAL RESPONSIVENESS VERSUS AMOUNT: EMPIRICAL EVIDENCE

In a set of three studies with different cohorts and ages, we contrasted the predictive validity of verbal responsiveness with other measures of maternal language. Our first investigation was based on a reanalysis of data we had gathered on maternal didactic encouragement and infant habituation at 5 months in relation to children's emerging language and representational competencies at 13 months (Bornstein & Tamis-LeMonda, 1989). We asked whether the quantity of mothers' verbal encouragement predicted their children's language and/or whether the quality of their encouragement (i.e., responsiveness) was critical. To address this question, we classified each episode of maternal didactic encouragement as "responsive" or "nonresponsive" and examined associations between these two forms of maternal interaction and children's later receptive and productive language. We found that maternal responsive encouragement predicted children's language abilities over and above their nonresponsive encouragement and that responsiveness continued to predict these outcomes after covarying children's own information processing abilities. Importantly, didactic encouragement that was not responsive did not predict children's language.

In another study, we coded maternal verbal stimulation from transcripts of children's language in order to explore associations between maternal verbal responsiveness and other forms of verbal behaviors in mother's and children's receptive language (Baumwell, Tamis-LeMonda, & Bornstein, 1997). Dyads were visited in their homes when children were 9 and 13 months old, and they were videotaped during free-play interactions. Sequential records of all mother and infant vocalizations and behaviors were transcribed at both ages. From these transcripts, we noted base rate frequencies of infant vocalizations, looks and bids to mother, and play and exploration of toys. Mothers' reactions to each infant behavior were classified as follows: verbal responses (mother replies contingently and

appropriately within 5 s of a change to infant behavior, e.g., “doggie” as child shifts attention to a dog), elaborations (mother builds on her prior response by providing additional information, e.g., “Furry dog!” said after a mother’s initial response and as the child maintains focus on the dog), focus shift (mother attempts to redirect her child’s attention to something new, e.g., “Look at the bus!” as child looks at a dog), or prohibitions/reprimands (mother verbally restricts her child’s actions, e.g., “Stop”). When children were “off task” we noted whether their mothers attempted to redirect their attention to the play materials (e.g., “Look at the dog!” when the child was not focused on anything in particular).

Factor analyses revealed two maternal factors at each age: Sensitivity (which loaded on mothers’ verbal responsiveness, elaborations, and focusing children’s attention when they were unfocused) and Intrusiveness (which loaded on focus shifts and prohibitions). Sensitivity (which was most strongly comprised of mothers’ verbal responsiveness) predicted children’s language comprehension at 13 months, but Intrusiveness did not. Specifically, maternal sensitivity to 9-month-olds uniquely accounted for 15% of the variance in 13-month language comprehension (after controlling for children’s 9-month language and mothers’ later responsiveness). Together, 9-month comprehension and 9- and 13-month maternal sensitivity accounted for 37% of the variance in children’s 13-month language comprehension. In contrast, Intrusiveness accounted for only 1% variance in children’s receptive language. The fact that Intrusiveness contained verbal information (e.g., mothers’ talking about objects/events outside of their children’s focus and their reprimanding children), but did not predict children’s language, again points to the importance of maternal verbal quality for children’s initial language acquisition.

In a third, prospective longitudinal study we assessed the role of maternal responsiveness in two contexts when toddlers were 13 and 20 months old (Bornstein, Tamis-LeMonda, & Haynes, 1999). We evaluated associations between mothers’ productive vocabulary and verbal responsiveness and children’s emerging language during play and mealtime across two ages (13 and 20 months). Continuity, stability, and several models of concurrent and lagged child–mother correspondences were evaluated based on transcripts of mother–child interactions at both ages and both contexts. Developmental change in maternal verbal responses between 13 and 20 months predicted child vocabulary at 20 months. That is, mothers who grew in their verbal responsiveness over time had children who demonstrated significant gains in their own vocabularies over time, both in play ( $\beta = .46, \Delta R^2 = .13$ ) as well as at mealtime ( $\beta = .45, \Delta R^2 = .18$ ). These analyses covaried children’s own 13-month contributions to language outcomes, which were also significant. Similarly, developmental change in child vocabulary across the 7 months predicted maternal responses at 20 months. In contrast, the sheer size of mothers’ productive vocabulary did not predict children’s language, nor did children’s language growth predict later maternal productive vocabulary ( $\Delta R^2$  ranged from .00 to .04).



## B. SUMMARY

In summary, investigations in our laboratory reveal that mothers vary substantially in the quality and quantity of language they provide their children. When both language amount and verbal responsiveness are considered, however, verbal responsiveness is found to contribute uniquely to children's emerging language. In fact, our findings suggest that verbal responsiveness has a more robust effect for children's language than do other measures of maternal language.

## VI. Does Maternal Responsiveness Predict the Timing of Children's Language Achievements?

These studies provided compelling support for the role of verbal responsiveness in children's early language acquisition. This research inspired us then to model the influences of verbal responsiveness more precisely by documenting mothers' responsiveness in relation to children's growing language abilities from the end of the first to the end of children's second year (Tamis-LeMonda *et al.*, 2001; Tamis-LeMonda, Bornstein, Kahana-Kalman, Baumwell, & Cyphers, 1998). To do so, we tracked biweekly changes in children's receptive and productive verbal competencies and estimated the effects of verbal responsiveness on the emergence of language milestones in children. This line of inquiry emphasized the predictive validity of verbal responsiveness for the developmental timing of children's language achievements. Specifically, we asked whether dimensions of mothers' verbal responsiveness and/or children's own earlier abilities predicted differences among children in various language capacities, such as the onset of the vocabulary spurt and achievement of combinatorial speech. Although our prior studies indicated that responsiveness explains variation in children's language at isolated points in time, they did not speak to whether and how responsiveness might alter the developmental unfolding of language competencies in children. This emphasis aptly shifts attention from static snapshots of children's linguistic abilities toward a focus on the processes that enable language achievements (see also Hollich *et al.*, 2000; Huttenlocher *et al.*, 1991; Plunkett, 1997; Smith, 1995).

## A. PROCEDURES

Forty mother-child dyads were visited in their homes when children were between the ages of 9 and 10 months and then again when the children were between the ages of 13 and 14 months; children's language acquisition was also tracked biweekly through maternal interviews from 9 to 22 months.

### 1. Coding of Child Behavior and Maternal Responsiveness

From videotaped observations of mother-child play, children's verbal, visual, and exploratory/play activities were transcribed sequentially and subsequently coded. Event-based coding of all child activities and all maternal responses was conducted from the transcripts in conjunction with the videotapes. Coders noted each time the child exhibited a change in his/her verbal and/or exploratory behavior (e.g., vocalizing, bidding to mother, and exploring a new toy) and whether or not the mother verbally responded within 5 s. From these data, the frequencies of children's behaviors and mothers' verbal responses were derived for each age. Maternal responsiveness and children's activities were then examined in relation to children's emerging linguistic achievements.

### 2. Language Assessments

Data on children's language were obtained through biweekly interviews with mothers. To facilitate these interviews, experimenters provided mothers with a packet of language inventories at the end of the 9-month visit and asked mothers about times that would be convenient to discuss their children's language progress on a weekly basis. Packets included versions of the Early Language Inventory (ELI; Bates, Bretherton, & Snyder, 1988) and MacArthur CDI (Fenson *et al.*, 1994) as well as checklists exemplifying various semantic and syntactic uses of words and phrases (Tamis-LeMonda & Bornstein, 1994). At younger ages (i.e., from start of study to around 13 months), a subset of items in the MCDI was used (specifically, the ELI on which the MCDI was based) as children at these ages expressed few words and their receptive language was still limited. Early interviews lasted approximately 15 to 20 min, whereas interviews at later ages, which utilized the full MCDI, took up to 2 h.

During each telephone interview, the interviewer asked the mother whether her child imitated and/or expressed each word/phrase on the list. In the case of spontaneous expression, the interviewer further asked whether the child's expression was context "flexible" or context "restricted" (e.g., saying "ball" to all balls, even not present, as opposed to saying "ball" only to a specific ball). To receive credit for expressing a "word," children had to: (1) approximate the phonetic form of the word (e.g., "ehh" for bottle was not credited, whereas "bot" for bottle was); (2) use the phonetic form in a consistent way with a recognizable meaning; (3) express the word spontaneously; and (4) use the word across contexts, that is, in a flexible manner.

After probing about specific words/phrases, the interviewer next asked the mother whether her child was "putting two or more words together." If a mother reported that her child was combining words, the experimenter probed for specific examples of the child's constructions and asked the mother to provide contextual information about the child's word combination(s). The achievement of combinatorial speech was credited when: (1) the child was reported to link two or more words in a single phrase, (2) the mother was able to provide the context for her

child's use of the phrase, (3) each of the words in the phrase could be classified as independent words in the child's vocabulary, and (4) each of the words in the phrase could be classified into distinct semantic categories (e.g., actor, action, object of action, patient, and possession; for additional details, see Tamis-LeMonda & Bornstein, 1994, Tamis-LeMonda *et al.*, 1998).

From these interviews, the timing of various language milestones in children was calculated. For illustrative purposes, we focus on findings related to two specific language outcomes: (1) the timing of 50 words in productive language, defined as the age at which the child accumulated a total of 50 flexible words in his/her productive vocabulary; and (2) the timing of combinatorial speech, defined as the age at which the child first combined two words in a single utterance. These two milestones were selected for analyses because of the high importance placed on each in the language literature. The onset of 50 words in children's productive language has long been considered a landmark in early vocabulary development (Nelson, 1973). Around the time children accumulate about 50 words in their expressive vocabularies, they also experience a sudden acceleration in lexical production (see Bloom, 1973, 1993; Reznick & Goldfield, 1992). For example, Bloom (1993) showed that at the time children evidenced a vocabulary spurt they had an average of 51 different words and that all children reached the 50-word vocabulary mark within 1 month of showing a substantial acceleration in their productive lexicons (Bloom, Margulis, Tinker, & Fujita, 1996). Based on these findings, they placed the end of the early word learning period at the time when children had acquired a vocabulary of about 50 words. The second milestone, the emergence of combinatorial speech, is thought to reflect a child's ability to infer and symbolically encode relations between entities (McCall, 1977) and has been thought to set the stage for future semantic and grammatical advances (Fenson *et al.*, 1994).

### 3. Analyses

To analyze the effects of maternal verbal responsiveness on the timing of these two language achievements, we utilized Events History Analysis (also referred to as Survival Analysis; Willett, 1991, 1993), a statistical approach that is suited to addressing questions of whether and by how much predictors affect the timing of events. In Events History Analysis, time is considered along its continuum, and the conditional probability of an event occurring can be modeled and plotted across discrete ages. If an event is equally likely to occur at any age, the conditional probability plot will be flat. Alternatively, there may be developmental periods during which the probability of the event peaks, indicating that its likelihood rises in a particular window of time. To the extent that the conditional probability shows peaks at discrete ages, it suggests that children are more likely to experience the event at certain ages than they are at others.

From conditional probabilities, cumulative probabilities can be plotted across successive ages. As a hypothetical example, if an investigator assesses a group of children monthly from 6 through 18 months, the cumulative probability of those

children walking independently might be .00 at 6 months (as no children have yet achieved the milestone), .10 by 9 months, .15 at 10 months, .50 at 12 months, and so forth, until all children have achieved the milestone of walking, at which point the cumulative probability reaches 1.00. The median lifetime represents the point at which the cumulative probability of the event reaches .50, that is, when half of the population experiences the target event.

Baseline conditional and cumulative probability functions can be contrasted with fitted functions which provide estimates as to how much the timing of an event is displaced (i.e., moved forward or backward in time) given data on relevant predictors. To do so, nested hierarchical chi-square analyses are conducted in which baseline probabilities (i.e., profiles in the absence of predictors) are compared to fitted functions (in which one or more predictors are included). A significant reduction in the chi-square goodness-of-fit statistic indicates that model fit improves when the predictor(s) is added to the baseline model. To examine the unique influences of two or more predictors over and above each other, fitted models that include multiple predictors are compared to models that include single predictors.

We used this approach to analyze a series of nested hierarchical models that tested the contributions of maternal verbal responsiveness at 9 and at 13 months in conjunction with children's earlier language abilities (e.g., the timing of first words and the timing of 50 words in receptive language) to the timing of children's later language milestones. We included children's earlier language abilities in these models as well, given the strong stability that is evidenced between children's earlier communicative skill and later language (e.g., Bates *et al.*, 1988; Bornstein *et al.*, 1999). Chi-square values for the baseline probability functions were compared to chi-square values for fitted models for each of the predictors in the investigation (i.e., the timing of children's first words, maternal responsiveness at 9 months, and maternal responsiveness at 13 months). Chi-square change values for model fit were examined as individual predictors were added to the model.

## B. RESULTS

First words in production, 50 words in receptive language, and maternal responsiveness at 9 and 13 months were each significant predictors of the timing of 50 words in production. Subsequent examination of the unique predictive validity of each of these measures showed that responsiveness at 9 months did not uniquely contribute to the timing of 50 words in production. In contrast, responsiveness at 13 months predicted 50 words in production over and above the timing of first words in production ( $\chi^2$  change = 5.1,  $p < .01$ ), 50 words in children's receptive language ( $\chi^2$  change = 5.5,  $p < .01$ ), and responsiveness at 9 months ( $\chi^2$  change = 6.6,  $p < .01$ ). This pattern of results suggests that the relation between earlier responsiveness and the timing of 50 words is mediated by intervening linguistic competencies as well as mothers' later responsiveness. In support of this conclusion are the findings that 9-month responsiveness predicted the timing

of 50 words in receptive language, the timing of first words in production, and 13-month responsiveness. In turn, these mediators predicted when children acquired 50 words in their productive lexicons.

With respect to the timing of children's achieving combinatorial speech, responsiveness at 9 months contributed unique variance, above the contribution of 50 words in receptive language ( $\chi^2$  change = 6.1,  $p < .01$ ), but did not contribute unique variance above the timing of first words in production or responsiveness at 13 months. Responsiveness at 13 months contributed unique variance to the timing of combinatorial speech over and above the timing of first words in production ( $\chi^2$  change = 5.4,  $p < .01$ ), the timing of 50 words in receptive language ( $\chi^2$  change = 8.0,  $p < .01$ ), and responsiveness at 9 months ( $\chi^2$  change = 3.7,  $p < .05$ ). Again, responsiveness at 9 months appeared to improve the fit of the model through its relation with first words in production and responsiveness at 13 months, both of which uniquely predicted when children first combine words.

### C. SUMMARY

We depicted the influence of verbal responsiveness on the temporal occurrence of key language milestones in children by plotting and contrasting baseline and fitted conditional probabilities of event occurrence across children's age. Children with verbally responsive mothers achieve the vocabulary spurt and combine words into simple sentences sooner in development than children with less responsive mothers. Predictive associations between responsiveness and the timing of children's language milestone are more robust at 13 than at 9 months, and they matter above the contributions of children's earlier language abilities. The best fitting model, however, is one that includes both children's and mothers' contributions to second-year language gains. That is, a child who produces first words sooner in development coupled with a verbally responsive mother is at a strong advantage for precocious achievement of key language milestones.

## VII. Is the Influence of Responsiveness on Child Language General or Specific?

Based on our prior findings, we were interested, first, in whether responsiveness should be further analyzed into different types and, second which subtypes of responsiveness would show differential prediction to which aspects of children's language growth. The efficacy of maternal responsiveness may not be global, but specific (Bornstein, 2002; Tamis-LeMonda, 1996; Tamis-LeMonda, Bornstein, Baumwell, & Damast, 1996). Moreover, when maternal responsiveness is analyzed into different components, its relations to children's abilities have been shown to be specific (Keller, Lohaus, Voelker, Cappenberg, & Chasiotis, 1999). This suggests that maternal responsiveness might be more profitably understood as a

multidimensional construct, with certain language or other outcomes in children being affected by specific types of responsiveness at specific points in development.

As an example, two mothers could demonstrate similarities in the frequency of their overall responsiveness (i.e., how often they respond to changes in their children's behaviors) and yet differ in (1) the target activities to which they respond—one mother might respond to her child's verbal overtures and another to her child's exploratory initiatives—and (2) in the type of responses they exhibit—one mother might respond by affirming her child's activities ("Good job!") and another by describing her child's actions ("You put the circle in the shape sorter"). In turn, this variation in responses might predict different child abilities. For example, labeling might be more relevant to early language acquisition, when children are acquiring their initial lexicon (e.g., mother says "Doggie!" as she points to a dog). In contrast, "wh-" questions might be relevant at more advanced stages of language, when children are able to draw on their lexical knowledge base and respond accurately to maternal prompts (e.g., mother says "What's that?" as she points to a dog). Our assertion is that the nature of what matters for language is dynamic and changing, depending on what is being learned and what children themselves bring to the task. Consequently, the relevance of different types of maternal responses will shift in parallel with children's emerging competencies.

In a follow-up study, we reutilized mother-infant interactions, this time coding targets of responsiveness (i.e., the behaviors in children to which mothers respond) and types of responsiveness (i.e., the contents of what mothers say when responding) (Tamis-LeMonda *et al.*, 2001). Broadly, our findings indicated highly specific associations between features of maternal responsiveness and features of infant language. We discuss select findings for illustrative purposes.

#### A. TARGETS OF VERBAL RESPONSIVENESS

Examination of responsiveness as a global attribute of mothers indicated the importance of responsiveness at 13 months (Tamis-LeMonda *et al.*, 1998). In our follow-up investigation of response targets (i.e., infant exploration, looks to mother, bids to mother, play initiatives, and language initiatives) we found that mothers' responses to certain child behaviors were more predictive than their responses to others. Specifically, mothers' responses to children's play and language were the strongest predictors of children's language milestones, predicting when children acquired 50 words in production, combined words into simple sentences, and first used language to talk about the past. Maternal responsiveness continued to predict over and above the contributions of children's observed language and play initiatives, as coded from the videotapes. Thus, as children become increasingly able to communicate meaning through the use of language and play, maternal responsiveness to these emerging capabilities becomes effective and meaningful in development (Tamis-LeMonda *et al.*, 2001).

## B. TYPES OF VERBAL RESPONSIVENESS

We next asked whether the contents of mothers' responses matter in terms of what mothers say when they respond to their children's behaviors. We speculated that, at 13 months, mothers who respond by imitating or expanding on their children's vocal attempts would support their children's emerging language. To examine this possibility, we evaluated six types of verbal responsiveness from videotapes of mother-child play in studies which used Events History Analyses as follows: (1) affirmations of a child's actions (e.g., "Yes," "That's right," and "Good job"); (2) imitations/expansions of a child's vocalization (e.g., "ball" after child said "ba"); (3) descriptions of an object, event, or activity (e.g., "That's the spoon you're holding"); (4) questions about an object, event, or activity (e.g., "What is that?"); (5) play prompts or demonstrations (e.g., "Why don't you feed the doll?"); and (6) exploratory prompts (e.g., "Look here" and "What else can we do?"). Over 90% of maternal responses could be classified into one of these six mutually exclusive categories. As before, we examined prediction to the second-year milestones of timing of 50 words in production and the achievement of combinatorial speech, and we also assessed children's use of language to talk about the past. We were interested in children's use of language to talk about the past due to the truly symbolic nature of such linguistic phrases. Across its early ontogenesis, language progresses toward increased decontextualization in which words that were once context-dependent come to be used in the absence of obvious referents (e.g., Tamis-LeMonda & Bornstein, 1990, 1994). For example, initially the word "car" might be said to a child's specific red toy car, only later to be generalized to all toy cars. Still later, a child might say "car" (in the absence of seeing a car) to communicate about a car drive to the zoo the prior week. This last instance gives evidence that the child is using language to symbolize a past experience that is separate from (and possibly in opposition to) the child's current experience.

When analyzed in this more differentiated fashion, different types of maternal responsiveness demonstrated differential predictive validity for children's language gains. In general, maternal imitations/expansions, play prompts, and questions were most predictive. However, the predictive validity of each of these depended on the milestone being considered. Maternal imitations/expansions of children's vocalizations at 13 months predicted the timing of their achieving 50 words in expressive language,  $\chi^2(2) = 13.3, p < .001$ . Maternal imitations/expansions and play prompts predicted the timing of children's combinatorial speech,  $\chi^2(2) = 8.4$  and  $4.7, ps < .01$  and  $.05$ , respectively. Finally, maternal imitations/expansions and open-ended questions predicted the timing of children's first talking about the past,  $\chi^2(2) = 5.3$  and  $4.8, ps < .05$ . The finding that questions specifically promoted children's verbal expressions of memory makes sense in that responsive questions push children to reconstruct experiences and to communicate them to adults.

### C. SUMMARY

To review, certain forms of responsiveness are more effective for children's language, vis-à-vis children's abilities and the cognitive challenges children face. At 13 months, responsiveness to children's language and play initiatives are especially important. Additionally, imitations/expansions of children's language attempts and prompting of children's symbolic play are two types of responses that predict children's later language gains.

## **VIII. What Is the Magnitude of Effects for Children Experiencing Extremes of Responsiveness?**

Responsiveness is clearly important for children's early language acquisition. In this section, we translate these statistical findings into their everyday reality by contrasting the language trajectories of children experiencing low versus high levels of maternal responsiveness. We begin by modeling the cumulative probabilities of children whose mothers were at the 10th and 90th percentiles of verbal responsiveness when children were 13 months of age. We then supplement this statistical analysis with a qualitative approach by presenting excerpts from the language diaries of two girls (drawn from a sample of over 100), one with a mother who was consistently responsive and one with a mother who was consistently unresponsive.<sup>1</sup>

### A. STATISTICAL MODELING OF CHILDREN EXPERIENCING HIGH VERSUS LOW MATERNAL RESPONSIVENESS

Parameter estimates of significant predictors can be used to statistically model conditional and cumulative probabilities for subgroups of children, as, for example, those in the highest and lowest percentiles on relevant predictors. These analyses demonstrate the displaced timing of an event under different levels of significant predictors. As predictors better explain the timing of developmental milestones, the median lifetimes (i.e., the average age of event occurrence) of the subgroups will diverge in the presence of those predictors. For example, if maternal responsiveness is a robust predictor of children's language achievements, the average ages at which children acquire language milestones will differ substantially as a function of responsiveness; if responsiveness is only weakly related to the timing of language achievements, children with mothers high or low on responsiveness will differ little in terms of when they acquire specific language abilities.

<sup>1</sup> Full diaries of participants include 12 months of entries; however, due to space constraints, a subset of each child's diary is presented.



We modeled the effects of mothers' verbal responsiveness on children's language acquisition for extreme values of significant predictors. After isolating significant predictors of children's language milestones, we modeled and plotted cumulative probabilities of language onsets for values at the upper and lower 10th percentiles on key dimensions of maternal responsiveness at 13 months. In instances in which significant child and/or mother predictors of language milestones were identified, using these values and the parameter estimates for the significant predictors, two functions were modeled for each of the child language milestones—one for low levels of maternal responsiveness (i.e., the value at the 10th percentile of the relevant predictor/s) and one for high levels of maternal responsiveness (i.e., the value at the 90th percentile of the predictor/s). This was done by substituting the extreme values and parameter estimates into modeled probability equations.

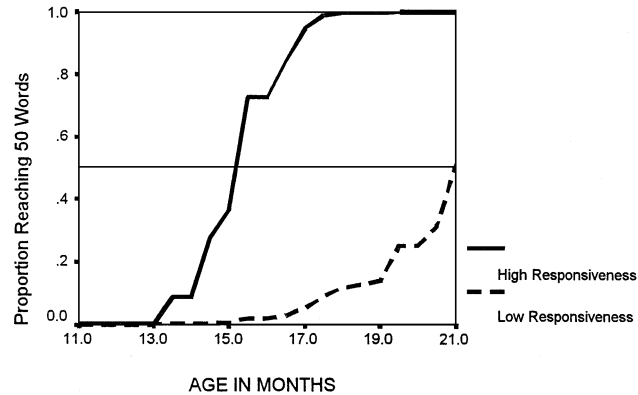
Although we conducted such analyses for all response targets and types as well as for all language milestones, here we focus on the timing of the vocabulary spurt (i.e., 50 words in productive language) for purposes of conciseness. For this outcome variable, we contrast cumulative probabilities for children with mothers who were high versus low in their verbal responsiveness to children's vocalizations and play and for mothers who were high versus low in their imitations/expansions of children's language attempts.

The cumulative probabilities for these subgroups are modeled across age in Fig. 1. Divergences in median lifetimes (i.e., the point at which half the subgroup attains the milestone) as well as in the percentages of children attaining each milestone by the study's end capture the impressive influence of verbal responsiveness on the timing of children's vocabulary spurt. Specifically, children with mothers high in responding to play and to vocalizations at 13 months were estimated to achieve 50 words in productive language on average by 15.2 months, whereas children whose mothers were low on responding to play and to vocalizations at 13 months were estimated to have a median lifetime for the same language milestone at 21 months, nearly 6 months, or one-fourth of their lifetime, later in developmental time (left panel of Fig. 1). Similarly robust predictive patterns are indicated for mothers' imitating/expanding their children's vocalizations (right panel of Fig. 1).

#### B. CASE STUDIES OF HANNAH AND ALYSSA

To make these group findings apparent at an individual level, the diaries of two girls, Hannah and Alyssa, are presented (Tables I and II). Hannah had a highly responsive mother, whereas Alyssa's mother was at the low end of verbal responsiveness. Due to space constraints, we excerpt from each child's complete diary. These excerpts present each child's language achievements during their 9th–10th and 21st–22nd months. These excerpts contrast the girls' starting points of language (which were similar) to their language at the end of study (which had

### Responding to Play and Vocalizations and the timing of 50 Words



### Responding with Imitations and the timing of 50 Words

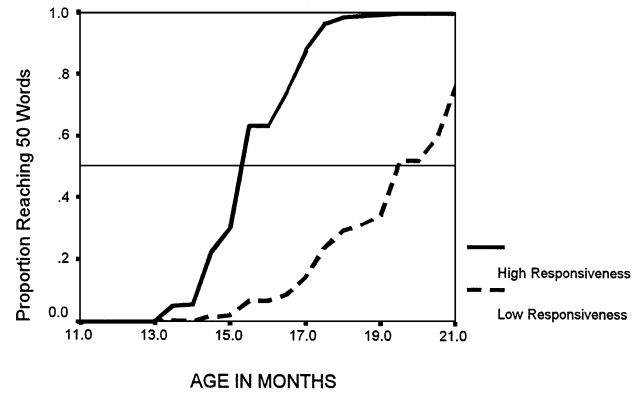


Fig. 1. (Left panel) Modeling cumulative probability functions for the timing of 50 words in children's productive language: estimated functions for high levels of maternal responsiveness to children's play and vocalizations at 13 months (upper 10th percentile) and for low levels of maternal responsiveness to children's play and vocalizations at 13 months (lowest 10th percentile). (Right panel) Modeling cumulative probability functions for the timing of 50 words: estimated function for high levels of maternal responding with imitations/expansions to children at 13 months (upper 10th percentile) and estimated function for low levels of maternal responding with imitations/expansions to children at 13 months (lowest 10th percentile).

Verbal Behaviors in Hannah's and Alyssa's Mothers at 9 Months

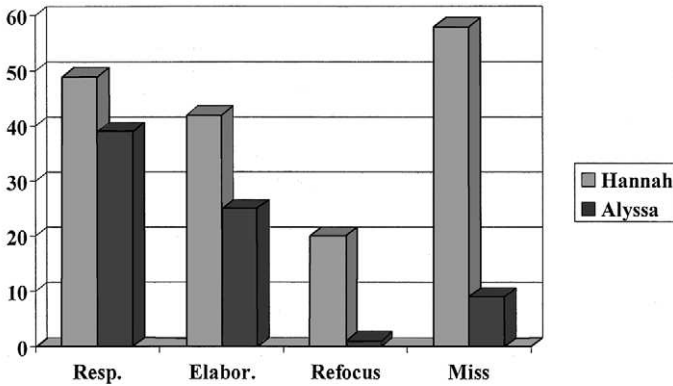


Fig. 2. Frequencies of responses, elaborations, refocuses, and misses in Alyssa's and Hannah's mothers at 9 months coded from observations of free-play.

diverged substantially). Figures 2 through 5 present data on the responsiveness of the girls' mothers, and Tables I and II present data on Hannah and Alyssa's language achievements.

1. Responsiveness of Hannah's and Alyssa's Mothers

Figures 2 through 5 present data on the two mothers based on behavioral categories used in our earlier 9- to 13-month study (Baumwell *et al.*, 1997). We provide data on total responsiveness (i.e., prompt, contingent, and appropriate

Types of Responsiveness in Hannah's and Alyssa's Mothers at 9 Months

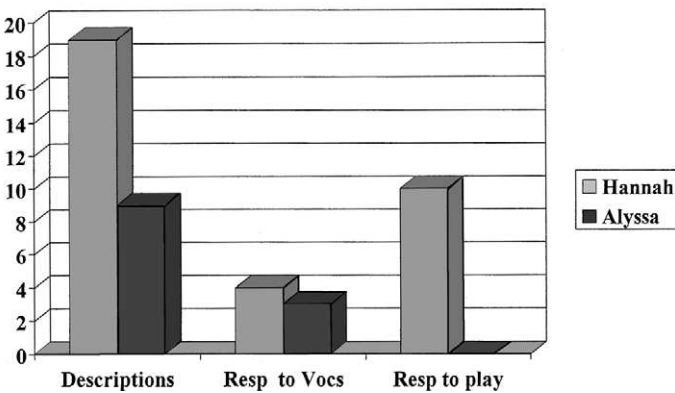


Fig. 3. Frequencies of specific forms of responsiveness in Alyssa's and Hannah's mothers at 9 months (i.e., responsive descriptions, responses to children's vocalizations, and responses to children's play).

## Verbal Behaviors in Hannah's and Alyssa's Mothers at 13 Months

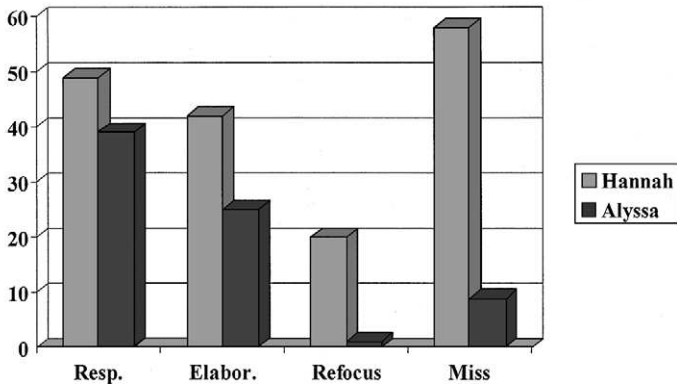


Fig. 4. Frequencies of responses, elaborations, refocuses, and misses in Alyssa's and Hannah's mothers at 13 months coded from observations of free-play.

reactions to changes in children's behaviors), elaborations (i.e., follow-up comments to initial responses, in which mothers build on their response by providing additional information), refocusing (i.e., attempts to redirect the attention of their inattentive child), and misses (absence of any reaction at all to the vocalizations or explorations of their children) for each mother at each age (Figs. 2 and 4 for 9 and 13 months respectively). Also presented are data on more specific forms of responsiveness—imitations, descriptions, responses to children's vocalizations,

## Types of Responsiveness in Hannah's and Alyssa's Mothers at 13 Months

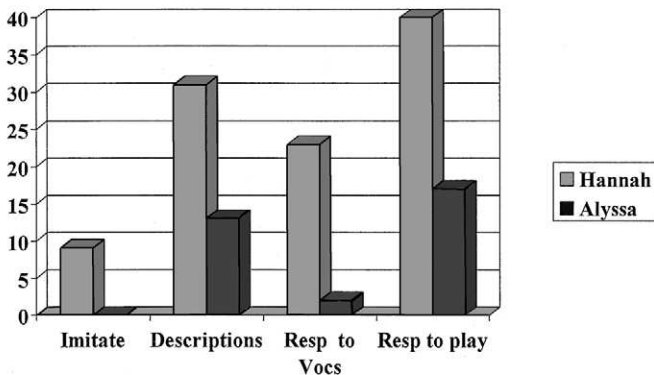


Fig. 5. Frequencies of specific forms of responsiveness in Alyssa's and Hannah's mothers at 13 months (i.e., imitations/expansions, responsive descriptions, responses to children's vocalizations, and responses to children's play).

and responses to children's play at each age (Figs. 3 and 5 for 9 and 13 months respectively). These particular forms of responsiveness were selected because they were found to be especially predictive of children's later language gains in the larger study from which these data were drawn (Tamis-LeMonda *et al.*, 1998, 2001).

As is shown in Fig. 2, at 9 months, Hannah's mother was more apt to respond to Hannah, to elaborate on her responses, and to refocus Hannah when she was inattentive. The only category for which Alyssa's mother outscored Hannah's mother was that of "missing" her child's cues. As shown in Fig. 3, Hannah's mother was consistently higher on all measures of responsiveness. Specifically, she described objects and events twice as often, responded to vocalizations 25% more often, and responded to Hannah's play 10 times more often (Alyssa's mother never responded to her play). Importantly, these patterns were not explained by the observed behaviors of Hannah and Alyssa. In fact, at 9 months Alyssa exhibited nearly twice as many opportunities for her mother to respond as Hannah (i.e.,  $N$  of vocal and exploratory activities = 100 versus 58 for Alyssa and Hannah, respectively).

By 13 months, the greater responsiveness of Hannah's mother continued. Hannah's mother again scored higher on responsiveness, elaborations, and refocusing (see Fig. 4). As is shown in Fig. 5, the two mothers continued to differ dramatically on specific forms of responsiveness (e.g., 23 responses to Hannah's vocalizations and 40 to her play as compared to 2 and 17 responses to vocalizations and play for Alyssa's mother). Unsurprisingly, the greater frequency of vocal and exploratory behaviors exhibited by Alyssa relative to Hannah at 9 months (i.e., base rate frequencies of observed behaviors) attenuated by 13 months. By this time, the two girls provided approximately equal opportunities to their mothers to respond (with Hannah slightly ahead at 124 to 103 behaviors on the part of Alyssa). However, Hannah's mother capitalized on virtually all of Hannah's actions (i.e., 107 of 124), whereas Alyssa's mother missed (or ignored) over 40% of Alyssa's actions (i.e., 44 of 103).

## 2. *Hannah and Alyssa's Language*

With respect to their language, Hannah and Alyssa were fairly similar when the study commenced (see Tables I and II). Both girls understood six to eight words/phrases by their 9th to 10th month, including their own names and routine-like play expressions (e.g., "so big" and "peek-a-boo"). Neither child produced any words spontaneously, although Hannah had a slight productive vocabulary advantage in that she imitated the word bottle (*baba*) and her name (*Nana*).

By the start of the second year (i.e., their 13th to 14th month), substantive differences began to emerge in parallel with differences in their mothers' responsiveness. Alyssa had acquired 46 new words in comprehension. Her language production was in the normal range for her age; she acquired 5 new words in

TABLE I  
Language Development for Alyssa

Language acquisition in the 10th month			
Comprehension		Production	
Word/phrase	Response	Word/phrase	Meaning
“Hello”	Looks up	Ahh-ah-ah	Sound when excited
“Bye bye”	Looks up	Puh	Sound when content
“Dog”	Excitement		
“Cat”	Excitement		
“Bird”	Excitement		
“Daddy”	Looks to door		
“Who’s at the door?”	Looks up in excitement		
“Gesundheit”	Laughs when said after someone sneezes		
“My baby—hug baby”	Smiles as mom says it to the doll, then hugs the doll		
“Peek-a-boo”	Takes cloth off mom’s head and self		
“So big”	Laughs and puts arms out		
“Alyssa”	Looks up at speaker		
“Ball”	Looks for ball		
“How big is Alyssa, so big”	Lifts arms up		
“One, two, three”	Excitement		
“Baby”	Points to picture of baby		
Language acquisition in the 21st month			
Single word utterances: New semantic usage			
Semantic Structure	Utterance	Meaning	
Actor	I	To label self as actor	
Action	Pee pee	To indicate she used the bathroom	
Object request	Grapes	To request grapes	
Playful routine	Happy birthday	Singing ‘happy birthday’	
Multiple word combinations: New semantic/syntactic structures			
Actor– action	I did it	To indicate she did something	
	I did it, I pee	To indicate she used the bathroom	

TABLE II  
Language Development for Hannah

Language acquisition in the 10th month			
Comprehension		Production	
Word/phrase	Response	Word/phrase	Meaning
Bye bye	Waves	Dada, baba, gaga, oy, blah blah blah	No consistent meaning
No	Stops	Hmmm hmmm (humming sound)	Tired or going to sleep
Uh uh	Stops	Mamama	Distressed when mother was absent
Hannah	Approaches or looks at speaker	Nana (i.e. Hannah)	Imitation
Mama	Looks at mother	Baba (i.e. bottle)	Imitation
Pattycake	Claps hands		
Where's Hannah	Pulls napkin off head; initiates game herself		
Peekaboo	Pulls napkin off head; initiates game herself		
Language acquisition in the 20th month			
Semantic structure	Utterance	Meaning	
Actor-desire-action	Mommy want to come I don't know		
Action-patient	Ask her/him	To ask mom to ask someone's name	
Memory-location	Remember park		
Action-location	Put some in it		
Playful phrase	See you later alligator		
Description	Looks like Christmas tree	To describe a muffin	
Person/object-description	Hannah sweetie Hannah munchkin	To describe self	
	It's hot	To describe her food	
Denial (nonexistence)-object	Candy all gone Nothing in it		
Actor-action-object of action	Hannah brush your teeth Hannah brush her teeth I see it Mommy use a dust buster Hannah need bottle Mommy need brush Yoni was eating an onion bagel Hannah want to hold little girl hand		
Denial/negation	This is not a Raffi tape		
Actor-action-patient of action	Hannah show mommy [X] Mommy take her Mommy take you Hannah goes see she Mommy listen to Hannah I'm sorry alligator	To ask mother to pick her up     To ask mother to listen to her play piano	
Interrogatives	What name? What her name is? What Raffi singing about? Who's that lives in California?	To ask someone's name	
Recipient-recurrence-object	Hannah more strawberries	To request more strawberries	
Actor-action-object/patient-location	Mommy put Hannah on your bed Mommy cook it in the microwave I don't know where she is?	To ask to be put on the bed	

imitation and expressed two new words spontaneously (i.e., “bye” and “Duck”). Hannah in contrast, was beginning to take off in her language. She acquired an impressive 60 words in receptive language and 30 words in production during the span of just 1 month (i.e., 13th–14th month). Most new words were nouns, but she also expressed a few action words (“walk,” “burp,” “poo-poo,” “up,” and “out”).

Differences in the acquisition rates of the two girls were dramatic by 18 months, and they continued to diverge to the end of the study. Alyssa acquired eight new words in a month (i.e., her 18th–19th month). Her use of words fell into the basic semantic categories of actor, action, and object of action. Her only two-word utterance was “Mama bye-bye” to indicate that her mother had left.

In contrast, Hannah acquired over 100 new common and proper nouns and over 50 verbs and adjectives during her 18th to 19th month. Paralleling these amazing gains in lexical language, she was using words across a variety of semantic categories (Tamis-LeMonda & Bornstein, 1994): actions, objects of action, patients, instruments, descriptors, words in anticipation, recurrence, interrogatives, language in pretense, indication, and so forth. Similarly, she was combining words into simple sentences, which expressed a range of semantic/syntactic meaning structures. These included more typical word combinations such as actor–action (“Hannah doing”) and action–patient combinations (“Kiss mommy”), as well as more advanced phrases such as interrogatives (e.g. “What that girl got?” and “Where dolly?”) and actor–action–patient (“Mommy change you” and “Mommy help Hannah”). She had also begun to create unique language forms (“Hannah homing” to state she wanted to go home) and spoke about her own actions incessantly (e.g., “Hannah reading ‘Alligator All Around,’” “Hannah talk grandma,” and “Hannah dry off daddy”).

As can be seen in the lower half of Tables I and II, by the end of the study, the two girls achieved substantially different levels of language ability. During Alyssa’s final month of study (i.e., her 21st month), she added fewer than 10 words to her productive vocabulary. Her use of language remained confined to the categories of actor, action, and object of action. She added “I did it” and “I pee” to her limited repertoire of two-word utterances. In contrast, during her final month of study, Hannah’s mother stated that she could no longer track Hannah’s lexical language growth, as it appeared she said just about everything. Her sentence complexity increased tremendously both semantically and syntactically; she began to use prepositions and gerunds regularly, and she combined four or five words into sentences (e.g., “Yoni was eating an onion bagel”, and “Hannah want to hold little girl hand”).

### C. SUMMARY

Findings from analyses on conditional probabilities of language onsets, modeled across discrete ages, as well as excerpts from the language diaries of Hannah and Alyssa, illustrate the powerful influence of responsiveness for children at the



extremes of experience. Enormous variability characterizes children's language growth in the first and second years of life, and the role of maternal responsiveness is central to this developmental process. At extremes of responsiveness, children differ in their onsets of key language milestones by as much as 6 months. Diaries of children's language growth portray these differences at an individual level. Although Hannah and Alyssa did not differ in their initial language status, Hannah's experience with a highly responsive mother was paralleled by rapid expansion in lexical and grammatical features of her language. Alyssa's small to modest gains in language might be explained by her engagements with a less verbally responsive mother. On a cautionary note, however, differences among children in their propensities toward acquiring language feed into a dyadic process, certainly affecting maternal responsiveness and children's future language gains. Indeed, Hannah's rapidly accelerating verbal abilities beginning at 13 months might have further stimulated her mother to provide an even richer language environment in accordance with Hannah's verbal precocity. The fact that Hannah's language was tracked weekly might have made her mother even more cognizant of her daughter's language gains, thereby feeding into a cycle of increased dyadic reciprocity, mutual communication, and language achievement over time. Thus, the impressive influence of mothers' responsiveness should always be considered in the larger context of mutually driven, transactional relationships (Cook, 2001).

## IX. Why Does Verbal Responsiveness Matter?

How might the predictive validity of maternal responsiveness be interpreted? In this penultimate section, we speculate about the role of maternal verbal responsiveness in children's language acquisition by first considering the timing of verbal information, followed by discussion of possible underlying mechanisms. Verbal responsiveness bears directly on two requisites for language acquisition—children's appreciation of the referential quality of communication and use of social cues to disambiguate topics of reference (Moses, Baldwin, Rosicky, & Tidball, 2001). Additionally, responsiveness may *indirectly* support language acquisition through its concomitant effect on motivational aspects of children's development. Consequently, we propose that verbally responsive mothers support language acquisition in three fundamental ways: (1) by fostering intersubjectivity, (2) by defining the topic of communication, and (3) by inciting motivation in children to learn about the world.

### A. THE TIMING OF VERBAL MESSAGES

Timing is fundamental to verbal responsiveness. The notion of promptness (i.e., temporal contiguity) lies at the heart of determining whether mothers' reactions to children are responsive. The fact that verbal responsiveness consistently

predicted children's language over and above the amount of language mothers provided indicates that when messages are communicated may be as important as what is communicated. At the onset of language, the interpretability and relevance of verbal information is maximized when messages are temporally linked to children's initiatives. Verbal information that keys in to changes in infant behavior (e.g., occurring as soon as a child shifts attention to a new object) exerts stronger influence on children's language gains than information that is not temporally bound to children's initiatives.

Why is timing important? We suggest two interrelated explanations, both of which may be tied to children's information processing and memory—temporal contingency and salience. First, children are inclined toward identifying environmental contingencies early in development (Dunham & Dunham, 1995). Learning accounts of early word association (Plunkett, 1997; Smith, 1995) propose “dumb attentional mechanisms” (i.e., association) as central to children's mapping words to objects and events. Whether two events come to be associated depends on their co-occurrence within a brief window of time. Rovee-Collier (1995) used the term “time window” to signify the span between the occurrence of an initial event and the point when the event can no longer be retrieved. According to her theory, time windows dictate whether two temporally disjunct events come to be integrated. New information that is encountered after a time window has “closed” is not associated with the initial event (Boller & Rovee-Collier, 1992). Dependence on time windows is especially strong during infancy when a linguistic knowledge base is being established and associative networks are forming (Rovee-Collier, 1995).

Second, and relatedly, connections between words and referents enormously depend on salience. Children inform parents about what they consider to be salient through changes to their facial expressions, eye gaze, gestures, vocalizations, and other behaviors. In essence, children are fairly effective at cuing parents about what they deem to be worthy topics of communication. During initial stages of language, the dominant cues that capture children's attention correspond to their own perspective and affective appraisals of the situation (Bloom, 1978, 2000). Because young children are unlikely to take adults' perspectives into consideration (e.g., by following eye gaze) until midway through the second year, the onus is on parents to match verbal input to what children consider to be salient. Experimental studies of word learning in 12-month-olds indicate that perceptual salience is fundamental to young children's learning of new words (Hollich *et al.*, 2000). Temporal contiguity between the verbal input and changes to children's attention ensure that adults' verbal messages are related to salient foci of attention.

#### B. RESPONSIVENESS FOSTERS SECONDARY INTERSUBJECTIVITY

We suggest that responsive interactions foster children's emergent secondary intersubjectivity by reinforcing the social-communicative functions of language

per se (Stern, 1985; Trevarthen, 1993). Intersubjectivity refers to children's appreciation that meanings can be shared with others and that dyadic communications may refer to objects and events in the outside world. Beginning at 9 months, there is an extended period of development during which children's acquisition of knowledge shifts from a primary reliance on direct perceptual exploration to using and seeking social information from other people. At this time, children display a range of behaviors that enable them to capitalize on adults' knowledge: They look where adults look, imitate adults' actions with novel objects, look toward adults in ambiguous circumstances, and use communicative acts (e.g., showing and pointing) to share their experiences (Moore & Corkum, 1994). These behaviors enormously expand children's possibilities for learning as they can now benefit from the knowledge of adults rather than relying on their own direct, unmediated experiences (Baldwin & Moses, 1996; Tomasello, 1993). Consequently, mother-child communications become increasingly triadic by the end of the first year: involving children, adults, and referents. Not surprisingly, the advent of language coincides with this "socio-cognitive revolution" (Tomasello, 1993).

The social referential skills of children rapidly improve over the course of their second year, as children become increasingly adept at utilizing social cues (e.g., eye gaze) to figure out others' foci of attention (Baldwin & Moses, 1996; Moses *et al.*, 2001). Nonetheless, because children's abilities at monitoring others' intentions are still evolving, mothers' verbal responsiveness may be fundamental to shared intersubjectivity. By definition, verbal responses are attuned to children's emotions, interests, and intents. This attunement may foster young children's sense of shared meaning and intention and appreciation of the "aboutness" in dyadic communications. Mothers who attune to children's needs and interests reinforce the intersubjective nature of experiences and highlight their own role as interpreters of a shared world (Nicely, Tamis-LeMonda, & Grolnick, 1999; Nicely, Tamis-LeMonda, & Bornstein, 2000).

### C. RESPONSIVENESS ESTABLISHES TOPICS OF COMMUNICATION

At a more concrete, pragmatic level, verbal responsiveness is paramount to ensuring that topics of communication are established and explicitly marked between mother and child. Responsive verbal information provides an optimal setting of language learning, as adult speech is focused on and relevant to children's attention (Bloom, 1993, 1998). Mothers who are verbally responsive, for example, by providing labels for objects and events that are under joint attention, facilitate children's matching linguistic symbols to their referents (e.g., Baldwin & Markman, 1989; Baumwell *et al.*, 1997; Bloom, 1993; Bloom *et al.*, 1996; Bornstein *et al.*, 1992; Carpenter *et al.*, 1998; McCune, 1995; Rogoff, Mistry, Radziszewska, & Germond, 1992; Tamis-LeMonda, Bornstein, Baumwell, & Damast, 1996; Tamis-LeMonda *et al.*, 2001; Tomasello & Farrar, 1986). By attuning to children's current

interests, mother serve as tutors who constrain interpretive possibilities, increasing the likelihood that children will draw psychological connections between verbal information and their referents (Snow, 1986). Adults who engage in responsive modes of interaction provide children with clear pragmatic cues to world learning, enabling children to more readily negotiate ongoing activities (Akhtar, Tomasello, & Carpenter, 1996; Bloom, 1998; Snow, 1989; Zukow, 1991). Findings we present here accord with the notion that children best acquire new pieces of linguistic information when engaged in joint attention with a mature language user (Baldwin, 1993; Bornstein, 1985; Moore & Dunham, 1995; Tomasello & Barton, 1994; Tomasello & Todd, 1983).

#### D. RESPONSIVENESS FOSTERS SECURE ATTACHMENT

Responsiveness might affect children's language indirectly by leading to a sense of attachment which in turn fosters children's motivation, exploration, and seeking of information from primary caregivers. Researchers have espoused the importance of responsive exchanges in defining sensitivity that is so important for the development of secure child-mother attachments (Ainsworth, 1973; Bornstein *et al.*, 1992; Skinner, 1986). Securely attached children benefit from their primary caregivers in several ways, two of which may directly bear on the acquisition of language. First, caregivers provide a comfort base from which children venture into the world and embark on self-discovery and independent exploration. Such children develop a sense of self-efficacy and motivation, which is manifest in persistent, task-directed exploratory styles (e.g., Belsky, Garduque, & Hrcir, 1984). The motivation to learn about the world may provide an intrinsic catalyst to figuring out what words mean so as to communicate with others. Second, secure attachment supports dyadic connectedness—such that secure children may more often seek information from their primary attachment figures. Empirical evidence demonstrates a link between attachment and social referencing, suggesting the two share a common developmental origin (Baldwin & Moses, 1996). Insofar as responsiveness is at the heart of attachment, attachment motivates social referencing, and social referencing in turn supports language attainment, children of verbally responsive mothers may be more prone and better able to learn from their caregivers.

### X. Responsiveness and Language: Additional Considerations

Findings from our research program underscore the powerful role of verbal responsiveness in children's early language acquisition. Several questions about the precise nature and meaning of mother-child associations warrant further inquiry. We address outstanding issues in this final section.

## A. FEATURES OF RESPONSIVENESS

We began this chapter by presenting three criteria that formed the basis of our definition of maternal responsiveness: promptness, contingency, and appropriateness. Although our findings suggest that these features together predict individual differences in children's language acquisition, their relative influence remains unexplored. For example, does the promptness of maternal replies contribute uniquely to children's language or are the contingency and appropriateness of verbal information sufficient? If promptness does matter, what is the precise time span that is most conducive to children's processing of verbal information? Although we based our 5-s window on evidence of temporal patterns in adults, a briefer span may be required for infants to coherently integrate words and experiences. With respect to appropriateness, which verbal forms are appropriate at which points in development? How does appropriateness interface with children's emergent cognition and language? Finally, to what extent is contingency central, and when in development does it matter? Experimental studies that have sought to disentangle the relevant contributions of competing cues to word meaning demonstrate that young children profit from different types of cues at different ages (Hollich *et al.*, 2000). Our findings suggest that children benefit from different forms of verbal responsiveness and that mother-child associations are highly specific. As an example, our finding that maternal "wh-" questions in the second year (e.g., "Where did we go?" and "What did you see?") support children's abilities to talk about the past suggests that appropriateness depends on children's developmental stage and the linguistic outcome assessed.

## B. QUANTITY VERSUS QUALITY OF LANGUAGE

A basic question that motivated our initial studies of verbal responsiveness concerned its unique prediction after considering the contribution of language amount. Because our research has focused predominantly on verbal forms of responsiveness, still unanswered is whether and how responsiveness fits within the larger context of overall maternal language. A mother who rarely speaks to her child, by definition, will not be verbally responsive. Consequently, amount of maternal language and verbal responsiveness are often confounded. We have attempted to address this issue by assessing multiple measures of maternal language and exploring their relative contributions. Our findings suggest that maternal responsiveness predicts children's language above mothers' amount of language as well as above children's contributions to their own language development. Nonetheless, others have documented the unquestionable importance of children's sheer exposure to language in naturalistic settings (Huttenlocher *et al.*, 1991), and experimental research indicates that frequent repetitions of new words aids acquisition (Hollich *et al.*, 2000). Still needed, however, are studies that systematically test

the joint and unique relevance of language quantity versus language quality for children's early language acquisition.

### C. AGES OF EFFECTS

We have emphasized mother's responsiveness to children aged 9 to 22 months. We began our inquiries at 9 months because of the emergent gains in social cognition that occur at this time (Tomasello, 1993, 1995). However, responsiveness appears to exert an expedient influence on children's emerging abilities, and its role in the development of prelinguistic children warrants further attention. Our earlier work suggests that responsiveness matters as early as 4 or 5 months, both within and across cultures (e.g., Bornstein, Miyake, Azuma, Tamis-LeMonda, & Toda, 1990; Bornstein & Tamis-LeMonda, 1989). In one investigation we found that maternal responsiveness to 5-month-olds not only predicted children's language outcomes 7 months later, but also related concurrently to children's habituation (Bornstein & Tamis-LeMonda, 1997). This study focused on the origins of three information-processing skills in early infancy—habituation, novelty responsiveness, and cross-modal transfer—each of which has been shown to predict mental ability in later childhood. Antecedents of each skill at 5 months after birth were examined in a short-term prospective longitudinal study of infant ability and maternal intelligence and interaction style. Infant perceptuocognitive performance at 2 months, maternal intelligence, and maternal responsiveness at 5 months predicted the expression of the three infant cognitive skills, but in different ways. It appeared to us that variation in infant information processing abilities could be explained by specific child and maternal factors that are evident soon after birth. Importantly, mothers' responsiveness appeared to influence children's information processing abilities.

Other investigators have also documented the importance of maternal responsiveness in early infancy, for example, by focusing on dialogic rhythms and turn taking (e.g., Jaffe *et al.*, 2001; Bloom, Russell, & Wassenberg, 1987). Bloom (Bloom *et al.*, 1987) studied the effects of turn taking in mother–infant conversation on subsequent infant vocalization. In one experiment, a group of 3-month-olds experienced conversational turn taking and another received random reactions on the part of an adult. Infant vocalizations were then counted and categorized as either speechlike or non-speech-like. When adults maintained a prototypic conversational give-and-take pattern, children produced a relatively higher ratio of speechlike to non-speech-like sounds. In a second experiment, adult responsiveness consisted of conversational turn taking or responsiveness using nonverbal vocalizations, smiling, and touching the infant's abdomen. Again, turn taking facilitated a speak–listen pattern of vocalizing by the infant. However, in the absence of a verbal component of the adult's response, turn taking did not facilitate infant production of speechlike sounds. The two experiments together show that children who participate in normal

“conversation” vocalize more, as though they are “really talking,” suggesting that responsiveness matters well before children begin to acquire formal language.

If responsiveness is contributing to early forms of communication, it must exert an influence via mechanisms other than referent matching, as children are not yet ready to benefit from language *per se*. Responsiveness may inculcate in infants an appreciation of the rhythmic patterning of social exchanges or alternatively may predict later language because it is stable over time. Mothers who are attuned to their infants, for example, might shift in their manner of responding in ways appropriate to children’s development—by describing events for children at the cusp of language and asking questions of children who are more adept communicative partners. These competing explanations would suggest very different mechanisms for early language growth. Whether, how, and why responsiveness exerts an influence in early infancy remains open to inquiry and speculation.

#### D. NONVERBAL FORMS OF RESPONSIVENESS

Although this chapter focuses principally on verbal responsiveness, nonverbal forms of responsiveness may matter as well, an observation that is in accord with the finding that responsiveness is relevant even in the first months of life. Our earliest studies (Bornstein, 1985; Ruddy & Bornstein, 1982; Tamis-LeMonda & Bornstein, 1989) focused on verbal and nonverbal forms of responsiveness (e.g., shaking a rattle for her baby as baby looks to rattle), both of which predicted cognitive and language development in children. More recently, we assessed 9-month-old children’s “emotional displays” and mothers’ responses to those displays in relation to children’s later language (Nicely *et al.*, 2000). We speculated that responsiveness to children’s emotions (which we termed emotional attunement) would be particularly relevant at 9 months, given the emergence of secondary intersubjectivity at this time (Tomasello, 1993). Examples of emotional displays in infants included smiles; laughs; whines; cries; forceful, rhythmic, or exuberant actions; and inflected patterns of vocal pitch and melody. Mothers’ responses could be either verbal or nonverbal (e.g., a mother softly whispering “nice” or softly stroking her child’s cheek after her child gently pats a doll’s hair). Children of mothers who were responsive to infant affect by virtue of “matching” children’s emotional displays achieved a number of language milestones sooner in development than children with mothers who did not match their emotional displays. This suggests that nonverbal forms of responsiveness may set the stage for children’s later language.

#### E. TRANSACTIONAL INFLUENCES

The focus on maternal responsiveness must be considered from a transactional perspective (Sameroff, 1975). By definition, maternal responsiveness reflects the

temporal sequence of child-act-and-mother-respond, a sequence that depends on children's own behavioral expressions. Therefore, children's own abilities and activities play a role in explaining the predictive validity of maternal responsiveness: Mothers can only responsively imitate and expand if their children vocalize. The transactional nature of dyadic engagements may also explain why certain forms of responsiveness matter at certain points in development, but not at others. Children actively solicit information from adults, and they themselves determine what is meaningful to them as they master language. Transactional models emphasize mutuality and reciprocity in mothers' and children's adaptations to one another (Kochanska, 1997) and often treat dyads as a single unit of study. Although we attempted to examine the unique contributions of children and mothers to children's linguistic outcomes, such a division may be artificial. Indeed, when we statistically modeled prediction to children's language milestones, the best-fitting model was one that included measures of children's early language (i.e., onset of first words) together with dimensions of maternal responsiveness (Tamis-LeMonda *et al.*, 1998; see too Vibbert & Bornstein, 1989). Recent methodological advances may promise to address questions such as "Who is influencing whom, and by how much?" (Cook, 2001).

#### F. THE LARGER ECOLOGICAL SYSTEM

Beyond a focus on transactional processes in mother-child interactions, both maternal responsiveness and children's language acquisition must be considered within a larger ecological system of influences. A comprehensive model of language acquisition should focus on how multiple factors contribute to the emergence and ontogeny of children's abilities. Maternal responsiveness is shaped by a constellation of intrinsic and extrinsic factors, including personality, social networks, education, socioeconomic status, and views about child development. Similarly, the origins of children's language are appreciably complex, reflecting personal characteristics (such as gender, temperament, attention, cognitive development, affect, and articulation), family situation and support, broader social networks, and socioeconomic status, all of which converge to explain individual variation. Even when focusing on a single factor—for example, the social environment—a multidimensional model is the best fit. Children vary in the amount and quality of language they experience when engaged with fathers, grandparents, siblings, relatives, and caregivers, yet little is known about how these social experiences affect children's early acquisition of language. Our studies suggest that patterns of prediction are similar for fathers' and mothers' responsiveness, and we surmise that responsiveness may be equally valid for nonprimary caregivers. Future studies on the social context of children's language should extend beyond the nucleus of the mother-child dyad.



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# SCHOOLING AS CULTURAL PROCESS: WORKING TOGETHER AND GUIDANCE BY CHILDREN FROM SCHOOLS DIFFERING IN COLLABORATIVE PRACTICES

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## REFERENCES

## I. Introduction

In this chapter, we examine the role of the ubiquitous cultural institution of formal schooling in children's forms of collaboration and assistance with each other. We argue that this institution, in which U.S. children spend years of their childhood, fosters particular approaches to working together and guidance, in accord with the everyday structures of interaction in the classroom. To examine this idea, we observed the interactions of pairs of children from two public U.S. elementary schools, one with philosophy and daily practices emphasizing collaboration throughout the school day and one with a more traditional format involving only occasional opportunities for children to collaborate. We observed how third- and fourth-grade dyads coordinated their work on several problems and how the fourth-grade partners provided guidance to the third-graders.<sup>1</sup>

Children's collaboration with each other has become a topic of widespread interest, stemming in part from Vygotsky's (1981) and Piaget's (1977) theories and from cognitive developmental research that indicates that collaboration can shape children's learning (Bos, 1937; Gauvain & Rogoff, 1989; Glachan & Light, 1982; Kruger, 1993; Roschelle, 1992; Tolmie, Howe, Mackenzie, & Greer, 1993). However, this research also shows that collaboration is not necessarily easy for many children from mainstream U.S. cultures. Commentators call for schools to teach children to collaborate, as this is a skill regarded as increasingly important in the workplace; growing literatures examine specific forms of cooperative learning as pedagogical techniques (Carnegie Forum on Education and the Economy, 1986; Human Capital Initiative, 1993; Johnson & Johnson, 1989; Sharan, 1990).

Research on the development of children's means of interacting when working on problems in common has focused primarily on age-related difficulties with collaborative communication (Azmitia, 1996; Ellis & Rogoff, 1986; Ludeke & Hartup, 1983; Patterson & Roberts, 1982; Peterson, Wilkinson, Spinelli, & Swing, 1982; Rogoff, 1990; Socha & Socha, 1994). For example, some child tutors neglect assisting their partners in preparing for the long-term goal of handling a task independently, either simply completing the task for their partners or insisting that their partners figure out the task without guidance (Ellis & Rogoff, 1986; Koester & Bueche, 1980; McLane, 1987; Peterson, Wilkinson, Spinelli, & Swing, 1982; Radziszewska & Rogoff, 1988; Schubauer-Leoni, Bell, Grossen, & Perret-Clermont, 1989).

However, Crook (1994) warned against looking at collaboration solely in terms of individual characteristics such as age, stage, or "skill" in comprehending others' intentions or communicating. He emphasized the importance of development of an "intersubjective attitude" that transcends the characteristics of individuals, as

<sup>1</sup>This work began when all three authors were affiliated with the University of Utah and continued while the first and third authors were at the University of California at Santa Cruz and when the first author was at the University of Delaware.



collaborators work toward constructing joint understanding. “If intersubjectivity does become a resource to support collaboration, it is because the conventions, rituals, institutions and goals of organized social life arrange that it should do so” (p. 145). This view calls for a cultural perspective in understanding “the conventions, rituals, institutions and goals of organized social life” that may support people’s development of shared understanding for collaborative endeavors.

#### A. CONVENTIONS IN THE ORGANIZATION OF CULTURAL INSTITUTIONS

Our general aim in this chapter is to widen the discussion of shared problem solving to a sociocultural view that emphasizes that individuals become proficient in the practices that are common and valued in the institutions and interactions of their daily lives (Rogoff, 1998). For many middle-class European American children, solo activity appears to be prioritized in their homes and schools (Matusov, 1998; Mosier & Rogoff, 2001; Rogoff, Mistry, Göncü, & Mosier, 1993). In particular, participation structures in schooling often enforce solo performance in a way that we argue guides children over the years to forms of interaction that seem “natural” to people who have spent many years in such cultural institutions.

The prevalence of particular discourse and structural features in U.S. classrooms, summarized below, supports the idea that schooling involves cultural practices—“ways of doing things” that are rooted in participants’ beliefs, expectations, traditions, and relations (see Argyris & Schon, 1978; Goodnow, Miller, & Kessel, 1995; Rogoff *et al.*, 1993). In organizations such as schools (or, for example, trade guilds, families, or churches), cultural practices are institutionalized with traditions that are somewhat predictable, normative, and structural. Habitual relations between people become institutionalized as accepted approaches that people come to regard as external to their functioning (Berger & Luckmann, 1966). Shotter (1978) explained as follows:

The *institutions* we establish between ourselves and others. . . implicate us in one another’s activity in such a way that, what we have done together in the past, *commits us* to going on in a certain way in the future. . . . The members of an institution need not necessarily have been its originators; they may be second, third, fourth, etc. generation members, having “inherited” the institution from their forebears. . . . Practitioners of institutional forms need have no awareness at all of the reason for its structure—for them, it is just “the-way-things-are-done.” The reasons for the institution having one form rather than another are buried in its *history*. (p. 70)

#### B. TRADITIONAL SCHOOLING’S INSTITUTIONALIZATION OF WAYS OF WORKING TOGETHER

Our work is based on the idea that schools teach not only the academic curriculum but also cultivate patterns of discourse, in accord with Vygotsky’s (1981) notion that higher mental functions are “internalized social relations.” We treat

collaboration as well as traditional instructional discourse formats as institutional cultural practices (consistent with the work of other scholars, such as Erickson, 1982; Mehan, 1979; Sharp & Gallimore, 1988).

Studies of classroom structure indicate that U.S. public school discourse is commonly organized with (1) a prohibition against students informally helping or even speaking with each other without teacher permission (often considered “cheating”); (2) the format of “quizzing” in which the teacher asks a known-answer question, a student responds with a simple answer, and the teacher evaluates the correctness of the answer; and (3) the use of directive guidance in which teachers ask children to produce actions without explaining their meaning or providing a rationale for the requests. (See Cuban, 1984; Heath, 1983; Lemke, 1990; Mehan, 1979; Mercer, Edwards, & Maybin, 1988; Minick, 1993; Newman, Griffin, & Cole, 1989; Wells, 1992; Wertsch & Minick, 1990; Woods, 1980.)

Several authors have suggested that children’s facility in collaboration may relate to the social structure of particular classrooms that do or do not support collaborative interaction (Cazden, Cox, Dickinson, Steinberg, & Stone, 1979; Cooper, Marquis, & Edward, 1986; Damon, 1984; Sharan & Sharan, 1992). For example, Forman and McPhail (1993) speculated that fourth-graders’ difficulty in collaboration on mathematical problems may have been because their traditional classrooms provide little support for engagement in the sort of dialogue involved in collaboratively solving problems.

There is suggestive evidence that schooled people use communication patterns of the school outside immediate classroom contexts and constraints (Chavajay & Rogoff, 2001). For example, children who have been asked to teach others in a lab context occasionally use schoolteacher intonations and “quiz” their partner or withhold information, as if their idea of teaching was based on the notion that schoolteachers regard open provision of information as out-of-bounds (Ellis & Rogoff, 1986; McLane, 1987).

### C. SCHOOLS WITH COLLABORATIVE TRADITIONS

The idea that schooling can be examined as cultural practice is supported by observations that schools in some communities are structured differently than the traditional U.S. pattern. In some Mexican classrooms serving indigenous communities, a collaborative approach prevails, in which children work together with the teacher’s support (Paradise, 1991). Some schools explicitly include instruction in how to collaborate. For example, in some Japanese elementary school classrooms, teachers provide explicit discourse forms for children to build on each other’s ideas, providing suggested wordings for offering opinions by first noting agreement or disagreement with a prior student’s idea (Toma, 1991).

Similarly, the collaborative school that was one of the settings of the present research includes learning to collaborate with and assist others as an explicit goal of the curriculum, with guidance often taking place in the process of working together

with others of varying expertise (Rogoff, Goodman Turkanis, & Bartlett, 2001). In this school, designed as an alternative to traditional schools, collaboration is central throughout the day in children's learning and projects as well as adults' decision making and guidance. Child and adult participants treat each other as sources of assistance, as they work together in small and large groups.

## II. A Cultural Comparison Focusing on Schooling Traditions

In our study, we asked children from the collaborative school and from a more traditionally organized school to work together in pairs to solve several academic problems posed outside of the constraints of their classrooms. We made efforts to organize conditions of the study to be similar and comfortable for the children from both schools. We were interested in how they coordinated their decision making and in how the fourth-grade partner, who was asked to assist the third-grader in learning to handle the problems, provided guidance.

Consistent with sociocultural methods, we examined *patterns* of differences and similarities rather than attempting to isolate variables (such as school affiliation or a particular practice within the schools) responsible for the observed patterns. We treated the children's school affiliation as a sort of cultural participation; cultural differences generally involve a constellation of connected practices (see Rogoff *et al.*, 1993, for research strategies for examining cultural patterns). We aimed to shed light on patterns that may function differently in communities that vary in numerous and structured ways; there are many differences in the two schools' philosophies and classroom structure besides the prevalence of collaboration or traditional instructional discourse patterns.

We did not isolate classroom practices from the practices of the families that form the communities involved in the schools. Attending particular schools is never random, and it was not for the children in the two schools we studied. Although the families in the two schools are of similar social class and the children perform similarly on the school district's standardized tests, there are probably differences between the families that choose one school or another. A primary difference between families selecting the collaborative instead of traditional schools may be in the collaborative school parents' commitment to being involved in the classrooms (they are required to work in the classrooms 3 h per week per child enrolled). Other differences, for many, include interest in innovative pedagogic practices, collaborative forms of instruction, and greater religious diversity than is common in Salt Lake City schools (Rogoff, Matusov, & White, 1996).

However, the differences in the children's approaches appear not to be simply due to preexisting emphasis and use of collaborative modes by the children's parents. Many parents from the collaborative school, although they may be

interested in collaborative instruction, appear not to bring collaborative discourse patterns with them. Many parents reported that their participation in the school leads them to become more collaborative at home with their children, applying approaches that they learned at the school in resolving problems or enlisting the children's help with chores in a collaborative way that they state is modeled on observing how the teachers interact with the children (Rogoff, Matusov, & White, 1996).

Systematic observations also indicated that many parents commonly do not already use collaborative approaches in their classroom interactions when they join this school—their instructional approaches seem to resemble their own traditional schooling. In the first few years of engagement as classroom volunteers, parents commonly demonstrate the use of adult-unilateral instruction and usually show collaborative relations only after 2 or 3 years of weekly participation in the classroom (Matusov & Rogoff, 2001).

#### A. OUR EXPECTATIONS IN THE STUDY

We expected children in the collaborative school to use more collaborative discussions involving transactional dialogue as well as more collaborative guidance embedded in the process of shared problem solving. We expected children with a traditional schooling background to use question–answer–evaluation “quizzing” and directive formats for guidance, based on the interactional formats of traditional schools.

Of course, many aspects of the children's collaboration and guidance were expected to be similar as well because along with their differences, the children from the two schools also have a great deal in common. The two schools are part of the same school district using the same state “core curriculum;” teachers in both schools provide explanation and demonstrations of information and skills—we expected no differences in the children of the two schools in guiding by providing explanations and demonstrations.

In addition, because the children of both schools live in the same European American middle-class community, we expected a great deal of these children's working together to employ specialized roles in a sort of division of labor. This expectation is based on research indicating that European American children often offered parallel, unrelated lines of instruction when teaching other children how to play a game, compared with Navajo children, who were more likely to build on each other's comments (Ellis & Gauvain, 1992), and young middle-class European American children more often interact by dividing resources—taking turns—than do young Guatemalan Mayan children (Mosier & Rogoff, 2001). Hence we expected children from both schools to engage often in forms of collaboration that involve specialized roles based on their common involvement in middle-class European American ways.

Thus, we expected both similarities and differences of approach among the children whose schooling provides them with different traditions of working together in the context of broader similarities in their schools' location in the same school district and community. Our expectation of both cultural similarities and differences is consistent with cultural studies more generally, where documentation of some similarities is an important accompaniment to observations of specific differences in line with cultural practices.

## B. METHODS

### *1. Participants and Their Schools*

Forty-eight 9- to 11-year-old children were recruited from two public elementary schools in the Salt Lake City (Utah) school district. Twelve same-sex pairs of third- and fourth-graders (the maximum available) were formed from the collaborative school and 12 pairs were formed from the traditional school. At each school, an equal number of boys and girls participated.

Our information on the collaborative school comes from participant observation as well as from systematic classroom observations and surveys and interviews with teachers, parents, and students (Baker-Sennett, Matusov, & Rogoff, 1992; Matusov & Rogoff, 2001; Rogoff, 1994; Rogoff, Matusov, & White, 1996). In addition, participants in the collaborative school have described its philosophy and practices in a collaborative volume (Rogoff, Goodman Turkanis, & Bartlett, 2001).

The collaborative school was organized as a parent-teacher cooperative and had functioned as a public school program for 14 years by the time of the study, with six or seven mixed-grade kindergarten-through-sixth-grade classrooms. The program is public, serving the whole school district, and optional, open for families to select. Children represent the range of aptitudes that are usual in classrooms throughout the district.

Learning to work effectively in groups is an explicit part of the collaborative school's curriculum, as indicated in written philosophy statements. During the school day, children usually work in various-size flexible small groups with the teacher and/or parent volunteers, and children sometimes work on their own. They often share decision making on projects with classmates and adults; they contribute to adults' guidance (conversing openly with teachers and parent volunteers, as well as with each other) and treat other people as a source of help.<sup>2</sup>

<sup>2</sup>The practices of the collaborative school differ in a number of ways from many approaches to "cooperative learning" pedagogies. A collaborative approach prevails in this school between adults and children, as well as among children. Adults as well as children enter in and help each other out in the children's activities, with a collaborative philosophy in which mutual assistance is expected (Matusov & Rogoff, 2001; Rogoff, Goodman Turkanis, & Bartlett, 2001). The collaborative approach of this school includes close adult involvement and teacher-led instruction in the context of children's ongoing activities.

The traditional school was selected for comparison on the basis of being similar to the collaborative school in family socioeconomic status, from a neighborhood like that of many of the children in the collaborative school, and having a traditional classroom structure with learning based mainly on whole class and individual instruction. The selection was based on the advice of school district personnel familiar with the schools, as well as informal classroom observations and interviews with teachers and principals that indicated that this school could be characterized as an excellent school following the usual U.S. instructional format of teacher-run whole-class and individual instruction, with little shared academic discourse between students. This school, like the collaborative school, had been honored with awards in recent years by the state governor.

Our interviews with children, discussions with teachers and the principal, and informal classroom observations indicated that cooperative learning in schoolwork was seldom employed in the traditional school at this time. Our study was carried out in 1991, a year before the Salt Lake City School District launched “cooperative learning” programs in elementary schools throughout the district. Most of the day in the traditional school involved either teacher/whole-class or teacher/individual-student interactions or individual work. Joint projects and freedom to collaborate were rare in the traditional school, as was assistance in learning to work together. Some of the children mentioned in postinterviews that in their classrooms, helping was treated as “cheating.” This arrangement is consistent with observations of U.S. elementary schools, in which students’ initiation of communication is controlled by the teacher, with teachers relying on known-answer questions in which they set students questions or tasks, students respond, and teachers evaluate the students and their responses (Cuban, 1984; Mehan, 1979).

Like the families at the collaborative school, families at the traditional school had the option of sending their children to other schools in the district because the district provided flexibility in attending out-of-neighborhood schools. Most children at the traditional school were from the surrounding neighborhood; middle-class families in Salt Lake City often choose housing on the basis of being close to particular schools. Parent involvement in the traditional school was mainly in PTA meetings, fundraising, and helping with children’s homework.

Many characteristics of the children were similar across the two schools, including standardized achievement test scores of the children. Ethnicity of the families at both schools was similar—predominantly European-American, consistent with the Salt Lake City population at the time. The traditional school draws from a middle- to upper middle-class population, whereas the collaborative school attracts a more heterogeneous but basically middle-class population. The proportions of students from low-income families (qualifying for free or reduced-price lunches) were 12% from the collaborative school and 6% from the traditional school in 1994, according to figures provided by the Salt Lake City School District.

## 2. *Observing Pairs of Children Working on Out-of-Class Academic Tasks*

Each pair consisted of one third-grader (9- to 10-year-old) and one fourth-grader (10- to 11-year-old) who worked together on four assigned problems, with the fourth-grader asked to help the third-grader learn how to do each problem. The sessions of about 30–40 min were videotaped in a quiet room in the school outside the regular classroom.

Because the collaborative school regularly blended age groups in the same classroom and the traditional school did not, we avoided differences in familiarity by not pairing children from the same classroom. In addition, we did not pair children who reported having close bonds outside the classroom. The researcher was not familiar to the children of these grade levels in either school.

The researcher requested the fourth-grader to sit next to him (to help distinguish the fourth-grader's instructional role) and explained that he was interested in finding out how children help each other learn. He asked the fourth-grader to help the third-grader learn how to solve the problems, "since you're in fourth grade."

The first problem was an open-ended card sorting problem that involved sorting 18 photographs of household items into any number of groups [using the photographs but not the procedure from Ellis & Rogoff, 1982, 1986; hair blowdryer, typewriter, toaster, scissors (2), knives (2), bowl, cup, bucket, broom, washing glove, mixer, wooden spoon, measuring cup, towels, toothbrush, and razor]. The researcher gave the 18 cards to the fourth-grader, saying, "Your job is to help the third-grader learn how to figure out which pictures go together so s/he could do it alone later on. Make sure s/he learns how to do it." The children were asked to group items that they thought "went together" and were not told how many or what sort of groups to make. When the children said they had finished, the researcher asked the third-grader to give a name to each group and to explain the rationale for the groups.

The remaining three problems were math story problems, taken and slightly modified from fourth-grade math textbooks that were in use in Salt Lake City schools (including these two schools). The teachers reported and our postsession interviews with the children showed that all fourth-graders in the study had already done these problems during their classroom math activities and all third-graders had not previously engaged in solving these problems. Each math problem was presented on a piece of paper given to the fourth-grader as follows:

- "Debbie is going to make sandwiches with either cheese, jam, or roast beef. She is going to use white or brown bread. How many different kinds of sandwiches can she make?"
- "Fifteen students in the fourth grade class sold tickets to their play. The graph shows the number of tickets sold each day for a week. Use the graph to solve the following problems. 1) How many tickets were sold on Wednesday? 2) How many tickets were sold on Thursday? 3) How many more tickets were sold on Thursday than on Wednesday?"
- "Use the data from the map [showing routes connecting 13 imaginary towns] to solve this problem: A family drove from Centerville to visit their grandparents. They traveled 52 miles to get there. Which town do their grandparents live in?" (The solution required adding several distances.)

The researcher instructed the fourth-grader, “Your job is to help the third-grader learn how to solve these problems. Here’s the first one. You can write whatever you want on the page, just make sure the third-grader learns how to do it.”

For all four problems, children were given as much time as they wanted. The researcher busied himself with paperwork as the children worked, to discourage children’s attempts to involve him in problem solving.<sup>3</sup> After the children indicated that they were done with each problem, the researcher asked the third-grader to explain each solution.

The fourth-graders from both schools usually followed the instruction to help the third-graders learn how to solve the problems by providing guidance or somehow taking the role of helper or director. Those from the collaborative school took a special role in 83% of the task sessions and those from the traditional school did so in 88% (not a significant difference). In the cases in which the fourth-grader did not assume a special role, either the third-grader took over control of the task or both children tried to solve the problem as equal partners. Of all 96 problems (24 dyads  $\times$  4 problems), there was only one in which a fourth-grader’s guidance was rated as insensitive and none in which a fourth-grader looked lost.

### 3. *Categories of Working Together and Guidance*

Our rating system focused on holistic patterns of children’s working together and guidance. Shared ideas are discernable in close examination of partners’ utterances and actions in relation to each other over time, but not within single individuals’ isolated utterances or actions (Crow, 1994), because partners coconstruct the meaning of their interaction as they work together. Coding sequences of discrete behaviors or utterances would not capture the meaning of children’s interactions, which requires judgments with attention to the surrounding moves of both partners as the communication develops. For example, a fourth-grader’s request to a third-grader to try the problem on her own might be a part of quizzing in one context, such as if the fourth-grader had just asked a question to which he or she already knew the answer and withheld helpful information from the third-grader to test whether the third-grader knew the answer. In another context, a fourth-grader’s request to a third-grader to try the problem on her own might be a part of guidance embedded in collaboration, such as if the fourth-grader provided opportunities for the third-grader to assume more responsibility within their collaboration and contributed his or her own suggestions as they worked together.

A focus on functional, contextual patterns of interaction is well respected in lines of research that examine the meaning of interaction rather than the detailed form of individuals’ moves (see especially Adamson & Bakeman, 1982; Bremme

<sup>3</sup>Analysis of the videotaped sessions shows that the researcher treated the dyads from the two schools similarly—he followed the verbal script 100% of the time in both schools, focused instructions on the fourth-grader in 100% of the sessions at both schools, and avoided giving any hints to the children for 92% of the requests in each school.



& Erickson, 1977; Cazden, Cox, Dickinson, Steinberg, & Stone, 1979; Cicourel, 1974; McDermott, Gospodinoff, & Aron, 1978; Mehan, 1979; Rogoff & Gauvain, 1986; Rogoff *et al.*, 1993; Wells, 1992). Participants in social interaction provide explicit evidence regarding the meaning of their actions to each other, informing each other of their purposes through jointly created discourse and action, including clarifications in cases of ambiguity. This evidence is essential to the achievement of understanding between participants, but also provides researchers with evidence regarding the meaning of actions. Interrater reliability of our analysis (see below) validates that such analysis is not idiosyncratic.

Our rating categories focused on discourse patterns that have been observed in studies of classrooms in traditional schools (quizzing with known-answer questions and directing a learner's actions without providing a rationale) as well as discourse patterns observed in research on joint problem solving and in our classroom observations in the collaborative school (transactional dialogue, and instruction embedded in collaboration).

To provide context for the differences that we expected, we also rated several formats in which we did not expect schooling differences. We expected the children from both schools to work together in specialized division of labor and to provide pure instruction (explanations and demonstrations) because both schools involve many occasions of division of labor and pure instruction and because these are also common in middle-class European American children's family relations (see Rogoff *et al.*, 1993). We also rated working together with flexible coordinated action to see how it would relate to working together in specialized division of labor. Based on the literature, we also rated engaging in nonshared decisions and making unilateral decisions, but we had no reason to expect differences between the two schools in these formats.

The approaches to working together and approaches to guidance are not conceived as independent classes of information. Rather, they have different foci: The approaches to working together focus on the type of involvement of the partners together, whereas the approaches to guidance focus on the role taken by the fourth-grader assigned a helping role (with information about the contributions of the third-grader required for interpreting the fourth-grader's guidance but not serving as the focus of coding).

*a. Approaches to Working Together.* The five approaches to working together varied in the extent and nature of collaboration.

*i. NONSHARED DECISIONS.* Children did not share their problem solving. While one of the partners was working on the problem, the other was not occupied with solving the problem (e.g., looking away, gazing blankly, just waiting, or not being allowed to see the materials) or both partners worked on the problem independently without any contact or coordination (e.g., by dividing the worksheet between them and working without showing the partner their solution).

*ii. UNILATERAL DECISIONS.* One child worked on the problem with no regard for the other, who observed—problem solving was minimally shared. Unilateral decisions could include taking long turns to work on a problem, with one child working for a while and then the other, without sharing of ideas across time but with both partners engaged with the problem. It was not considered unilateral decision making if the children built on each other's ideas in turn or if one lectured or supervised the other.

*iii. SPECIALIZED WORKING TOGETHER.* Children coordinated different contributions to the work by dividing the labor. The job was divided in parts to regulate each partner's active participation in problem solving. The partners coordinated their activity with tacit or explicit role specialization (e.g., one pointed to the route in the map problem and directed the other to calculate the distances, one asked questions for the other to answer, and or one took responsibility for reading the problem or lecturing or supervising the partner).

*iv. WORKING TOGETHER WITH FLEXIBLE COORDINATED ACTION.* Partners played interchangeable roles without specialization, but also without building on each other's ideas to seek consensus. Both children worked on the same aspect of the problem (perhaps exploring different ideas) at roughly the same time, attending to the immediate outcome of each other's efforts and adjusting actions to each other. For example, in the card-sorting problem, children classified cards using a common framework and were aware of and adjusted to each other's decisions; in the sandwich combination problem, the children used a joint list on which they each wrote down new combinations of sandwiches. Flexible coordinated action did not involve explicitly checking with each other for evaluation of ideas and did not need to involve fine-tuned adjustment to each other or evidence of shared thinking.

*v. TRANSACTIONAL DIALOGUE.* Children together examined the problem and possible solutions, building a new understanding collectively. Each child concentrated on the other's ideas as they were offered and the solution came directly from the process of dialogue, with the partners directly addressing ideas to each other, as in Bearison's (1991) "transactional discussion." (The dialogic turns could be accomplished by words or by actions directed to the partner for consideration.)

Both partners checked with each other for evaluation of their own ideas and for feedback. This often led to extensions and development of ideas and a new joint understanding of the problem and, finally, its solution. For example, on the map problem, when one child examined distances to Centerville (by connecting each neighboring city to Centerville with his finger) and noted, "Look, there isn't any city that's 52 miles away from Centerville," his partner agreed, "No," and suggested, "I think we should add two or three distances to get 52 miles." The second child's contribution of new possibilities for a solution of the problem built on the first child's observation. Transactional dialogue did not need to involve equal contribution of ideas from the partners or equal leadership, nor agreement on intermediate steps of shared problem solving; rather, it involved children presenting, testing, and building on each other's ideas and finalizing the solution together.

*b. Guidance Approaches.* Only communication by fourth-graders that appeared to be aimed at assisting the third-graders' learning or performance was rated as guidance—it involved explaining, offering guiding questions, talking-aloud strategies for the partner's benefit, or demonstrating. Guidance did not need to be effective or accepted by the third-grader.

*i. QUIZZING.* The fourth-grader verbally tested the third-grader with known-answer questions [e.g., "which of these (displayed cards) belong together?"] to focus attention on specific information and/or evaluate the third-grader's answer (e.g., "Good job, those cards match!"). Quizzing often involved the fourth-grader withholding information from the third-grader such as by providing a challenge [e.g., "Think again, there should be another combination (of sandwiches)"] or by giving accuracy feedback that avoided giving further information (e.g., "No, that's not it"). However, quizzing could involve some presentation of information for assistance, such as when a fourth-grader structured the problem for the third-grader's benefit by selecting the right answer and asking the third-grader to explain this solution or leading the third-grader by means of prompts to see the correctness of the solution.

*ii. DIRECTING ACTIONS, WITHOUT RATIONALE.* The fourth-grader controlled and directed the third-grader to carry out the actions of solving the problem without explaining or prompting the learner to seek a rationale (e.g., in the card sorting problem, "Now put the cup and bowl together"). Directing actions did not involve provision of rationale or ideas that represent the whole solution—it was as if learning comes from actions directed by the teacher, even without understanding.

*iii. PURE INSTRUCTION.* The fourth-grader provided explicit demonstration and/or explanation and justification of actions to the third-grader, who was treated as an audience/observer (e.g., "I'll tell you how" or "See how I do it"). With demonstration, even if there was little or no justification, interaction was still rated as pure instruction if it was clear that the fourth-grader's purpose in demonstrating was instructional. An example of pure instruction in the sandwich combination problem involved a fourth-grader explaining the solution for making all possible combinations of two types of bread and three types of toppings to his third-grade partner: "OK, brown bread and white bread—it's two . . . . And three toppings make it six. OK? Because two times three is six . . . . And, let's say, if you had eight things that had to go with . . . four things; eight times four is . . . what? thirty-two." Then the fourth-grader drew a graph putting all possible connecting lines between an upper row of 8 dots and a bottom row of 4 dots. After counting the 32 connecting lines together with the third-grader, he asked, "Get it?" The third-grader replied, "Yeah."

*iv. INSTRUCTION EMBEDDED IN COLLABORATION.* Here, guidance was offered *during* the process of collaborative solution. The partners worked together with the fourth-grader providing explanation, demonstration, or justification in the context of joint action. Instruction embedded in collaboration differs from quizzing and pure instruction because the fourth-grader did not need to know the solution

of the problem prior to guiding the third-grader. [If there was extended didactic instruction (e.g., several paragraphs' worth of explanations or demonstrations), the interaction was not rated here but in "pure instruction."] For example, in the map problem, after exploring the map together with a third-grader, a fourth-grader suggested (while writing numbers), "Now let's add these two distances to see if we get fifty-two miles," and started adding the numbers while the third-grader looked for alternative routes. In the card-sorting problem, another fourth-grader said, "Let's pick up kitchen stuff," and the third-grader took a card, asking, "Like this cup?" The fourth-grader confirmed, "Yes, the measuring cup, the mixer, the toaster" while selecting those cards; the third-grader proceeded to help her find more "kitchen stuff".

*c. Coding Occurrence and Extensiveness of the Different Approaches.* The raters treated each of the four problems as a separate coding unit. For each problem, the raters characterized the extent to which each of the five approaches to collaboration and four approaches to guidance were used in the dyad's work on the problem. The raters used a scale to distinguish whether each approach was the only one applied to the problem, the approach predominated in duration and/or importance to the problem solution but another or others were important at times, the approach was used minimally, or it was not used at all. For most problems, each dyad was characterized as using one or two approaches.

Results were identical whether we analyzed the ratings of extensiveness of each approach within each problem or simply examined the occurrence of each approach (beyond minimal use) within each of the four problems. Hence our results report only the occurrence of each approach (beyond minimal use) within each of the four problems.

*d. Reliability of Rated Categories.* All 24 dyads were rated by one person who did not know the design or the questions of this study and was not aware that we were comparing interactions of children from two different schools. For reliability purposes, 14 dyads (7 from each school; 58% of the total data base) were rated also by the first author. Interrater reliability of occurrence of the approaches to working together and to guidance yielded Cohen's kappa values ranging from 0.74 to 0.88 (except for the variable of fourth-graders directing actions without providing any rationale, which almost never occurred). Kappa values in this range reflect "good" to "excellent" levels of agreement (Fleiss, 1981).

### C. TWO CASES ILLUSTRATING THE PATTERNS FROM THE TWO SCHOOLS

Combined qualitative and quantitative analyses of the videotape data helped us discern that the children from the collaborative school used transactional dialogue

and guided during collaboration more than the children from the traditional school, who used more quizzing. In this section, we present a qualitative analysis of two cases illustrating the distinctive patterns of working together and guidance in the two schools. We describe one dyad from each school, along with justification of the ratings of the categories of working together and guidance. We provide these descriptions both to give a more solid feel for how several prototypical cases developed their approaches over the course of dealing with one of the problems and to illustrate the rating categories defined previously.

Both cases involved pairs of girls, working on the first problem—card sorting, with the instruction to the fourth-grader (“4G”) to help the third-grader (“3G”) learn how to figure out which pictures go together. (This problem was designed to have items that could be classified in multiple ways; it does not have a single “right” answer.)

### 1. Case 1: Dyad from the Traditional School

This dyad’s approach to working together was rated as *specialized working together*. Throughout the problem, the dyad’s joint activity was based on division of labor between the fourth-grader—who presented problems for the third-grader and provided guidance—and the third-grader, who was responsible for replying to the fourth-grader’s quizzing.

This dyad’s approach to guidance was rated as *quizzing*. The fourth-grader guided by trying to solve the problems in advance of involving the third-grader, posing known-answer questions, and testing and evaluating the third-grader’s knowledge (and giving hints and modifying the questions if the third-grader had trouble). This dynamic is reported as follows:

As soon as the researcher gave the cards to 4G, she started silently putting each card on the table. Then she picked up the electric mixer card, showed it to 3G, and *quizzed* her, “OK. What do you use to do this with?” 3G looked perplexed, “I use . . . ah. . . .” Then 4G *clarified* by circling her hand over all the cards, “. . . out of all of these pictures.” That helped 3G, who replied, “Okay,” and looked at the other cards spread on the table. She found the measuring cup card and said, “You use one of these. . . to put it into.” 4G *approved*, “All right,” and handed 3G the two cards, “So put these together.”

Then 4G picked up the card showing the wooden spoon and *quizzed* again, “What do you use to do *this*?” 3G identified the bowl card and said, “This!” 4G *asked for explicit justification*, “Because?” and 3G replied, “Because of stirring.” 4G *evaluated*, “OK.”

4G looked over the cards for a while and continued *quizzing*, with the toaster card, “What do you use to go with this?” 3G took the card, examined the rest of the cards on the table, and expressed puzzlement, “Hmmm . . .” 4G turned the cards right side up for 3G, who continued to hesitate. Then 4G *prompted*, “OK, what do you eat out of this?” 3G replied with puzzlement, “Toast?” 4G prompted further, “And what do you eat with food usually? What do you drink if you’re eating?” 3G smiled, picked up the cup card and exclaimed, “Oh, yeah!” 4G *approved*, “OK,” when her *hints* led to the answer 4G wanted.

4G examined the cards to *determine the next pair for herself* in advance of asking 3G to find the pair, “And then, let’s see . . .” After 4G found the pair, her *quizzing* continued. She gave 3G the hair blowdryer card, “What goes with this?” While 3G was thinking of what goes with a blowdryer, 4G turned the razor card to look at it. 3G seemed to take this as a prompt, picked the razor card, and replied, “This! Because they’re both used in the bathroom.” 4G *approved*, “OK,” but with some reservation in her voice as she looked at the rest of the cards carefully, saying “Um, let’s see.” 3G picked up 4G’s uncertainty and said, “No, wait,” and put the razor card back down. Now 4G *deviated from her quizzing* with uncertainty about the grouping; she paused to *solve the grouping for herself* and then gave the answer to 3G by taking the towel card, showing it to 3G, and saying, “I think it’s this one because you use towels when you use the hairblower.” 3G enthusiastically agreed with 4G, “Uh huh!” and took the card, putting it with the blowdryer in the growing collection of pairs of cards beside her.

4G continued the cycle of *quizzing* the third-grader for the fifth and sixth pairs, giving 3G a *hint* when she had difficulty on the sixth pair and continuing to *evaluate* 3G’s answers.

The *quizzing* routine continued until all cards were paired. However, the criteria for grouping slipped with the last three pairs, as not all cards could easily be paired according to their functions. Nonetheless, this dyad *chose to overlook problems in their categorization scheme to maintain the question-response-evaluation rhythm* of the roles they had been using for six pairs (“Which?” “This.” “Good.”). Thus when 4G asked for the card to go with the broom, she accepted 3G’s choice of typewriter with no discussion of rationale and no checking of prior pairs to see if there was a better functional pair. (There was no better option among the remaining four cards.) The two children hardly skipped a beat in their rhythm, though brief strange facial expressions marked some dissatisfaction with this pair. The last two pairs were formed by being in the same category rather than having a functional relation (two types of scissors and two types of knives). In making this shift, 4G successively transformed her usual question—asking about the first scissors card, “How do you use this? . . . What goes with this? . . . What matches this?” As soon as the last pair was formed, the children turned to the researcher, who asked 3G to explain the groups.

## 2. Case 2: Dyad from the Collaborative School

This dyad’s approach to working together was rated as *transactional dialogue* because the children built solutions together through constant consulting and giving each other feedback; they also used some *specialized working together* as the fourth-grader assumed a specialized role in setting the activity—providing the frames of problem solving, explicating important aspects of the activity, and adjusting the third-grader’s participation. All contributions of the fourth-grader were open for the third-grader to observe and participate in. The dyad’s approach to guidance was rated as *instruction embedded in collaboration* because all of the fourth-grader’s guidance occurred as part of the joint activity. This dynamic is reported as follows:

After 4G placed the 18 cards one by one on the table and asked the researcher several clarification questions about the goal of the task (to which the researcher replied, “Do what you think best”), 4G turned to 3G, who was watching closely. 4G said “So, we can put them into different categories . . . OK, so . . . like we would have . . . (picking up cards) scissors, scissors, and maybe razor, because they’re all “sharp” or

something . . . and maybe the knife.” 3G nodded enthusiastically and said *collegially*, “Okay. That’s good.” So 4G put those four cards aside, “OK. . . This is the ‘sharp’ category,” *specifying the category rationale* 3G and *modeling the process during selection of this first group*.

Meanwhile, 3G *pitched in and began the second group, following the same process*. With 4G watching closely, 3G picked up cards and put them into a pile, “Hairdryer. . . Hmmm. . . Toothbrush. . . And what else goes into bathrooms?” 4G was looking for an appropriate card when 3G answered herself with enthusiasm, “Towels go into the bathroom!” She put the towel card into the pile and turned to 4G, who replied, “Yeah.”

4G *provided leadership* on the next group, saying, “Kitchen stuff,” and the two girls *worked closely together, consulting on the items* for this group. 3G was very attentive as 4G looked for an appropriate “kitchen” card, “We can have knife. . .” (handing it to 3G), and then 3G chimed in, saying “yeah, butter knife. . . bowl,” as she put these cards in a pile. 4G said “bowl” along with 3G, and then both girls said “cup” as they placed that card together. 3G picked up the wooden spoon card and then hesitated, “You’d find this in a kitchen, wouldn’t you?” 4G assured, “Yeah!” and 3G nodded and echoed 4G’s “yeah.” The two girls each picked out several other cards for the kitchen pile, briefly *discussing* their appropriateness; at one point 3G checked the cards in the kitchen pile. 4G then checked the cards in the prior “bathroom” pile, affirming, “Those go together,” while 3G pushed the “kitchen pile” to the middle of the table, indicating nonverbally that the “kitchen” pile was done. The girls then *consulted together* to construct a “cleaning” category.

When the girls noticed that the one remaining card (the typewriter) would not fit their categories, 4G *suggested* reluctantly that they reconsider their groups, “Maybe we should do some other ones?” and 3G said “Hmmm.” 4G *provided leadership* in suggesting a new scheme. She took the hair blowdryer card from the “bathroom” pile and gave it to 3G, with the typewriter card, announcing, “Electric things.” 3G grabbed the “kitchen” pile to check whether there were other “electric” items there. 4G *supported* her, “Yeah, the mixer and toaster from there,” and the two moved these items to the new “electric” category. Then the two girls looked through the remaining piles.

4G then *suggested* exploring further possible ways of sorting the cards, “We can do it by. . . kinds [they are made of]. Like, here’s glass. . . Here’s metal. . . (putting cards into the new piles), metal, metal, metal. . .” 3G *joined in*, making a “plastic” group, grouping three items “Plastic, plastic, and plastic.”

The dyad handled several ambiguous items by *sharing problems and discussing possible solutions*. Often the girls *appropriated each other’s solutions* in solving ambiguous cases (where an object had both metal and plastic). Sometimes it was 3G who provided the solution accepted by the dyad. At times, 4G *appropriated and transformed* 3G’s reasoning and applied it to another ambiguous case. 4G had a *special guiding role in explicating and justifying solutions* to these emergent problems.

The children reviewed the new new groups together, with the fourth-grader *leading* in naming the groups and 3G *contributing*.

4G *proposed* making another sorting by color, and 3G *agreed* enthusiastically. They continued the pattern of their work, sorting the cards into eight groups by color, *watching and checking each other’s placements*. Then 4G *offered the lead* to 3G to suggest another way of sorting, “Now what do you want to do?” But 3G replied, fidgeting a bit, “I don’t know.” 4G suggested, “Hmmm. . . [We could do] which ones have wires?” 3G said, “Okay,” and counted the objects with wires. 4G *suggested* several other criteria for sorting (shapes and whether the objects had handles) and the two sorted *together* by each criterion in turn. Finally, the researcher asked 3G to explain the (last) sorting.

TABLE I  
Mean Number of the Four Problems (and Standard Deviations) Employing Each  
Category of Working Together More Than Minimally

Approach to working together	Collaborative school	Traditional school	$F(1, 22)$
Nonshared decisions	1.08(1.00)	.75(.97)	0.7
Unilateral decisions	.66(1.23)	.83(.94)	0.1
Specialized working together	3.17(1.03)	3.17(1.19)	0.0
Flexible working together	.25(.45)	.33(.49)	0.2
Transactional dialogue	1.58(1.08)	.67(.78)	5.7, $p < .05$

As can be seen in these two cases, the dyads used rather coherent and distinct approaches to working together and guidance. The character of the dyads' approaches developed over the course of problem solving in ways that fit with the practices of their schools.

#### D. REGULARITIES OF THE DYADS' APPROACHES TO WORKING TOGETHER AND GUIDANCE

In this section, we examine the regularities of the approaches to working together and guidance across all the dyads in all four problems. Because there were no significant main effects for problem or interactions between problem and school factors in repeated-measures ANOVAs with problem as a repeated factor, all further analyses were based on values combining the four problems.<sup>4</sup>

##### 1. Approaches to Working Together

Table I shows the mean number of problems (of the four total problems) in which the dyads demonstrated more than minimal use of each category of working together. The most common approach used by the children from both schools was specialized working together (and there was not a significant difference between the children from the two schools in the average number of problems in which they worked together with specialized roles). All dyads from both schools used specialized working together more than minimally, and many from both schools used this approach extensively.

The next most common approach for the children with a collaborative schooling background was transactional dialogue, the most shared form of decision making, in which partners built on each other's ideas. The children from the collaborative

<sup>4</sup>There were no main effects of gender. Although there were some significant interactions of gender and school, the sample sizes per cell ( $n = 6$ ) were so small that we regard the interactions as uninterpretable. Entering gender in the ANOVAs testing school effects did not affect the findings regarding differences between schools.



TABLE II  
Mean Number of the Four Problems (and Standard Deviations) Employing Each Category  
of Guidance More Than Minimally

Approach to guidance	Collaborative school	Traditional school	$F(1, 22)$
Quizzing	.83(1.19)	2.00(1.41)	4.8, $p < .05$
Pure instruction	1.00(1.35)	1.08(1.16)	0.0
Instruction embedded in collaboration	1.00(1.04)	.17( .39)	6.7, $p < .05$

school were judged to use this approach on significantly more problems than were children with a traditional schooling background (see Table I). In addition, we noted that 9 dyads from the collaborative school used transactional dialogue more than minimally for at least some of the session, whereas only 2 dyads from the traditional school did so.

The other approaches to working together—nonshared decisions, unilateral decision making, and flexible working together—were seldom used in either group, with no significant differences between the two groups in use of these approaches.

## 2. *Approaches to Guidance*

Table II shows the mean number of problems (of four) in which dyads demonstrated more than minimal use of pure instruction, quizzing, and instruction embedded in collaboration.

In the traditional school, as expected, dyads were judged as engaged in quizzing (asking known-answer questions to test understanding, often evaluating the responses) in significantly more of the problems, on average, than were dyads in the collaborative school (see Table II). Our analysis also showed that 10 of the 12 dyads from the traditional school used quizzing more than minimally, whereas only 3 dyads from the collaborative school did so.

Instruction embedded in collaboration, the most collaborative form of guidance, was judged to have been used by the children from the collaborative school in significantly more of the problems than by children from the traditional school (see Table II). We also noted that 7 dyads from the collaborative school engaged more than minimally in instruction embedded in collaboration, whereas only 2 dyads from the traditional school did so.

“Pure instruction” was employed more than minimally by about half of the dyads from both schools (6 dyads with collaborative schooling and 5 dyads with traditional schooling), with no significant difference between the schools in the number of problems in which pure instruction was employed (see Table II).

Directing actions without providing rationale almost never occurred (and thus is not included in the Table). Out all four problems for all 24 dyads, there was only one problem in which one fourth-grader directed the third-grader’s actions

without providing a rationale. It was surprising that neither group engaged in direction of the third-grader's actions because previous studies (Ellis & Rogoff, 1986; McLane, 1987) have found that peer instruction may involve a focus on task completion rather than on increasing the learner's overall understanding of the problem and its rationale.

### *3. Dyads That Used Transactional Dialogue Often Embedded Instruction in Collaboration*

It is informative, but not surprising, that dyads that used instruction embedded in collaboration also often used transactional dialogue in working together. Considering all 24 dyads from both schools, 11 of the 14 dyads employing instruction embedded in collaboration (including those who did so to only a minimum extent) also used transactional dialogue (Cramer's  $V = .50$ ,  $p < .05$ ).<sup>5</sup> Both instruction embedded in collaboration and transactional dialogue were predominant in the collaborative school. These findings are consistent with the collaborative type of discourse encouraged in the collaborative school that could be expressed both as collaboration through transactional dialogue and as instruction embedded in collaboration.

## **III. Discussion of the Findings: Culture of Schooling in Shaping How Children Work Together and Guide Each Other**

Consistent with the idea that participation in schools with varying practices may contribute to shaping the formats of interaction, the children with a collaborative schooling background more commonly built on each others' ideas through transactional dialogue and more commonly embedded their instruction in collaboration than did the children with traditional schooling experience. In contrast, the children with a traditional schooling background predominantly used a "quizzing" form of guidance based on asking known-answer questions and withholding information to test learners' understanding, consistent with guidance often used by teachers in traditional schools. These results, supporting the idea that children learn more than curriculum content in their involvement in the teaching and learning practices of their school, are consistent with the view of schooling as a cultural process.

In this section, we discuss educational practices relating to the differences that we observed and argue that schooling is a central cultural contributor in children's

<sup>5</sup>The other relations between approaches to working together and to guidance are less informative: Instruction embedded in collaboration co-occurred with the ubiquitous specialized working together (in 14 of 14 cases of instruction embedded in collaboration) with almost no correlation, presumably due to the widespread use of specialized working together. Instruction embedded in collaboration seldom co-occurred with flexible working together, which very seldom occurred (in only 1 of 14 cases of instruction embedded in collaboration).

learning how to collaborate and to assist each other in learning. We also examine similarities in the approaches of the children from the two schooling backgrounds. Then we discuss questions of whether one approach is better than another—which requires consideration of what they might be better *for*. Finally, we argue that children’s learning and collaboration needs to be considered in the ecological niches in which they both learn to participate and in which judgments of value are nested.

#### A. EDUCATIONAL PRACTICES PRODUCING CULTURAL DIFFERENCES

Differences in children’s approaches to working together and to guidance, outside their classrooms in our experiments, resembled differences in their everyday classroom practices. This finding supports the view that participation in schooling amounts to a form of enculturation, extending beyond the classroom situation. Children with experience in a school organized around collaboration more often built on each others’ ideas in problem solving and provided guidance in ongoing collaboration, whereas children with experience in a traditional classroom structure used the traditional teaching format of known-answer question/response/evaluation sequences.

The contrast is clear in two brief examples from the card-sorting problem. In the first example, a dyad from the collaborative school used transactional dialogue and instruction embedded in collaboration as follows:

4G picked up two cards—knife and bowl—and suggested combining cards as “kitchen stuff,” while 3G picked up the yellow hairdryer and yellow washing gloves and suggested organizing the cards by color. Then 4G noticed the different potential strategies and said, “We can do it by kitchen, by color. . . .” 3G interrupted him, “. . . by size, by material. . . .” 4G ended (with excitement), “Yeah, we can do it in many ways. Let’s. . . let’s try to find all of them!”

These children built on each other’s ideas through transactional dialogue as they broadened the definition of the task by deciding to find all possible systems of classification, and the fourth-grader provided commentary that helped to guide the problem definition as the children developed it together.

The second example illustrates how children with a traditional schooling background often used guidance involving quizzing, temporarily withholding information to test the third-graders’ knowledge or asking questions not to get information but to lead the third-graders to a correct answer as follows:

4G from the traditional school pointed at the toothbrush card and asked 3G, “Where in your house do you keep a toothbrush?” 3G answered, “In the bathroom.” 4G kept quizzing, “So where’re you gonna put this card?” 3G pointed at a group of cards and responded, “With the bathroom stuff.” 4G evaluated 3G’s answer, “That’s correct. Put it with the bathroom stuff.”

Thus, children whose classrooms prioritized working independently of others, with teachers structuring the classrooms in traditional fashion—presumably frequently quizzing the children with questions with known answers, providing hints to move children closer to the right answer, and evaluating replies—more commonly employed quizzing in out-of-classroom helping of another child.

These differences in the children's approaches to working together and guidance were accompanied by broader differences in the children's attitudes and values regarding collaboration with other children and with adults—supporting the idea of cultural, not just behavioral, differences in the children's approaches. In interviews subsequent to our observations, many children from the traditional school indicated a belief that when a more knowledgeable person does not know how to solve a problem in advance, guidance is impossible, whereas children from the collaborative school indicated that a more knowledgeable person can guide by demonstrating his or her ways of approaching the problem. Students' help to each other unsanctioned by the teacher was viewed as cheating by children from the traditional school but as a resource for learning by children from the collaborative school. The collaboratively schooled children tried to involve the researcher in their thinking twice as often as did traditionally schooled children, consistent with differences in their classroom experience—in the collaborative school, adults are potential partners and resources for help, whereas in the traditional school, adults often give students a task as a test in which engaging with the adult in problem solving is illegitimate.

The totality of differences in the children's approaches, attitudes, values, and relations constitutes differences in cultural practices situated in the two school institutions. Through participation in these cultural practices, children learn how to initiate the practices, assume appropriate social roles and identities, and become members of the communities of practice. These cultural practices of organizing formal education are, in their own turn, embedded in local communities and broader societies and belong to political, economic, social, and cultural realms.

#### B. CULTURAL SIMILARITIES ACROSS THE TWO SCHOOLS

The broader settings in which the two schools are embedded support not only differences between their cultural practices but also similarities. The schools are not opposites, standing apart on all dimensions.

Not surprisingly, children from both schools frequently used specialized roles in working together. The prevalence of specialized working together, in which children assume different roles in a division of labor, fits with other research with children of this cultural heritage (Ellis & Gauvain, 1992; Mosier & Rogoff, 2001). In contrast, division of labor in problem solving was less common in indigenous Mayan family groups in which an adult had spent few or no years in

formal schooling; these groups usually engaged in a more fluid multiparty form of collaboration (Chavajay & Rogoff, 2001).

Similarities in approaches to guidance were also expected and found in the extent to which the fourth-graders from the two schools provided pure instruction (explanation and demonstration). This approach was used in both schools. The children from both schools also were similar in rarely engaging in nonshared or unilateral decision making or in flexible working together.

It was unexpected that the children from both groups almost never directed the third-grader without providing a rationale regarding the purpose of the actions. We had expected that fourth-graders from the traditional school would more often employ this approach based on literature describing classroom teachers' direction of children's actions without providing a rationale.

There are many potential sources for similarities, including the children's membership in middle-class European American populations from similar neighborhoods in the same city and the children's parents' background in traditional U.S. schooling. Other sources of similarity include both schools' commonalities in meeting state core curriculum requirements, school district mandates, required standardized testing, and many features in common (such as the use of math textbooks—indeed, the same math textbook). Similarities could also be accounted for in terms of our procedure, which, for comparison purposes, was standard across the two schools—perhaps prompting the children of both schools to act similarly in some ways.

### C. IS ONE EDUCATIONAL APPROACH BETTER THAN THE OTHER? BETTER FOR WHAT?

It is tempting to try to judge which of the schools or which set of practices is better. However, in our view, the key question requires consideration of which is “better” for what? Is it better for learning how to participate in activities that prioritize solo contributions and quizzing or is it better for learning how to participate in collaboration? This is ultimately a question of diverse cultural values (Matusov, 1998). Different communities in our society struggle (often through political and ideological means) to promote different practices and institutions based on their diverse values.

#### 1. *The Value of Learning to Participate in Different Discourse Formats*

One could argue that cultural practices that support children in learning both types of discourse format may be most advantageous for children's adaptation to future settings (see Rogoff *et al.*, 1993). From the standpoint of the present, it would appear that U.S. children are likely to be called upon to collaborate skillfully

as well as to engage in quizzing forms of discourse and solo activities such as in standardized tests. However, the future itself is a dynamic and uncertain process defined by its past, current, and upcoming participants (Griffin & Cole, 1984) embedded in the life of the whole society.

Questions of the value of collaboration and of testing are clearly connected with political and economic struggles that will contribute to defining the future. The cultures and communities prioritizing collaboration and testing are different and to some degree antagonistic to each other. (They also have different power in U.S. society—one of the cultures is mainstream.) What can be viewed as collaboration in one culture may be viewed as cheating in another culture. What can be viewed as guidance through quizzing in one culture may be viewed as rejection of collaboration in another culture. Determining whether one approach is better than the other, or even whether learning to participate in both is preferable, requires value judgments regarding the roles of both collaborative and solo formats in the communities and institutions of the future.

Our study itself both reflects and contributes to a struggle among different communities, social institutions, economic interests and cultural values for defining the future. We, like the adults in the collaborative school and many other educators and researchers, would argue for the importance of children learning how to collaborate with others for success in other settings of their lives—a skill that until recently was not seen as important in traditional U.S. schooling. Learning how to engage in the quizzing discourse format promoted in a traditional school (without necessarily believing it is a desired form of guidance outside of the setting imposed by the mainstream institutions; see Wertsch, 1999) may also contribute to success in some key U.S. institutions, as they are currently structured. However, judgments of which practices are valuable must take into account the changing nature of institutions and the cultural, political, and economic values reflected in arguing for one approach, the other, or both together.

## 2. *The Value of Different Discourse Formats for Learning School Subjects*

Beyond the question of learning to participate in differently organized communicative formats, some readers may ask, “Which form of instruction best teaches school subjects like math?”

Answering this question is not merely an empirical issue but one that involves cultural values regarding quality of learning and goals of development (both cognitive and communicative), as well as the definition of doing mathematics itself. For example, doing mathematics can be defined as an individual demonstrating well-defined math skills on demand of a more authoritative person. In this case, traditional schooling may have an advantage over collaborative schooling. However, if the definition of math practice includes collaborative efforts to solve open-ended math problems, then collaborative schooling may have an advantage. As seen in the examples we presented, children in the collaborative school commonly

explored the card-sorting problem in greater depth, considering alternatives in an open-ended fashion that would be a disadvantage in a timed test but which provided greater engagement with the process of classification.

Similarly, Butler and Ruzany (1993) pointed to differences in the norms of schools and broader communities to account for differences in kibbutz and urban middle-class Israeli children's approaches to learning. Kibbutz children explained their own (and other children's) glances at peers' work in terms of wanting to learn from another child's efforts (e.g., "I wasn't sure what we were meant to do, so I wanted to check" and "If you see what other kids do you can get new ideas," p. 536). In contrast, urban Israeli children explained that they (and other children) looked at other children's work to be able to compare and assess their own ability ("to see whose design was best, whether mine was as good as his, and so on," p. 539). Butler and Ruzany suggested that the cooperative emphasis in the kibbutz environment may encourage children's motivation to learn and to offer and seek help in the face of learning difficulty, whereas the urban school's competitive environment, individual work, and normative evaluations may discourage intrinsic motivation, encourage children not to seek help from each other (with worry that trying to learn from others will be regarded as cheating), and "convey the message that performance does not count if it is not achieved alone" (p. 540).

Each schooling approach seems to be valued within its local community, serving different ends. However, most means of assessment of children's learning are based on the form of adult-child interaction that prevails in traditional U.S. schooling, with quizzing of children on an individual basis by adults who do not otherwise enter into the problem-solving process. Assessment of learning is often based on speedy solo responses to large numbers of items on demand, rather than exploration and understanding of ideas in depth, building understanding together with other people.

The testing situation—where a tester or experimenter giving a problem does not participate in solving it—is less close to the relationships of the collaborative school, where adults (teachers as well as experienced parent volunteers) often participate collaboratively in activities *with* children (Matusov & Rogoff, 2001). This was evident in the collaboratively schooled children's more frequent attempts to involve the researcher in their thinking, compared with the traditionally schooled children, although the researcher attempted to avoid involvement with the children's problem solving in order to serve as a tester. In addition, teachers in the collaborative school often report that in standardized tests, children find it difficult to stop helping each other figure out problems.

The usual psychological methods for measuring learning fit traditional schooling's definition of learning, which attempt to isolate students from others to examine knowledge and skills (Matusov, 1998; Rogoff, 1998). However, substituting an assessment of cognitive development designed for the collaborative school would not be appropriate in the traditional school, and using separate criteria for the two

schools would raise the classic cross-cultural issue of conceptual equivalence of measurement (Cole, Gay, Glick, & Sharp, 1971; Cole & Means, 1986; Sears, 1961).

The issue of how to appropriately assess learning is one faced by the U.S. educational system as a whole (Committee on Developments in the Science of Learning, 1999); it is an especially prominent issue in comparisons of math skill across nations with differing educational priorities and in judging the effectiveness of educational innovations within the United States. An interesting question for future research is to examine how the practices employed in research, as well as in educational institutions, may give differing views of the ways that children collaborate with and guide each other—and learn.

#### D. DEVELOPMENT OF CHILDREN AND INSTITUTIONS IN ECOLOGICAL NICHES

Our findings distinguished out-of-class interactive patterns of students that fit the character of instruction cultivated by two cultural institutions. However, it is clear in our discussion of challenges in comparing the value of the approaches that the particular practices are not themselves independent of values, goals, and practices of related institutions and cultural traditions. The philosophies and practices of the two schools, as cultural institutions, function in the context of many differing educational and social priorities and different involvement of families and larger communities. The children's participation in distinct cultural practices in their classrooms is likely associated with other related and important practices that may also relate to the children's approaches to collaboration and guidance.

To examine the ecological niches in which the different approaches to collaboration and guidance fit, it would be interesting to investigate the stability of the interactive patterns in varying contexts, corresponding to distinct communities of practice (Lave & Wenger, 1991). In particular, the dynamics of patterns resulting from circumstances that are unusual for the immediate ecological niche are likely to be revealing (see Bell, Schubauer-Leoni, Grossen, & Perret-Clermont, 1990; Schubauer-Leoni, Perret-Clermont, & Grossen, 1991; Siegal, 1991). We would expect a dynamic pattern of adjustment, for example, if our study were repeated with dyads in which one of the partners has a collaborative schooling background and the other has a traditional schooling background. In such circumstances, we anticipate that children's communication would require dynamic adjustment because they would not be intuitive and comfortable with each other's instructional and interactional formats.

However, even within the settings that we observed, the dynamic aspects of cultural practice may be seen in the variations between different dyads within the same school. The distinctive patterns of working together and guidance that we observed were not uniform within the dyads from each school. For example, a few children from the traditional school used transactional dialogue and a few children from the collaborative school demonstrated the quizzing type of guidance.



Children from both schools are familiar with formal schooling through its portrayal in books and television. Likewise, children from both schools have experienced a variety of instructional formats other than those in their elementary school—including those used in their families, preschools, church schools, and scouting organizations. Individuals often participate in more than one cultural community, and cultural communities and institutions are themselves dynamic, with aspects that build on and borrow from other settings (Rogoff, *in press*).

An important direction for developmental research is to focus directly on discourse practices and other traditions in institutional and cultural settings themselves rather than to focus so exclusively on individuals in situations presumed to be independent of particular cultural and institutional traditions. To address the question of how children learn interactional patterns in their participation in cultural communities, research needs to address more explicitly the development and functioning of children's institutional and cultural participation. This requires developmental research to attend to children's functioning within their everyday setting and, in addition, to study how children's settings, such as schools, function as cultural institutions that have their own dynamics, development, and communication practices.

As a step in this direction, we have investigated the collaborative school's everyday practices not as "background" to children's use of different interactional patterns outside of the classroom, but as phenomena in which individuals learn through participating with others in sociocultural activities that themselves develop (Matusov & Rogoff, 2001; Rogoff, Goodman Turkanis, & Bartlett, 2001). More generally, a greater awareness of the history and values of ubiquitous forms of schooling, and other institutions in which children participate, would help bring to light the unexamined cultural practices in which children participate on an everyday basis.

Indeed, we would argue that a great deal of developmental psychology is the study of children's learning to participate skillfully in the formats that are valued in the institutions and cultural practices of their everyday lives. If researchers become more aware of the institutional traditions of our lives and those of the children we study, we will be able to make more sense of our observations of human development.

In sum, our study suggests that children learn more than the content of their lessons; they learn means of social engagement that may serve rather different social structures and also learn what are considered appropriate modes of interaction for specific institutional contexts. This study contributes to sociocultural work in which human development is examined in terms of changing participation in activities within cultural institutions involving systems of values, goals, and patterns of communication (Fullan, 1993; Hargreaves, 1995; Rogoff, 1998). This is a shift from considering human development simply as age-related individual skills or conceiving of contexts such as schools as collections of stimuli or pedagogical

techniques. Our findings are consistent with the notion that people develop by participating in diverse and overlapping complex cultural systems with associated practices and philosophies.

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BEYOND PROTOTYPES: ASYMMETRIES IN INFANT  
CATEGORIZATION AND WHAT THEY TEACH US  
ABOUT THE MECHANISMS GUIDING EARLY  
KNOWLEDGE ACQUISITION

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## I. Introduction

In this chapter, I focus on asymmetries in the categorization of visual information by young infants. These asymmetries are used to support a perceptual learning model of early category formation that is described in the conclusion. Before discussing the data and model, I place the overall theoretical framework in the context of historical and contemporary views of infant development. In addition, I briefly review the infant behaviors and experimental methods that have allowed investigators to study perceptual and cognitive development in general and categorization in particular.

## II. Historical and Contemporary Views of Infant Development

In the very first volume of *Advances in Child Development and Behavior*, Lewis Lipsitt (1963) wrote the following:

Any complete theory of human behavior, and most particularly of human development, should contain information about the learning processes of the young child. Developmental observation and testing have demonstrated well that the human child is an exceedingly complex creature from the standpoint of the changes in the behavior occurring in the very first year of life. To assert without data, however, that the most important determinants of developmental change are hereditary, or maturational, or inevitable, seems gratuitous. Many of these changes could not possibly occur without a learning process, the precise mechanisms of which are still obscure. (p. 149)

Although this paragraph was written decades ago by someone who pioneered the systematic study of learning in infants, its content reveals a remarkable correspondence with the concerns of a new generation of developmentalists.

Discussions of infant perception and cognition have become common at professional meetings and in issues of *Journal of Cognition and Development*, *Journal of Experimental Child Psychology*, *Infancy*, *Infant Behavior and Development*, and *Developmental Science* (Aslin, 2000; Baillargeon, 1999; Carey, 2000; Cohen & Cashon, 2001; Haith, 1998; Mandler, 2000; Meltzoff & Moore, 1998; Needham, 2001a, 2001b; Rovee-Collier, 2001; Smith, 1999; Spelke, 1998; Yonas, 2001). What is the fuss about? Much of it centers on the appropriate level of “richness” of interpretation of the evidence and what kinds of skills and knowledge can be attributed to infants based on their performance in experiments conducted with habituation/dishabituation and spontaneous preference methodologies. In accord with traditional constructivist views of development, some theorists argue that infants may detect low-level stimulus variables like brightness and frequency and gradually learn to organize them by means of experience (i.e., instruction by the environment) into more complex mental structures that eventually attain the status of representations. From a more nativist perspective, other theorists



propose that infants may innately possess deep cognitive constraints which in time take the form of theories that organize domains of knowledge. The question becomes whether we should characterize the infant as being primarily perceptual or intelligent.

A third view is to consider the infant both perceptual *and* intelligent (Kellman & Arterberry, 1998; Quinn & Bhatt, 2001). According to this view, in the extremes of the nativist versus empiricist debate, theorists may miss the point that basic processes, when put into operation in the developing infant, can begin to yield functional knowledge in a fairly short period of time. For example, much of the experimental work reported in the present chapter was conducted with infants between 2 and 10 months of age, and infants during the first months of life may utilize sufficiently sensitive perceptual systems and a general learning mechanism to build up a set of expectations about objects, their appearance, and their behavior. This type of framework for understanding early knowledge acquisition thus attempts to avoid radical nativist solutions that rely on innate knowledge, although it also recognizes that species-specific biological constraints of a general nature (i.e., biases) may make possible the rapid development of cognition (e.g., Jusczyk, 1997; Quinn, 1999; Walton & Bower, 1993).

### **III. Infant Visual Preferences and Their Translation into Methodological Tools to Investigate Early Cognitive Development**

Much of what we have learned about the early development of visual cognition since the early 1960s has been obtained through the use of procedures that rely on the visual selectivity of young infants. These preferences can be observed from the neonatal period and have been reported for (1) low-level sensory attributes such as movement, contrast, and curvature (Fantz, 1961; Fantz, Fagan, & Miranda, 1975; Fantz & Nevis, 1967; Volkman & Dobson, 1976); (2) higher level perceptual features such as complexity and attractiveness (Fantz, 1961; Langlois, Ritter, Roggman, & Vaughn, 1991; Samuels & Ewy, 1985; Slater, Quinn, Brown, & Hayes, 2000; Slater, Von der Schulenburg, Brown, Badenoch, Butterworth, Parsons, & Samuels, 1998); and (3) even cognitive variables such as novelty and familiarity (Fantz, 1964; Hunter & Ames, 1988; Slater, 1995). Such preferences have been informative in revealing the dimensions of stimulation to which infants are sensitive and have yielded insights into the workings of the infant's perceptual and cognitive processing mechanisms (Cohen, 1979). In particular, the presence of the preferences from the earliest beginnings of development has suggested that the rapid course of initial learning may be guided by inherent biases or constraints (Quinn, 1999).

Infant visual preferences have also provided important methodological tools that investigators have used (1) as probes for exploring infant visual behavior in general

and (2) as a basis for making inferences regarding the nature of the infant's underlying mental representation of experience. For example, the differential preference that infants from birth onward display for novel versus familiar stimulation has led to the development of habituation/dishabituation and familiarization/novelty-preference procedures for measuring simple perceptual discrimination and memory abilities (Cohen & Gelber, 1975; Fagan, 1970). The basic protocol involves familiarizing infants with a single stimulus and subsequently testing infants with a novel stimulus and the familiar stimulus, presented either together in the case of the familiarization/novelty-preference procedure or in succession in the habituation/dishabituation procedure. A reliable preference for the novel over the familiar stimulus that can be measured in looking time or some other response measure (e.g., sucking rate) and that cannot be attributed to an a priori preference is taken as evidence that the infant has formed a representation of the familiar stimulus and can use that representation as a basis for differentiating the novel stimulus.

#### IV. Perception in Service of Cognition

Although the familiarization/novelty-preference procedure has provided a means for learning how infants respond to one versus another stimulus, the ability to perceive and differentiate individual stimuli is not likely to be a sufficient platform from which to launch adaptive behavior and intellectual development. An infant or young child that represented each stimulus as independent from every other stimulus would find intellectual development slow-going (Bruner, Goodnow, & Austin, 1956; Smith & Medin, 1981). Infants need to do more than just detect and discriminate; they need to group, organize, relate, and synthesize. Intelligent behavior requires the extraction of higher order stimulus relations among stimuli and the production of representations that constitute abstract, meaningful descriptions of the environment. Kellman and Arterberry (1998) have argued that such representations "can support ongoing action, but they also can be stored and recruited for later thought and action. The rest of cognition—such as memory, categorization, thinking, and problem solving—requires representations obtained from perceiving" (p. 283).

One important indicant of *cognitive* functioning is the emergence of organized and meaningful *groupings* of stimuli. At some point during development, humans must come to recognize discriminably different objects with important common characteristics as members of the same *category*. When and how category representations become available have been enduring issues for several generations of investigators, and the traditional view was that category representations were a late achievement, dependent on the emergence of language, logic, and instruction (Bruner, Olver, & Greenfield, 1966; Hull, 1920; Leach, 1964; Piaget, 1952; Vygotsky, 1962). However, since the early 1980s, the results of a number of studies

are consistent with the conclusion that at least some of the abilities needed for category formation are functional in preverbal infants (for reviews of various portions of this body of work, see Bornstein, 1984; Cohen & Younger, 1983; Eimas & Miller, 1990; Hayne, 1996; Madole & Oakes, 1999; Mandler, 1998; Quinn, 1998, 1999, in press-a, in press-b; Quinn & Eimas, 1986, 1996b; Reznick, 1989; Reznick & Kagan, 1983).

## **V. Assessing Categorization in Young Infants**

What kind of procedures and data are needed to permit the inference of categorization in young infants? One can use the familiarization/novelty-preference procedure, but two modifications are necessary. First, a number of different stimuli, all from the same category, are presented during familiarization. Second, infants are presented with two novel stimuli, one from the familiar category and the other from a novel category, during a novel category preference test. If infants generalize their familiarization to the novel instance from the familiar category and display a preference for the novel instance from the novel category, then we infer that infants have somehow grouped together the instances (including the novel one) from the familiar category and recognized that the novel instance from the novel category does not belong to this grouping (or category representation). Another way of describing infant performance is to say that the infants have formed a category representation of the exemplars presented during familiarization that includes the novel instance of the familiar category, but excludes the novel instance from the novel category.

When conducting investigations of early categorization abilities, considerable care must be taken to insure that the infants are not responding to idiosyncratic features of individual exemplars or small sets of exemplars. One way of meeting this objective is to preselect a large number of exemplars to represent each category under study. The exemplars should be chosen so as to approximate the variability of the exemplars as they appear in the natural environment. Each infant can then be familiarized with a different and randomly selected set of exemplars from one category and preference tested with a different and randomly selected pair of novel exemplars—one from the familiar category and the other from a novel category. By taking these precautions, the investigator increases the validity of the experiment as a study of category formation, one in which the infants must represent category-level information (e.g., features characteristic of the category as a whole) to perform at an above-chance level.

To infer category formation by infants, two further conditions must be met. First, investigators must show that the preference for the novel category instances did not occur because of an a priori preference. The category formation study should thus be repeated with a control group of infants with one important difference: Infants

would be presented with the preference test exemplars and not the familiarization exemplars. In this way, one measures spontaneous preference for the exemplars that appeared on the preference test trials of the category formation study. An inference of category formation is permitted if the novel category preference observed in the experimental group is significantly greater than the spontaneous preference (for the same category) observed in the control group.

Second, because categorization denotes equivalent responding to a set of discriminably different instances, investigators must confirm that infants can discriminate items within categories. If infants do not discriminate between the individual instances from the familiar category, then the category formation study would simply demonstrate between-category discrimination, a process that may be considerably simpler than a categorization process that requires grouping of discriminably different instances together (see Quinn & Eimas, 1998, for further discussion of the dissociation between processes of categorization and discrimination). To demonstrate within-category discrimination, each infant in a separate control group is presented with one exemplar from the familiar category and subsequently presented with a preference test pairing the familiar exemplar and a novel exemplar from the same category. The exemplar pairings would be chosen randomly and be different for each infant in the control group. A reliable preference for novel items from a familiar category allows for the conclusion that infants in the category formation study had grouped together a class of discriminably different entities.

## VI. Asymmetries in Infant Categorization

As discussed in the preceding section, two categories (familiar and novel) are needed to determine whether infants can form a category representation for one set of exemplars (the familiar category) that excludes instances of the other group of exemplars (the novel category). Consequently, investigators commonly run the categorization experiment in both directions. Half the infants are presented with exemplars from category A, whereas the other half of the infants are presented with exemplars from category B. Both groups are then tested with novel instances from categories A and B. If knowledge acquisition were to proceed with equal ease for all categories of stimulation, then one would predict equivalent results for the two groups of infants. That is, one would expect both groups to (1) display a reliable preference for exemplars from the novel category in the preference test or (2) divide attention equally between the familiar and novel category exemplars in the preference test. In the former case, one would conclude that infants represented both categories, each of which excluded instances of the other, whereas in the latter case, the null result would not permit the inference of representation of either category.

Of primary interest in the present chapter is that one sometimes obtains asymmetries: Infants display a preference for instances from novel category B after

presentation with exemplars of familiar category A, but do not display a preference for instances from novel category A after presentation with exemplars from familiar category B. In the remainder of the chapter, I focus on such asymmetries and discuss what these asymmetries tell us about the structures and processes that determine the course of early knowledge acquisition. I consider three reports of asymmetry in infant categorization performance in detail: cats versus dogs (Quinn, Eimas, & Rosenkrantz, 1993), humans versus nonhuman animals (Quinn & Eimas, 1998), and female versus male faces (Leinbach & Fagot, 1993; Quinn, Slater, & Pascalis, 2001).

#### A. ASYMMETRY 1: CATS VERSUS DOGS

Around the time that I began to work on the problem of categorization and its development, investigators had documented that 3- and 4-month-old infants could categorize local attributes of stimuli such as orientation (Bomba, 1984; Quinn & Bomba, 1986) and hue (Bornstein, 1981). Infants under 1 year of age were also shown to form category representations for more global visual patterns, including angles (Slater, Mattock, Brown, & Bremner, 1991), forms (Bomba & Siqueland, 1983; Colombo, McCollam, Coldren, Mitchell, & Rash, 1990; Quinn, 1987; Younger & Gotlieb, 1988), and black-and-white schematic faces and animals (Roberts, 1988; Sherman, 1985; Strauss, 1979; Younger, 1990). Not clear from the initial round of infant categorization studies was whether infants could form category representations for realistic and computationally complex natural objects that later come to have conceptual significance for children and adults. For example, the stimuli that infants encounter in the real world include naturally appearing faces and animals, and instances of everyday generic object categories (e.g., furniture, vehicles). Therefore, an initial investigation was undertaken to determine whether young infants, 3 to 4 months of age, could form separate category representations for cats and dogs chosen from the superordinate category animal (Quinn *et al.*, 1993). These categories seemed like good candidates to begin to study infants' natural category formation because some of the earliest words in the child's vocabulary refer to animals and include "dog" and "kittie" (Roberts & Cuff, 1989). This work relied on the familiarization/novelty-preference procedure; consequently, a third category, birds, was used as a contrast (i.e., novel) category. The stimuli were 54 photographic exemplars from the categories (18 exemplars/category), and the exemplars were chosen to represent a variety of shapes, colors, and poses so as to approximate their variability in the environment. However, across the categories, stimuli were selected to be nearly the same size as possible. If size was not removed as a cue and babies formed category representations of the animals, then the result would have been subject to the criticism that only simple size discrimination (rather than complex categorization) had been demonstrated.

We first asked whether infants could form separate category representations for dogs and cats that were sufficiently differentiated to exclude instances of birds.

**(a) Cats or Dogs versus Birds**

Familiarization	<u>Cats</u>		<u>Dogs</u>	
	C <sub>1</sub>	C <sub>2</sub>	D <sub>1</sub>	D <sub>2</sub>
	C <sub>3</sub>	C <sub>4</sub>	D <sub>3</sub>	D <sub>4</sub>
	•		•	
	•		•	
	•		•	
	C <sub>11</sub>	C <sub>12</sub>	D <sub>11</sub>	D <sub>12</sub>
Novel Category Preference Test	C <sub>13-18</sub>	B <sub>1-18</sub>	D <sub>13-18</sub>	B <sub>1-18</sub>

**(b) Cats versus Dogs**

Novel Category Preference Test	C <sub>13-18</sub>	D <sub>1-18</sub>	D <sub>13-18</sub>	C <sub>1-18</sub>
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Fig. 1. Schematic depiction of the experimental designs used by Quinn, Eimas, and Rosenkrantz (1993) to investigate whether 3- to 4-month-old infants could form individuated category representations for cats and dogs. The letters B, C, and D correspond with bird, cat, and dog, respectively. The numerical subscripts correspond with individual exemplars presented during familiarization and the preference test. (a) The experimental design for investigating whether infants form category representations for cats and dogs, each of which excludes instances of birds. (b) How the preference test would need to be modified to investigate whether infants form category representations for cats and dogs, each of which excludes instances of the other.

As can be seen in the top half of Fig. 1, half the infants were exposed to a dozen cats, and the other half were shown a dozen dogs. Infants in each group were then administered a novel category preference test. Those infants who saw cats were presented with a novel cat paired with a bird, and those infants who began with dogs were presented with a novel dog paired with a bird. Looking time to the stimuli was measured by trained observers who were naive to the hypotheses under investigation. On test trials, infants who saw dogs looked predominantly to the novel birds, and those who saw cats also looked mostly to the birds. A control experiment indicated that the preference for the bird stimuli was not due to an a priori preference for the birds; that is, infants did not simply like to look at birds more than dogs or cats. We also determined that the bird preference could not be attributed to a failure to discriminate among the exemplars within the dog and cat categories.

Given the abilities of young infants to categorize shape and form information described above, it is perhaps not surprising that they would form category

representations for cats and dogs, each of which was structured to exclude instances of birds. Birds can be represented separately from cats and dogs based on differences in global shape, surface texture (feathers vs fur), a single attribute (two legs vs four legs), or the pattern of correlation (beaks, feathers, and two legs vs noses, fur, and four legs). We next asked whether infants could form a category representation for cats that excluded dogs and a category representation for dogs that excluded cats. We believed that the cat versus dog categorization task might be more difficult for infants because of the perceptual overlap of the two species. Both cats and dogs possess comparably shaped bodies, the same basic facial features, the same number of legs adjoining the body in the same way, and similar coloring and surface texture.

Infants were familiarized as before with either cats or dogs and then, as shown in the bottom of Fig. 1, tested with a novel cat versus a novel dog. Here, infants familiarized with cats preferred dogs over novel cats, but infants familiarized with dogs divided their attention between cats and novel dogs. At face value, these results were surprising because they suggested that infants had succeeded in forming a category representation for cats that excluded dogs, but had failed to form a category representation for dogs that excluded cats. This pattern of findings fits with the more general model of the category A versus category B asymmetry described in the previous section.

The task now became one of determining the basis for the asymmetry. Our initial hypothesis was that an a priori preference might be responsible. That is, infants might, for whatever reason, simply prefer to look at dogs more than cats. If such a preference was operative, then it would presumably facilitate a novel category preference for dogs after familiarization with cats; however, it would interfere with a novel category preference for cats after familiarization with dogs. To assess the possibility of a spontaneous preference for dogs over cats, the cat versus dog categorization experiment was repeated, but in this case, without presentation of the familiar category. The test stimuli were simply paired together with no prior familiarization. To our continued surprise, no preference was observed. The infants divided their visual attention evenly between the cats and dogs.

After establishing that the asymmetry did not result from a spontaneous preference for the dog stimuli, we considered the possibility that the dog exemplars might be more variable than the instances of cats. Our dog category included French poodles, collies, German shepherds, and bulldogs, and although we had attempted to obtain a comparable category of cats, the differences between the tabby, Siamese, and birman breeds did not seem to match those observed among the dogs. We speculated that infants might not be able to form a category representation for the dogs because the dogs were just too variable to pull together into a common representation that excluded cats.

The variability explanation was tested in two steps. First, we obtained typicality ratings of the stimuli. Typicality ratings for individual exemplars were used instead

of similarity ratings for pairs of stimuli because we wanted to gain a sense of the variability of one category relative to another. That is, we wanted to see if the internal structure of the dog category had greater breadth relative to the internal structure of the cat category. Mothers of our infant research participants were therefore asked to indicate, on a scale of 1–9, how representative an item was of its particular category. The results were consistent with our expectations: The variability of the ratings for the dogs was reliably higher than the variability of the ratings for the cats.

The second step was to remove from our stimulus set the 5 dogs that were rated the most atypical. We were left with a set of 13 dogs (i.e., just enough to run a categorization experiment with each infant presented with a randomly selected set of 12 and tested with the remaining instance versus a randomly selected cat). Importantly, this set of dogs matched the cats in terms of variability as determined by the maternal ratings. When we presented the infants with the reduced-variability set of dogs, a reliable novel category preference for the cats over the novel dogs was observed. In other words, the infants had succeeded in forming a category representation for dogs that was exclusive of cats.

The overall pattern of results of Quinn *et al.* (1993) was of interest on at least two levels of analysis. When considering categorization in general, the findings that infants are able to form separate representations for cats and dogs indicate that the category distinctions made by quite young infants are often the same distinctions that later in life come to have a conceptual nature. This early veridical parsing of the world should permit the infant to begin to associate new knowledge with the category representations. For example, if young infants possess abilities to form a category representation for cats (e.g., one that is based on observable surface attributes, including body shape, parts, markings, face information, communicative sounds, and motion), then more abstract information that is learned later (e.g., that cats are meat eaters, possess cat DNA, and give birth to kittens) can be used to enrich the early perceptually based category representation and allow for the development of a conceptually based representation (i.e., a concept) for cats. The conceptual representations found later in life can thus be viewed as informational enrichments of young infants' category representations (Eimas, 1994; Quinn & Eimas, 1997, 2000). Although the process of conceptual knowledge acquisition by children and adults is far from agreed upon (Carey, 1985; Keil, 1989; Piaget, 1952; Vygotsky, 1978), it is significant that the infant has the correct parse to start the process of further knowledge acquisition whatever that process turns out to be. By this view, the abilities that young infants have to form perceptual category representations may form the primitive base from which adult conceptions of objects develop.

One clarification that may be helpful at this point in the discussion is to acknowledge that the infants who are presented with exemplars of cats or dogs and form category representations in the laboratory are not necessarily leaving the laboratory with long-term representations for cats and dogs that will themselves



represent the start-up structures into which subsequent experience and knowledge can be incorporated. The claim is more that the infants are demonstrating parsing skills in the laboratory that may be successfully deployed to form representations for classes of real objects when those objects are encountered in the natural environment. It is the latter group of representations that may serve as the actual supports for further knowledge acquisition.

At a more specific level, the Quinn *et al.* results and the cat-versus-dog asymmetry in particular were interpreted as indicating that variability of the familiar category exemplars is an important factor influencing the processes of category formation by infants (see also Oakes, Coppage, & Dingel, 1997, for a similar conclusion). Narrow categories that are tightly structured around a prototype may be efficiently represented by infants. Broader, less coherent categories with widely varying exemplars might be more difficult for infants to construct.

#### B. CATS VERSUS DOGS REVISITED

Subsequent results suggested that variability alone might not be a sufficient explanation for the cat-versus-dog asymmetry. These results consisted of demonstrations that young infants, 2 to 4 months of age, can form global category representations for broad classes of objects such as mammals and furniture (Behl-Chadha, 1996). Consistent with a differentiation-based model of early category development (Gibson & Gibson, 1955; Quinn, in press-b; Werner, 1957), further experimental work with infants even suggested that these more general category representations might be acquired earlier than more specific category representations (Mandler & McDonough, 1993, 1996, 1998; Quinn & Johnson, 2000; Quinn, Slater, Brown, & Hayes, 2001; Younger & Fearing, 1999, 2000). Because these global category representations presumably encompass considerable within-category variability, young infants' ability to form them implies that something other than or in addition to variability was responsible for the cat-versus-dog asymmetry. In other words, it is hard to accept the argument that the difficulty young infants have with forming a category representation for dogs is due solely to variability when young infants can form an even broader category representation for mammals.

Given that the 3- to 4-month-olds in the Quinn *et al.* (1993) study first formed separate category representations for cats and dogs, each of which was sufficiently structured to exclude instances of birds, one way to think about the asymmetry is in terms of inclusivity (or exclusivity). The inclusivity of a category refers to its range of extension. What exemplars are included in the representation and which are excluded? One might therefore describe the cat versus dog asymmetry observed in Quinn *et al.* in the following way. Infants familiarized with cats formed a category representation for cats that included novel cats, but excluded dogs and birds. Infants familiarized with dogs formed a category representation for dogs that

included novel cats and dogs, but excluded birds. The critical question becomes “Why did the representation for cats exclude dogs when the representation for dogs included cats”?

To develop a more formal, quantitative approach for understanding the asymmetry in the exclusivity of the cat-versus-dog representations, Mareschal, French, and Quinn (2000) measured the values of 10 surface dimensions of the cat and dog stimuli. The dimensions included the following geometric and head/face extents: vertical extent, horizontal extent, leg length, head width, head length, ear separation, eye separation, ear length, nose width, and nose length. The choice of geometric dimensions was inspired by the skeleton extraction model of object recognition developed by Zhu and Yuille (1996). This model represents individual objects as a set of connected parts or perceptual primitives whose axes form two-dimensional skeleton structures. The geometric dimensions corresponded with the skeletal structure of the cat and dog exemplars. The large number and detailed nature of head and face dimensions were selected because of evidence that infants (1) are highly attracted to facial information (Johnson & Morton, 1991) and (2) appear to use information from the head and face region of cats and dogs to categorically represent them (Quinn & Eimas, 1996a; Quinn, Eimas, & Tarr, 2001; Spencer, Quinn, Johnson, & Karmiloff-Smith, 1997). Also, psychophysical and neurophysiological data indicate that some head and face dimensions (eye separation, head length and width, and nose length and width) may be used in face recognition (Rhodes, 1988; Yamane, Kaji, & Kawano, 1988; Young & Yamane, 1992). Of course, in referring to inputs as “legs” and “ears,” we do not mean to imply that the infant has a conceptual understanding of them. The inputs were all surface dimensions of the stimuli and potentially available to low-level parsing routines that segment a shape into a number of component parts.

The dimensional data provide an explanation for why the infants exhibit an inclusivity asymmetry. Figure 2 displays the probability distributions of the 10 dimensions, for both cats and dogs, when fit to Gaussian distributions using means and standard deviations from the normalized dimensional values. These data are based on the original, full set of dogs used by Quinn *et al.* (1993), before eliminating those dogs that mothers judged to be atypical. Some of the dimensions are similar in terms of their means and distributions for both cats and dogs (e.g., head length and head width). Others, especially nose length and nose width, are dissimilar and will provide an explanation for the surprising asymmetry reported in Quinn *et al.* (1993).

Consider the nose width dimension. The (normalized) mean nose width for the dog population was 0.53 with a standard deviation of 0.20, whereas the mean for the cat population was 0.24 with a smaller standard deviation of 0.07. The nose width of all the cats thus fell within 2 standard deviations of the nose-width mean for dogs. In contrast, the nose width of most of the dogs did not fall within 2 standard deviations of the nose-width mean for cats. In sum, the findings for this

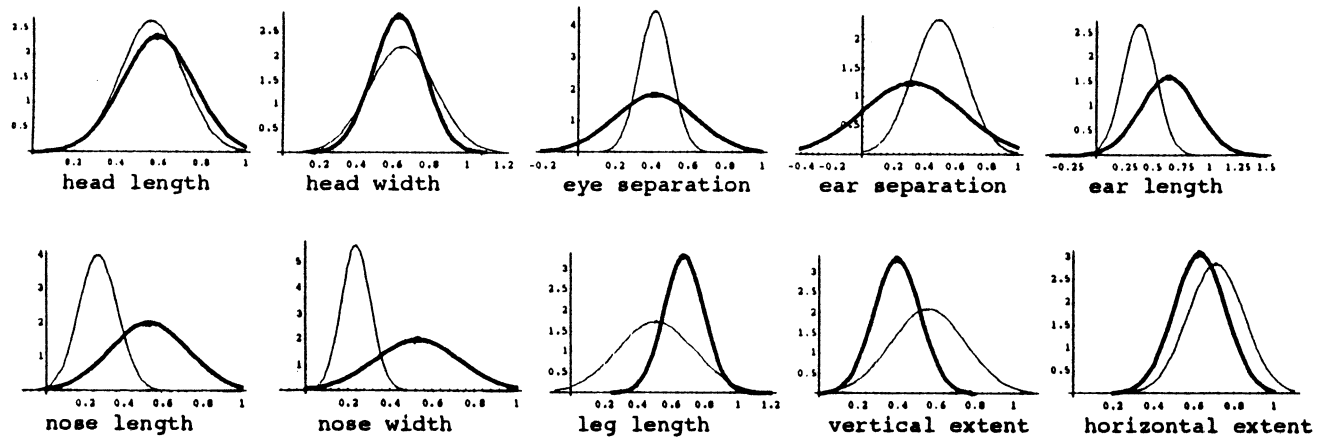


Fig. 2. Gaussian probability distributions generated from the means and standard deviations of normalized cat features (thin lines) and dog features (thick lines). The area under each curve sums to 1.0. From Mareschal, French, and Quinn (2000).

trait indicate that all cats could be exemplars of dogs, whereas most dogs could not be exemplars of cats.

Inspection of Fig. 2 reveals that in almost all cases the distribution for each dog trait (represented by the dark line) subsumed the distribution for the corresponding trait for cats. In contrast, the narrower distributions for most cat traits did not subsume the range of values for the corresponding dog traits. In other words, cats are possible dogs but the reverse is not the case: Most dogs are not possible cats. Specifically, when all members of the two populations are examined, the values of all 10 traits for 9 (i.e., 50%) of the members of the cat category fall within a 2 standard deviation cutoff for those traits for the dog category. Fully half of the cats in the population could be reasonably classified as dogs. In contrast, the smaller means and lower variances of a number of traits (especially, nose length and nose width) for cats compared to dogs indicate that only 2 of the 18 dogs could conceivably be classified as members of the cat category. The exclusivity asymmetry of the categories formed on the basis of these exemplars may thus reflect the distribution of features characteristic of the cat and dog exemplars presented to the infants. The key aspect of the data is that the distribution of values for the cat features are (in general) subsumed within the distribution of dog features. The greater variability of dogs along certain features does not, alone, cause the asymmetry; the inclusion relation is crucial.

The claim that the cat-versus-dog asymmetry can be explained by the cat-versus-dog inclusivity relation is supported by neural network simulations in which an autoassociative connectionist learning system was provided with cat or dog exemplars, in the form of input vectors consisting of the attribute values described above (Mareschal *et al.*, 2000). In an autoassociative network, inputs are simply mapped to outputs (which are copies of the inputs) through a layer of hidden (representational) units. In terms of internal architecture, the number of hidden units is kept smaller than the number of inputs. The information compression created by this architectural feature is consistent with the idea that categorization exists in part to reduce physical diversity and serve cognitive economy. The job of the network at the level of the hidden units is to extract enough of the statistical regularities in the input to reproduce the input as the output. This architecture stands in contrast to a standard backpropagation network in which inputs are mapped through a layer of hidden units to categories at the output. When a backpropagation network with exemplars as input and categories as output is used to model infant learning, it is subject to the criticism that this manner of simulation is an unrealistic way to model the presumed unsupervised category formation achieved by young infants. The autoassociative network architecture may be more appropriate for modeling infant categorization because there is no teaching signal that maps exemplars to categories. The important finding that emerged from the autoassociative simulations is that the network developed cat and dog category representations that reflected the same asymmetry as that observed in the infants in Quinn *et al.* (1993).

## C. CATS VERSUS DOGS: A REVERSAL OF THE ASYMMETRY

If the inclusion relation is at the heart of the cat-versus-dog asymmetry observed by Quinn *et al.* (1993), then we should be able to reverse the asymmetry by constructing a set of cats that are more variable and inclusive than a set of dogs. Through a combination of exemplar preselection and image processing, French, Mermillod, Quinn, and Mareschal (2001) created such a set of stimuli, and Fig. 3 displays the probability distributions of the 10 dimensions, for both cats and dogs, when fit to Gaussian distributions using means and standard deviations from the normalized dimensional values. Now the cat category is marked by more variable and inclusive features relative to dogs. And in neural network simulations, again using input vectors to represent individual cat and dog exemplars, the inclusiveness properties of cat and dog category representations were reversed.

The proposed explanation of the original cat-versus-dog asymmetry makes the following prediction regarding the abilities of infants to categorize the narrow set of dogs that is included in the more variable set of cats: Infants familiarized with dogs should form a category representation for dogs that is exclusive of cats, whereas infants familiarized with cats should form a category representation for cats that is inclusive of dogs. This prediction was tested with two groups of 3- and 4-month-old infants who were familiarized with a set of 12 exemplars from the same category, cats or dogs, and then preference tested with a set of two test trials that paired a novel cat and a novel dog. The prediction is that infants familiarized with dogs should display a novel category preference for the cats on the preference test trials, whereas the infants familiarized with cats should display looking times divided evenly between the dogs and cats displayed on the preference test trials. The results were that infants familiarized with dogs preferred novel cats, but infants familiarized with cats did not prefer novel dogs. A control experiment demonstrated that this pattern of preferences could not be attributed to a spontaneous preference for the cats over the dogs.

As was predicted, infants familiarized with dogs formed a category representation that excluded cats, but infants familiarized with cats did not form a category representation that excluded dogs. The findings were exactly the opposite of those reported in Quinn *et al.* (1993). The stimulus manipulations had apparently been successful in reversing the inclusion relation between dogs and cats reported by Mareschal *et al.* (2000).

The reversal of the asymmetry by French *et al.* (2001) makes the important point that at least in the case of cats versus dogs, infants are forming their category representations over the course of the familiarization trials rather than tapping into preexisting concepts that had been formed prior to arriving at the laboratory. Had infants in the earlier studies simply been tapping into categories established before participation in the experiments, then infant responsiveness should not have varied with the variations in the familiar category information presented. The fact that

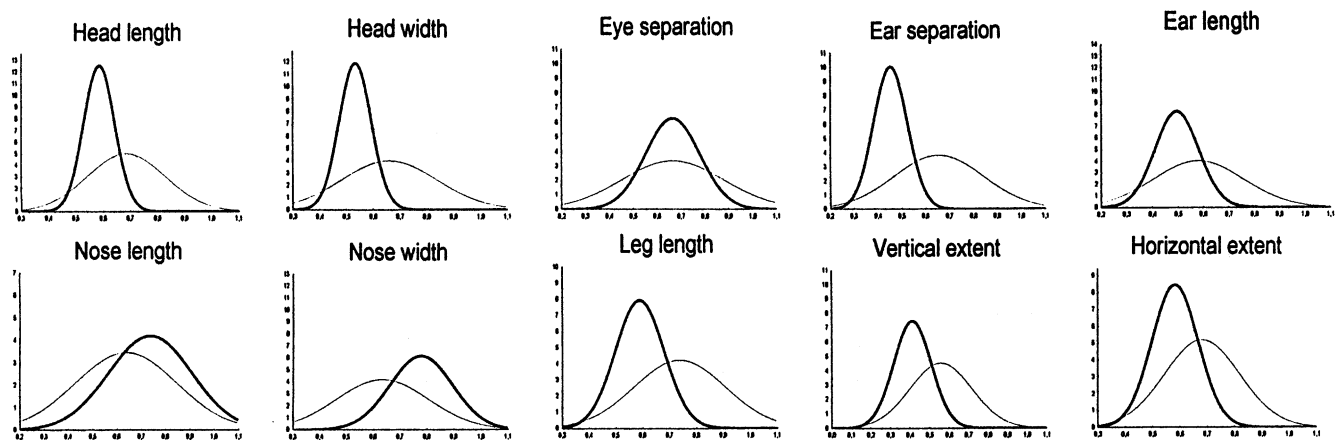


Fig. 3. Gaussian probability distributions generated from the means and standard deviations of normalized cat features (thin lines) and dog features (thick lines). The area under each curve sums to 1.0. From French, Mermillod, Quinn, and Mareschal (2001).

infant responsiveness did vary across experiments suggests that the categories were being formed during the familiarization experience and that the boundaries can be manipulated depending on the information presented during familiarization (see also Rakison & Butterworth, 1998). In the following sections, I discuss two cases of asymmetry in which the category representations formed in the laboratory *are* more likely to be influenced by experiences occurring prior to the experiment.

#### D. ASYMMETRY 2: HUMANS VERSUS NONHUMAN ANIMALS

After investigating how young infants represented a number of species of non-human animals such as cats, dogs, horses, and even mammals more generally (Behl-Chadha, 1996; Eimas & Quinn, 1994), we next asked whether infants would represent humans. At the time that we began to consider this issue, a search of the literature revealed no studies of whether young infants could form a category representation for humans that would include novel humans, but exclude nonhuman animals (for relevant evidence with older infants and children, see Johnson, Mervis, & Boster, 1992; Oakes, Plumert, Lansink, & Merryman, 1996; Ross, 1980). However, a substantial body of data showed that infants could form category representations of particular animal species that included novel members of that species, but excluded other, perceptually similar animal species (reviewed in Quinn & Eimas, 1996b). Also, other results indicated that infants at different ages could represent a variety of human attributes, including age (Fagan & Singer, 1979), gender (Cornell, 1974), attractiveness (Langlois *et al.*, 1991), emotion (Nelson, 1987), speech (Jusczyk, 1997), and action sequences (Meltzoff & Moore, 1992). On these bases, we believed that even very young infants might well categorically represent humans independently of other animals.

To our surprise, we failed in an initial attempt to find evidence for a category representation of humans that excluded cats and horses (Quinn & Eimas, 1998). In the experiment, 3- and 4-month-old infants were familiarized with photographic exemplars of 12 humans randomly selected from 9 men and 9 women, depicted in a variety of standing, running, or walking stances and in earth-tone clothing. The stimuli were color photographs of female and male models taken from a *Lands' End* catalog. Each infant was tested with a novel human paired with a cat and a different novel human paired with a horse. No preference for either the cats or horses emerged. A spontaneous preference for humans might have interfered with the novel category preferences for cats and horses. However, a control experiment in which infants were presented with pairings of humans versus cats or horses, but without familiarization, provided no evidence for such a spontaneous preference for humans over cats or horses.

Because of our earlier work with cats versus dogs, we also tested the idea that the human pictures might have been more variable than the pictures of horses and cats. However, when undergraduates rated the typicality of the three sets of

pictures, following the procedure used in our previous study (Quinn *et al.*, 1993), humans were *less* variable than cats or horses. Thus, this outcome provided no support for the idea that the young infant did not form a category representation for humans because of high variability among the human exemplars. It is notable that the category of humans may not have the same extent of graded structure as other object categories. That is, the undergraduates were willing to consider some cats as better examples of cats than other cats, but were less willing to judge that the human stimuli varied in the extent to which they resembled other humans.

The initial set of results with humans versus nonhuman animals—that is, the generalization of familiarization from humans to cats and horses—leaves open the question of whether infants did not categorize the human exemplars or whether the infants formed a broad category representation for humans, one that included novel humans, cats, and horses. After eliminating spontaneous preference and variability as explanations for lack of categorization, we began to investigate the possibility that infants categorize humans, but that the representation of humans in psychological space is extremely broad, being based primarily on a relatively wide range of individual exemplars as a result of the young infant's considerable familiarity with humans. The suggestion is that infants may develop an exemplar-based representation of humans (i.e., specific representations for individual humans clustered together in a broad representation of humans in general) in some  $n$ -dimensional space where each dimension represents quantitative variation of an animal attribute (e.g., eye separation, leg length). This broad representation is in opposition to some form of relatively narrow summary representation for other species (Purelius, 1993). For example, in the  $n$ -dimensional space, the exemplar nature of the human representation could be taken as a cluster of exemplar points defining a human region rather than a single summary (i.e., prototype) point defining nonhuman animal species (e.g., cats). An extensive representation for humans may form a special kind of category—a cognitive reference region (Rosch, 1975)—for infants. Because of the size difference between the human region and the cat point, the representation for humans would be more accepting of a wide range of values along each dimension and thus more likely to incorporate nonhuman animal species. In effect, a category representation for humans could behave as a powerful attractor, somewhat like a perceptual magnet (e.g., Kuhl, 1991), that acts to include (i.e., pull in) stimuli that have at least some common attributes (e.g., faces, skeletal appendages, and elongated bodies).

One might therefore predict an asymmetry in the categorization of humans versus nonhuman animals. In particular, nonhuman animals with sufficient attributes common to humans would often not be considered sufficiently novel after familiarization with human exemplars: They would not be sufficiently distant in psychological space from the many represented human exemplars to be preferred during test trials. However, after familiarization with members of a nonhuman



species, cats or horses, for example, a novelty preference would be expected for a novel human when paired with a novel cat or horse. The latter would occur as a consequence of the relatively narrow representation of cats or horses, a single point in psychological space, as opposed to the relatively broad representation of humans in psychological space, in which any one of the individually represented humans is likely to be perceived as quite different from the single familiar summary representation of the nonhuman species.

Additional experimentation has provided evidence for the predicted asymmetry in young infants' categorization of human versus nonhuman animal species. In one experiment, a group of 3- to 4-month-old infants was familiarized with humans and then given three preference tests, one pairing a novel human with a horse, another pairing a novel human with a fish, and a third pairing a novel human with a car. A second group of 3- to 4-month-olds was familiarized with horses and then given a preference test with a novel horse versus a human, a novel horse versus a fish, and a novel horse versus a car. Our prediction based on the "humans as a reference region" hypothesis is that infants would exclude humans, fish, and cars from the category representation for horses, but that infants would include horses and possibly fish in their category representation for humans. However, we expected cars to be excluded from a category representation for humans given their perceptual and ontological distinctiveness. In other words, the magnet effect would presumably occur only for stimuli that share some commonalities with humans.

The categorization experiment was accompanied by another experiment designed to assess spontaneous preferences among the test categories. On a series of paired-preference trials, separate groups of 3- to 4-month-old infants were presented with exemplars from one category paired with exemplars of another category. The category contrasts tested were humans versus fish, humans versus cars, humans versus horses, horses versus fish, and horses versus cars.

The combined findings from the categorization and spontaneous preference experiments demonstrated the following: Infants familiarized with humans formed a category representation that included novel humans, horses, and fish, but excluded cars; infants familiarized with horses formed a category representation that included novel horses, but excluded humans, fish, and cars. The data thus supported our hypothesis. The asymmetry with respect to the categories of horses and humans is significant because it suggests that Carey's (1985) results showing that 4-year-old children classify a number of nonhuman animals by their similarity to humans may have an early perceptual basis (Carey, 1985). Both the infant and child data suggest that humans may function as an organizing structure for information acquired about other animals. In addition, Pauen (2000), using a habituation/dishabituation procedure has reported corroborating evidence for a broadly inclusive category representation for humans that included nonhuman animals in 5-month-old infants. The findings of the Pauen study were impressive in that the categories were

composed of small toy objects that varied considerably. Infants that habituated to a category of male and female humans that varied in age, race, size, stature, and posture generalized their habituation to instances of mammals that included a baboon, bear, cat, chimpanzee, dog, and kangaroo.

The demonstrated asymmetry in the representations for humans and horses (and presumably other nonhuman animal species given the findings of Pauen, 2000) in terms of categorical exclusivity raises the question of whether humans are represented differently from other nonhuman animal species. Because of the greater experience that most 3- to 4-month-olds have with humans (even if limited to repeated presentations of just a few humans—parents, older siblings, caregivers) relative to nonhuman animal species, humans might be represented by infants as *individual exemplars* belonging to the same category (see Humphrey, 1974, for evidence consistent with this suggestion in monkeys). Also reasonable is the possibility that the less frequently experienced nonhuman animal species might be represented by *category-level information*, possibly a summary prototype representing an average of the exemplars presented in the laboratory rather than exemplar-specific details, i.e., details about each individual instance or member of a category (Bomba & Siqueland, 1983; Quinn, 1987; Strauss, 1979; Younger & Gotlieb, 1988). In effect, over the course of a time span as short as 3 to 4 months of life, the differential experience that infants have with humans versus nonhuman animal species may have the inductive effect of pushing infants to become human “experts.”

To examine the nature of the representations infants form for humans versus nonhuman animal species, one group of 3- to 4-month-olds was familiarized with 12 humans and another with 12 cats. Both groups were administered two preference tests: in one, a novel cat was paired with a novel human (the test of categorization), in the other, a novel member of the familiar category was paired with a familiar category member (the test of exemplar memory). The latter pairing is based on the assumption that if individual exemplars are represented, then the novel member of the familiar category should be preferred. If individual exemplars are not represented, then looking times to both stimuli should be approximately equal.

The results revealed a significant interaction: infants familiarized with cats preferred a novel human to a novel cat, but not a novel cat over a familiar one; infants familiarized with humans did not prefer a novel cat over a novel human, but did prefer a novel over a familiar human. This interaction provides further support for the claim that the young infant’s category representation for humans includes many other animals (at least cats, horses, and fish), whereas the category representations for nonhuman animal species (cats and horses) exclude humans as well as other animal species (Eimas & Quinn, 1994; Quinn *et al.*, 1993). The data also support the notion that the category representation of humans is exemplar based, whereas the category representation of nonhuman animal species is based on summary information on the order of a prototype that represents an averaging of the familiar exemplars.

The magnet or reference point effect observed in the young infant's category representation of humans may not be unique. A possible corresponding kind of reference point has been observed for infants in the domain of speech. For example, Miller and Eimas (1996) have demonstrated that 3- to 4-month-olds respond asymmetrically to stimuli from consonant categories. Infants habituated to a prototype stimulus generalized their habituation to a nonprototype stimulus. In contrast, infants habituated to the nonprototype stimulus dishabituated to the prototype stimulus. Other reference point effects that follow this same pattern have also been reported for adults judging the orientation, color, and form of stimuli (Rosch, 1975; Tversky, 1977). Because the various demonstrations of reference point effects are marked by large differences in procedure, stimuli, and participant population, one must be cautious about proposing a common mechanism, but what does seem clear is that there is a category of reference point effects that have functionally similar outcomes. In each instance, surrounding stimuli are pulled toward the reference point (but see Quinn, 2000, for discussion of contrasting "anchor" effects in the domains of form and orientation). However, the precise mechanism by which such "pulling" occurs may differ across the cases.

In the overall scheme of reference point effects, what may be emphasized as being significant about the particular demonstration that humans may serve as a reference point for nonhuman animals is the following. Given the perceptual differences between humans and nonhuman animal species like cats, horses, and fish (e.g., presence vs absence of clothing, vertical vs horizontal body torso, and arms vs no arms), an issue for cognitive developmentalists is to explain how a broad representation for animals can develop from perceptually distinct human and nonhuman animal species. The incorporation of other animal species into a category representation for humans may be a critical step in the development of a more conceptually based representation for animals in general, a point that will be discussed further in the concluding section.

#### E. ASYMMETRY 3: MALE VERSUS FEMALE FACES

Given the interest in how infants represent humans, we now consider the representation of an important human attribute: face gender. In past work, using the familiarization/novelty-preference procedure, Cornell (1974) found that 6-month-olds, but not 5-month-olds, familiarized with either four male or female faces, demonstrated greater attention to a novel face from the novel gender over a novel face from the familiar gender. However, Cornell did not demonstrate that the 6-month-olds could discriminate the faces within each gender category, thus leaving open the question of whether these infants had formed *category* representations of each gender. Moreover, only four faces were used to depict each gender, thus making it unclear whether 5-month-olds might have categorized gender if provided with additional familiarization experience. Another question left unanswered by

the Cornell report were the cues that the 6-month-old infants used to categorize gender. For example, the single cue of hair length might have provided infants with a sufficient basis to separate the two genders.

Leinbach and Fagot (1993) also investigated the categorization of gender by 5- to 12-month-old infants and reported an unexpected asymmetry: Infants habituated to males looked more to a novel female than a novel male, whereas infants habituated to females did not look more to a novel male relative to a novel female. This pattern of results could be taken as evidence that the infants had formed a representation for male that excluded female, but not a representation for female that excluded male. The findings were intriguing and led Leinbach and Fagot to speculate that “young infants simply prefer to look at a female face” (p. 330). A spontaneous preference for female over male faces would facilitate any novel category preference for female faces after familiarization with male faces, but would interfere with any novel category preference for male faces after familiarization with female faces.

In a series of experiments, Quinn, Slater, and Pascalis (2001) further investigated the male versus female face asymmetry reported by Leinbach and Fagot (1993). We were interested in (1) whether the asymmetry could be replicated; (2) whether it generalized to other stimulus sets, age groups, and procedures; and (3) the basis for the asymmetry. To begin to answer these questions, we used the familiarization/novelty-preference procedure to examine the representation of gender of human faces by 3- to 4-month-olds. The faces were color photographs of female and male models taken from a *Lands' End* catalog. In the first experiment, infants were administered four familiarization trials with eight male or female faces (two faces per trial) and then given two test trials with a novel male face paired with a novel female face. The asymmetry reported by Leinbach and Fagot was replicated: Infants familiarized with males preferred females, but infants familiarized with females did not prefer males.

In a second experiment, we explored the explanation for the asymmetry suggested by Leinbach and Fagot (1993), namely that infants might spontaneously prefer female faces. To investigate this possibility, a group of 3- to 4-month-olds were presented with a series of paired-preference trials, each of which presented a different male face with a different female face. The mean preference for females was reliable. The asymmetry reported in the first experiment thus appears to be the result of a spontaneous preference for female faces. This spontaneous preference could have facilitated a novel category preference for females after familiarization with males and interfered with a novel category preference for males after familiarization with females.

In additional experiments, we pursued two low-level sensory explanations for the spontaneous preference for female faces. First, we asked whether the spontaneous preference for female faces might be attributable to higher contrast information resulting from a greater amount of hair surrounding the internal face region of the stimulus. The spontaneous preference was thus repeated, but in this instance with

face stimuli without external hair cues. Here, the infants still preferred the female faces, indicating that the preference for the female faces is not the result of higher contrast created by a greater amount of hair.

Second, we questioned whether the spontaneous preference for female faces was due to higher contrast of the internal features, possibly resulting from females' greater use of cosmetics. We repeated the first control experiment with faces without hair, but in this instance, the faces were inverted. We reasoned that if the female preference was due to higher contrast of the internal features, then the preference should be preserved with the inversion manipulation because the internal features are present in both upright and inverted faces. The result was that the infants no longer preferred female faces, suggesting that the spontaneous preference depends on processing of the internal features in their upright orientation.

Given that the evidence did not support sensory explanations for the female face preference displayed by young infants, we began to examine a cognitive explanation for the preference, namely that infants might prefer female over male faces because of greater familiarity with female faces. Infants with only several days of postnatal experience will spontaneously prefer a mother's face over an unfamiliar female face (e.g., Pascalis, De Schonen, Morton, Deruelle, & Fabre-Grenet, 1995). Also, female faces differ structurally from male faces, albeit in complex ways (Burton, Bruce, & Dench, 1993; O'Toole, Vetter, Troje, & Bulthoff, 1997). Finally, a majority of infants in the first 3 months of life are reared with female primary caregivers, and this was true for all the infants thus far reported in the experiments performed by Quinn *et al.* (2001). Therefore, we suggested that infants might generalize their experiences with primary caregivers who are female to female faces more generally. The argument is that young infants reared with a female primary caregiver may become experts at processing female faces relative to processing male faces. Adult participants display an other-race effect in identification of human faces that may be the result of differential experience (O'Toole, Deffenbacher, Abdi, & Bartlett, 1991), and we proposed that young infants may display an other-gender effect in the processing of human faces that results from early differential experience.

If young infants reared with female primary caregivers become "female experts," then it should be possible to reverse the gender preference in infants reared with male primary caregivers. Although far fewer infants are reared primarily by their fathers, Quinn *et al.* (2001) tested five such infants, between 3 and 4 months of age. On the spontaneous preference test between upright male and female faces without hair, 57% or more of the total looking time was directed to the male faces by four of the five infants. This outcome is not definitive because of the small sample, but it is consistent with the idea that infant attention to human stimuli may be biased toward the gender with which the infant has greater experience.

The idea that infants reared with female primary caregivers become female experts has two other testable implications. The first is that at some point during

early development, infants will begin to encounter more and more male faces, a course of experience that should reduce the preference for female faces. Quinn *et al.* (2001) therefore compared the spontaneous preferences for upright male and female faces without hair in 3- to 4-month-olds, 6- to 7-month-olds, and 9- to 10-month-olds. Preference for female faces was reliably higher than chance in all three age groups. We are currently testing a group of 12- to 13-month-olds. The 12- to 13-month-olds possess locomotor skills not possessed by the younger groups (i.e., walking), thereby providing access to a greater variety of human stimulation (see Bertenthal & Campos, 1990, and Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, & Witherington, 2000, for discussion of a number of cognitive changes associated with the onset of locomotion). This human stimulation would presumably include both male and female faces, thus conceivably decreasing the preference for female faces.

A second implication of female expertise for infants raised with female primary caregivers is that young infants may display expertise-type effects for female faces relative to male faces. In particular, infants may become more efficient at processing the exemplar-specific details of individual female faces relative to male faces. This suggestion follows from the earlier arguments and evidence that infants may be more expert at processing human versus nonhuman animal stimuli and may be more likely to process individual humans as specific exemplars as opposed to the prototype summaries observed for nonhuman animals. To test the processing of female versus male face information by infants, 3- to 4-month-old infants were presented with eight male or female faces. Infants familiarized with males were then preference tested with a novel versus familiar male face, and infants familiarized with females were preference tested with a novel versus familiar female face. The findings were that infants familiarized with male faces did not display a differential preference between a familiar and novel male face. In contrast, infants familiarized with females displayed a preference for the novel female face. The results are consistent with the idea that infants were representing the male faces in terms of a summary structure (i.e., a male prototype), whereas the female faces were represented as individual exemplars. These findings provide further confirmation that infants reared with female primary caregivers are more expert at processing the details that define individual female faces relative to male faces.

As was the case with the cat/dog and human/nonhuman animal asymmetries, we believe the male/female face asymmetry to be theoretically significant because it implies that knowledge acquisition does not proceed along an equivalent developmental course for all classes of stimulation. Rather, inherent attentional biases (e.g., to attend to faces; Johnson & Morton, 1991) that operate on frequently experienced perceptual inputs (e.g., male versus female caregivers) create cognitive reference regions in the overall representational scheme of young infants. Learning may be especially rapid when it proceeds from such regions (e.g., Quinn & Eimas, 1998; Quinn *et al.*, 2001; Walton & Bower, 1993).

## VII. Conclusion: Relation of Specific Findings to Knowledge Acquisition in General

### A. SUMMARY OF FINDINGS

The discussion in the preceding sections of the chapter emphasizes asymmetries in young infants' categorization of visual information. The first asymmetry, cats versus dogs, demonstrated that infants represent information about cats more readily than dogs, a likely consequence of breeding practices that have created greater variability and inclusiveness of dogs relative to cats. Importantly, this learning can be reversed with a combination of appropriate exemplar selection and visual image processing that reverses the inclusion relation between cats and dogs. Moreover, the formation of representations for cats versus dogs can be simulated in a learning device with no category teaching signal (i.e., the autoassociative neural network described above; Mareschal *et al.*, 2000) that receives inputs measured directly from the surfaces of the stimuli presented to the infants—inputs to which young infants might conceivably be sensitive.

The second asymmetry, human versus nonhuman animals, shows that infants can also represent humans, and do so apparently with a broad, exemplar-based, magnetlike structure that has the power to attract nonhuman animal species like cats, horses, and even fish, but not cars. Cats, horses, and fish share with humans an abstract, but nonetheless perceptually based resemblance in that they possess an elongated body axis that is headed by a set of facial features and conjoined by a set of skeletal appendages. Given the differential experience even young infants have with humans relative to nonhuman animals, the human versus nonhuman animal asymmetry in categorization performance is likely the result of infants representing humans at the expert (subordinate) level, and nonhuman animals at a more summary (prototype-based) level.

The third asymmetry, male versus female faces, indicates that the representation of information about humans is likely to be influenced by the gender of the primary caregiver. In particular, infants reared with a female primary caregiver prefer female over male faces, a preference that is (1) strong enough to block a novel category preference for male faces after familiarization with female faces and (2) not attributable to low-level sensory cues like external hair length or higher contrast internal features. The evidence points to the idea that the female face preference is based on the cognitive variable of familiarity, an idea that receives support from the reversal of the preference in the small sample of infants reared with male primary caregivers. As was the case with the human versus nonhuman animal asymmetry, the preference for the gender of the primary caregiver appears to be an acquired, expertise-based effect, given that infants reared with female caregivers more readily represent information about individual female faces relative to individual male faces.

B. PROPOSAL FOR A PERCEPTUAL LEARNING MODEL OF EARLY KNOWLEDGE ACQUISITION

The collection of findings, taken together, lays the foundation for a perceptual learning model of early knowledge acquisition. This model is sketched out schematically in Fig. 4. Young infants, during the course of early experience over the first few months of life, begin to experience numerous objects from various categories. Initially, as shown in Fig. 4a, because of limited experience with a small number of exemplars, the infants' system of representation is likely to consist of individual entities, loosely clustered. However, as is illustrated in Fig. 4b, with sufficient experience, and aided by core abilities to represent within-category similarity and between-category dissimilarity, the infant may begin to form structured representations organized around summary-level prototypes. The expectation is that such representations (1) would be formed for a variety of generic object categories and (2) could serve as perceptual placeholders for the acquisition of knowledge beyond infancy.

One issue that will be important to resolve in the further development of this model is how much experience is sufficient for prototype formation. In this regard, it should be observed that there are a few investigations that have examined the influence of exemplar number on the formation of exemplar-based versus prototype representations for infants performing in object categorization tasks (Quinn, 1987; Sherman, 1984). With the presentation of a small number of instances from a single object class (i.e., between 4 and 6), 3- to 4-month-old infants respond by representing them as individual instances of a category. However, with the additional

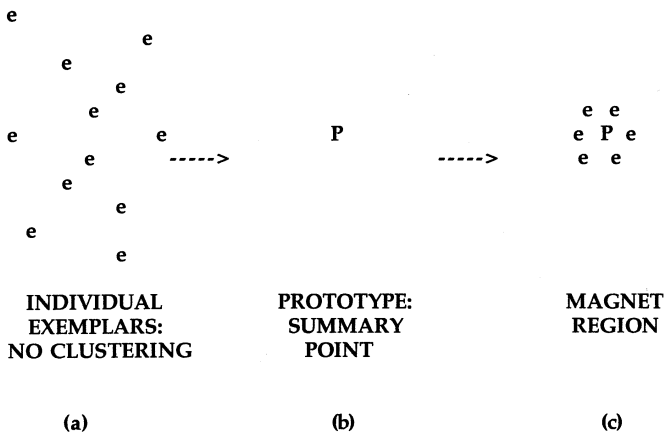


Fig. 4. Schematic perceptual learning model of development in early category representation. The letter "e" corresponds with the individual exemplars represented and the letter "p" corresponds with a summary (prototype) representation.



familiarization experience provided by the presentation of 12 exemplars from a single object class, the infants respond by abstracting a prototype to represent the category (Bomba & Siqueland, 1983). Needham (2001a) has reported a somewhat more rapid transition from representing exemplars to representing a more general category representation when 4.5-month-olds are presented with two versus three exemplars of given class in an object segregation task.

The learning of certain categories may proceed beyond prototypes if infants are provided with additional experience that might come in the form of larger numbers of exemplars or rich or lengthy interaction with a smaller number of exemplars. As is depicted in Fig. 4c, the summary structure might then become elaborated by the addition of information about individual exemplars. This information serves to both enrich and empower the summary structure, in effect, giving rise to the beginnings of an “expert” representation or cognitive reference region. In the infant’s overall system of category representation, this region might come to consist of a relatively large number of points in mental space, one point for each exemplar as well as the summary structure. The representational magnification that occurs around these regions of mental space may give rise to psychophysical magnetlike properties. Such regions may be the cognitive equivalents of “local minima” described in the neural network literature (Elman, Bates, Johnson, Karmiloff-Smith, Parisi, & Plunkett, 1996) and “attractor basins” in the dynamic systems literature (Thelen & Smith, 1994).

Early category representations that serve as magnet regions in psychological space may have considerable significance for knowledge acquisition in general because of their potential to organize large portions of experience. As noted above, the incorporation of nonhuman animal species into a category representation for humans may be the process that allows for the development of a category representation for animals in general. By this view, humans may be the “glue” that provides the coherence for a category representation of animals. If humans and nonhuman animals can be conjoined through early experience, a perceptual basis for a broad representation of animals in general is implied. This abstract representation might consist of the presence of a head shape with internal facial attributes (Johnson & Morton, 1991; Quinn, Eimas *et al.*, 2001), adjoined to an elongated body axis with attached appendages (Zhu & Yuille, 1996)—a skeletal structure that displays biological movement as it changes location (Rakison & Poulin-Dubois, 2001).

### C. FUTURE QUESTIONS

As research inquiring into the beginnings of knowledge acquisition continues, one question that remains for the perceptual learning account is to determine more precisely how long-term experiential knowledge for a variety generic object classes, including humans and their attributes (i.e., gender), interacts with short-term experiential knowledge acquired during a series of familiarization trials to

produce a particular pattern of looking on preference test trials. Another question that arises concerns the long-term significance of the “magnet regions” used by infants to organize experience. The work reported by Quinn *et al.* (2001) suggests that the male versus female face asymmetry could conceivably dissipate by 12 to 13 months of age, and the studies of Pauen (2000) suggest that the human versus nonhuman animal asymmetry may no longer be present by 9 to 11 months of age. Thus, the perceptual reference regions of infants may be important cognitive structures for organizing memory and allowing for rapid learning in the early going, but their importance may decrease with the growth in knowledge that is acquired during the lifespan of an individual. Studies examining the loss of information in older adults might be helpful in determining whether the information that accrues to the early attractor regions is among the last to be lost during development in accord with a “first in, last out” principle (Bayles, Tomoeda, & Trosset, 1990; Tippet, McAuliffe, & Farah, 1995). However these questions are resolved, the proposed model of perceptual learning of early category formation can accommodate much of the data on early categorization, including the asymmetries described in the present chapter, and may represent a viable framework for thinking about the course of knowledge acquisition more generally.

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# PEER RELATIONS IN THE TRANSITION TO ADOLESCENCE

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## **I. Introduction**

Children in the adolescence and toddler developmental periods are probably the most preoccupied with issues of autonomy. The toddler who asserts that she can do it all by herself and the teenager who argues that he is "too old" to have

a bedtime sound surprisingly similar. The two developmental periods also have similar parallels in the construction and reliance on affective relationships and self-regulation. An affective relationship is one that includes feelings of affection or what would be called trust and love in adult–child attachment relationships or friendship in peer relationships. Self-regulation is the ability to modulate emotional responses and act effectively in emotionally evocative contexts (Eisenberg, Fabes, Murphy, Maszk, Smith, & Karbon, 1995).

Toddlers, adolescents, as well as persons in other developmental periods maintain and construct new affective relationships. The quality of these affective relationships, present and historical, is important in understanding and predicting social and emotional competence (Cassidy & Shaver, 1999). Toddlers who have day-to-day access to peers construct both complex social interactive sequences and affective relationships with their playmates (Howes, 1983). Toddler affective relationships have attributes of friendship common to the “best or close friendships” that provide adolescence children with emotional security and closeness (Howes, 1996; Howes & Tonyan, 1999).

Toddler-age children form friendship relationships in the context of a network of adult caregiver–child attachment relationships (Howes, Hamilton, & Phillipson, 1998; Howes, Hamilton, & Matheson, 1994; Howes, Matheson, & Hamilton, 1994). Adolescents also form friendships within the context of affective networks, but their social networks are larger and more complex than are toddlers’ because they include an array of past and present adult and peer affective relationships.

Toddlers cannot really “do it all by themselves.” In order to form an affective peer relationship toddlers use their adult–caregiver attachment relationships as an (optimally) secure base for the development of skills and the exploration and construction of close relationships with peers. By the time they reach adolescence most children have basic skills for social interaction and in turn can form close peer relationships “all by themselves.” Therefore the developmental task of adolescents is to make a transition from an adult caregiver as the primary attachment figure to close friends and romantic partners as lifelong attachment relationships (Ainsworth, 1989; Allen & Land, 1999). However, the notion that adolescents switch dramatically from an orientation to adults to an orientation to peers has been dispelled by research that suggests that autonomy most competently is developed in the context of secure caregiver–child relationships that endure well beyond adolescence (Allen & Land, 1999).

In our work, we draw on several theoretical traditions to examine affective relationships over four developmental periods. Central to our work is attachment theory (Bowlby, 1982; Cassidy & Shaver, 1999), particularly because of the powerful push for continuity in relationship quality found in attachment theory’s assumptions about working models of relationships, their tendency to stay the same, and opportunities for change. Although attachment theory is essential for our understandings of dyadic relationships it cannot, in our opinion, explain variations in development that are associated with variations in the contexts of development:

social settings for socialization and culture and societal organization. Therefore we drew from current theorists that place relationship development within wider social contexts (Howes, 1999; Howes & James, in press; Pianta, 1998). Attachment theory, as well, is a theory that better explains affective, child–adult relationships than peer relationships. Buhrmester’s (1996) work on peer relationships in adolescents (derived from Sullivanian theory) was important in helping us understand the potential compensatory role of peers. Finally we needed to draw on Maccoby’s (1998) theories of gender segregation and socialization to help us explain the persistent influence of gender.

#### A. AFFECTIVE RELATIONSHIPS WITH PEERS AND SELF-REGULATION

In this chapter we are concerned with two social and emotional competencies: friendship quality and self-regulation. Children’s perceptions of the quality of their close friendships is a direct measure of an affective peer relationship. Self-regulation as perceived by others may be considered an indirect measure of peer relations. In order to regulate behavior children must engage with others without withdrawing or aggressing. They must interact with peers by modulating emotional responsiveness and acting competently and effectively in emotionally evocative contexts (Coie & Dodge, 1997; Eisenberg *et al.*, 1995).

Friendship quality and self-regulation are associated throughout development. Getting along with peers and cooperating with caregiving adults require both the toddler and the adolescent to manage experiences of conflict, disagreement, and defiance and to construct ways of resolving conflict that maintain good relations with others. Therefore, behavioral and emotional regulation as well as autonomy/relatedness are developmental issues across the course of development.

Self-regulation and affective relationships with adults also are not independent. In general children who experienced positive, trusting relationships with caregiving adults (mothers and others) as infants and toddlers are better able to both engage in self-regulation (Cassidy & Shaver, 1999) and construct positive relationships with peers (Howes, 1999; Thompson, 2000). Therefore we would expect children who had more trusting early relationships with adults to be better able to self-regulate as adolescents and to have a history of supportive friendships. As well, children who are better able to regulate their attention and emotions are better liked by their peers (Shonkoff & Phillips, 2000). Thus behavioral and emotional self-regulation are embedded within affective relationships with caregiving adults and peers.

#### B. CONTINUITY OF SOCIAL AND EMOTIONAL COMPETENCE: TODDLER TO ADOLESCENT

We know relatively little about how the quality of close affective relationships with peers and attachment relationships with caregiving adults changes as the children move from the toddler to the adolescent developmental periods. In our

project, we have examined caregiver attachments and peer relationships as well as self-regulation across the transition from childhood to adolescence. In examining continuity of social and emotional competence we expect that parent, teacher, and peer affective relationships will make both unique and compensatory contributions over time. We explored alternative pathways towards positive and not-so-positive outcomes in adolescence because we are interested in both the maintenance and disruption of close and trusting relationships with caregiving adults and peers. For example, do children whose secure childhood adult-child attachments are disrupted in adolescence nevertheless construct positive friendships and have fewer behavior problems if they have had a history of positive relationships with peers? Do children who have had a history of conflictual relationships with peers establish more positive adolescent friendship and have fewer behavior problems if they have maintained positive adult-child attachments across the transition to adolescence?

The participants we have been studying are remarkable for their continuity of relationship quality (Howes, Hamilton, & Phillipsen, 1998; Howes, Matheson, & Hamilton, 1994; Howes & Phillipsen, 1998 ). There are strong links in relationship quality within social partner—within mother-child relationships, teacher-child relationships, friendship relationships, and peers in general from toddlerhood to early adolescence (Howes *et al.*, 1998; Howes & Philipsen, 1998). Once established, individual differences in relationship quality and in social interaction remained relatively stable. When we predicted relationship quality in this sample in middle childhood (Howes *et al.*, 1998) and early adolescence (Howes & Tonyan, 2000) we found that relationship quality within relationship partner, peers, mothers, and teachers was more stable than across partner, particularly child-mother to peer. In this chapter we extend this analysis of continuity through another 2 years into middle adolescence.

### C. THE DEVELOPMENT OF SOCIAL AND EMOTIONAL COMPETENCE AS NESTED WITHIN PARTICULAR CULTURAL CONTEXTS AND PARTICULAR SOCIAL HISTORICAL PERIODS

We assume that not only is social and emotional competence of children nested within a network of affective relationships with adults and peers, but that these networks are themselves embedded within larger contexts of social setting, culture, and societal organizations (Howes & James, in press). Therefore, to examine friendships and self-regulation over development, it is important not only to understand that child-mother attachment relationships change over time, but also to examine caregiving networks of the participating families and the societal location of these caregiving networks.

#### 1. *Child Care as a Setting for Child Rearing*

All families make a series of decisions about where and how to care for their toddler- and preschool-age children. The particular choices families make depend

in part on the meanings they have constructed from their own history of caregiving and affective relationships, as well on their perception of their current financial situation. For example, three mothers in our study offered very different explanations: "I loved my mother and had fun being home with her, but with my education, I feel an obligation to work, unlike my mother, who stayed home with us." "The only way we can make our house payments is if I work full time. My mother worked and I grew up loving her." And, "I hated being poor and not having my mother at home. If I worked our child care costs would take all my income, therefore I decided to use the center half-time." Accordingly the children of our participating families had varying child care experiences.

But because many families did use outside-of-the family child care we included teachers as well as mothers in our observations of attachment relationships. When the children were toddlers and preschoolers we studied the children's child care setting as the context for constructing peer relations. When the children were in elementary school we again considered teachers as potential attachment figures. Our longitudinal approach that included observations in similar locations (i.e., child care and school) allowed us to examine the role of teacher-child relationships over time even though different teachers fill the teacher role at each time point.

Consistent with our assumption that the development of social and emotional competence is nested within particular cultural contexts we evaluated the potentially direct and indirect effects of variations in child care experiences. Emotional and behavioral regulation are particularly important behaviors to examine longitudinally in children with known child care histories. Early child care attendance itself has been hypothesized to influence the development of problematic behaviors (Belsky, 1988).

Beyond possible associations between child care attendance, child care quality, and problem behavior, variations may also occur in the particular socialization experiences children have within child care. Within child care children have daily experiences that call for sharing (or not) limited adult and material resources with other children, of seeking (or avoiding) attention from teachers, and cooperation (or conflict) with peers. These socialization experiences could promote prosocial and cooperative behavior patterns or antagonistic and noncompliant ones. Children's self-regulation in child care may set the stage for problem behaviors later on as longitudinal studies suggest a continuity between preschool emotional regulation and later behavior problems (Caspi, Henry, McGee, Moffitt, & Silva, 1995). We expected children's emotional regulation within child care as well as variations in their child care history to be important in understanding continuity and discontinuity of self-regulation over time.

## *2. Culture and Societal Organization*

Additionally, our assumptions about development requires understanding how affective networks are themselves embedded within culture and societal organizations. On these dimensions our participating families show relatively little

variation. They are white, affluent, and live in stable families in a suburban area. All the children in this longitudinal sample were enrolled in child care during their preschool years and they experienced remarkably few changes in caregiving arrangements. Consequently, for most of the children their first encounters with peers outside of their families were within small organized groups of same-age peers who were closely monitored by an adult. These contextual features limit our work in that we can speak only to a particular set of developmental experiences.

### 3. *Social Historical Period*

We have been following these children since their first birthdays and at the time of this writing the children are 16 years old. They were born in 1985 in a suburb of Los Angeles. Los Angeles itself over this period withstood earthquakes, floods, riots, and waves of immigration from Asia and Latin America. For many children growing up in Los Angeles this historical period included major life disruptions. When we began this project we had two parallel groups of families (Howes & Hamilton, 1992; Howes, Hamilton, & Matheson, 1994). The second group of families was drawn from child care centers that served mixed-income families. We were able to follow these children through only their first 5 years because the disruptions of their lives meant that we could not maintain sufficient numbers to continue to the longitudinal study. In contrast, the participating families in this chapter report few changes in life circumstances.

#### D. CHILDREN'S NETWORKS OF AFFECTIVE RELATIONSHIPS: THEORETICAL ASSUMPTIONS

Early attachment theorists, such as Bowlby and Ainsworth (Ainsworth, 1989; Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1982) suggested that individual's working models of relationships become increasingly stable and unconscious over time. Children continue to utilize expectations, interpretations, and behaviors within their relationships and explore new ones in a manner consistent with these working models of relationships, thereby reinforcing these models and making them more resistant to modification. This interpretation is most parsimonious when only one adult caregiver, usually the mother, is implicated in the construction of an internal working model. But as Thompson (2000) has pointed out, the empirical evidence for the predictability of toddler child-mother relationship quality for later relationship quality is thin, thus suggesting that a network of attachment relationships rather than a single relationship influences children's representations and may lead to change in skills and relationship quality over time.

In this manner, some theorists have suggested that these working models may be open to some degree of change as children become older (Bowlby, 1982). Specifically, two factors have been identified as possible contributors to the reorganization of working models: (1) an interpersonal experience that provides individuals with

the opportunity to experience consistency and support, which may in turn facilitate changes in self view and relationship expectations; and (2) cognitive insight into the role that interpersonal relationship experiences have had in influencing adolescent's development and formation of working models. Over the course of development, children may begin to recognize that other types of relationships are capable of meeting their attachment needs. The development of alternative attachment relationships may provide children with more secure attachment experiences than had previously been experienced, providing them with corrective emotional experiences, which may facilitate the modification of self and relationship expectations. Additionally, within the context of these positive and sensitive relationships, adolescents may experience opportunities that support the development of greater emotional flexibility and openness, more adaptive problem solving, modified social skills, as well as more effective behavioral approaches. Together, these intrapersonal modifications and skill development may potentiate discontinuities for children, allowing individuals to view past attachment relationships in a more organized and coherent fashion while also setting the stage for the development of more positive and adaptive future social relationships.

### *1. What Kinds of Relationships May Be Compensatory?*

The question that emerges is, "What kinds of relationships may be compensatory in nature?" When attachment networks are studied (Howes, 1999) different adult caregivers appear to play different and perhaps compensatory roles. Teachers may serve as an alternative attachment figure, providing a secure base from which children may explore new thoughts, emotions, and relationships, thereby supporting the development of modified internal working models, competencies, and relationships. Indeed in our earlier work, we found that children had relationships of independent quality with their mothers and teachers (Howes & Hamilton, 1992) and that predicting the nature of their toddler (Howes *et al.*, 1988) and preschool (Howes *et al.*, 1994) relationships with peers required knowing the quality of their child-teacher as well as child-mother relationship. Additional research with children in therapeutic day care has demonstrated that children with histories of neglect and abuse are able to form a secure relationship with an alternative adult caregiver, provided that the therapeutic caregiver exhibited great stability, consistency, and sensitivity (Howes & Ritchie, 1998). These findings suggest that perhaps poor-quality attachment relationships and the resulting negative internal working models of self and others can indeed be positively reconstructed with particular attention to demonstrated sensitivity.

Peers may also play a compensatory role, particularly in adolescence, when growth in social, cognitive, and developmental arenas support the emergence of their attachment function (Buhrmester, 1996). Across the course of development, peer relations take on increasing salience for children. In early childhood they provide children with the opportunity to learn skills for interaction and provide

companionship; however, later in development these relationships begin to become intertwined with adolescents' developing identities. Adolescents begin to use their friendships as a context in which to explore their evolving ideas about themselves and others. Thus, over the course of development these relationships appear to make unique contributions to social and emotional growth, beyond the primary contributions of the early caregiver relationship—and may indeed serve a compensatory role for those adolescents who have experienced negative histories of parent–child interaction. Abused children who are able to form friendships may be able to use these relationships as contexts for skill development and practice, bases for interpersonal resources, and providers of emotional support (Price, 1996). These friendships therefore may serve as both a context for the expression and modification of early family experiences (Price, 1996). Indeed, over the course of a year, those maltreated children who were able to develop and maintain a friendship evidenced higher self-esteem and interpersonal skills (Bukowski, Hoza, & Newcomb, 1994).

Consistent with this hypothesis of peers as compensatory relationships, Sullivan and Piagetian theory (Rubin, Bukowski, & Parker, 1998) suggested an incremental growth model in which divergent relationships make unique contributions to children's development of competencies and overall growth. In support of this theory, peer relationships facilitate the socialization of close relationships beyond the impact of the mother–child relationship (Buhrmester, 1996). Although moderate continuity in quality across parent and peer relationships has been evidenced (with correlations ranging from .20 to .40) these findings also support a moderate level of discontinuity. Together, these theories and research suggest that for some children peer relationships may serve as compensatory relationships which facilitate the modification of intrapersonal perspectives and interpersonal skills and competencies.

## *2. Changes in Adaptation with the Onset of Adolescence*

In addition to the role of positive alternative relationships in influencing children's adaptation and compensating for previously negative parent–child relationships, changes in adaptation may emerge in adolescence, when cognitive development provides adolescents with the resources necessary for reevaluating their working models, which may subsequently support the formation of more positive social competencies and relationships. Bowlby (1982) posited that the restructuring of working models over time is a normative task that characterizes individuals who are functioning well. Some theorists (Bretherton, 1996) have suggested that securely attached individuals are characterized by such openness and flexibility that revisions in their representation models over time are so small and incremental that they are hardly noticeable. The more rigid cognitive patterns characteristic of insecure children would thus appear to interfere with their abilities to modify



their internal representations. Specifically, the narrow focus of insecurely attached individuals on negative self-cognitions and expectations creates a systematic bias in processing attachment related information which may prohibit the reevaluation of “outdated” working models or dysfunctional cognitions.

However, in adolescence normative developmental changes in the structure of relationships and cognitive capacities may provide adolescents with more resources for the reorganization of internal working models of self and others. The focus of adolescents’ self views shifts over the course of development with adolescents’ cognitive capacities playing an important function in the shape of adolescents’ self-cognitions (Hattie & Marsh, 1996). Indeed previous work has suggested that adults have more malleable self-concepts than children, thus providing them with opportunities to change and enhance their self-conceptions (Hattie & Marsh, 1996). Moreover, with the advent of formal operational thought in adolescence, adolescents’ self-views become both more differentiated and more integrated (Harter, 1988). Thus, children are able to conceptualize themselves along a number of dimensions and are also able to abstract from these thoughts to form more generalized and integrated self-perceptions. This emerging self-awareness and introspection may provide children with more complex and advanced approaches for self-evaluation, which may lay the groundwork for the reevaluation of working models of self and others. Kobak and Cole (1994) suggest that the development of greater metacognitive abilities provide children with the ability to think about their relationships with their parents and their representational models which have emerged in response to these relationships.

In addition to adolescents’ increased cognitive capabilities, adolescents’ developing autonomy from parents during the adolescent years may provide them with the necessary “space” to reevaluate these relationships and resulting representations. Previous research has suggested the salience of secure parent–child relationships for the emergence of adolescent autonomy; however, limited attention has been paid to the potential role of positive alternative relationships in supporting children’s autonomy strivings. Together, this emotional distance as well as adolescents’ increased cognitive complexity may support adolescents’ ability to reflect upon their working models in a more metacognitive manner. This process may be crucial to resolving attachment difficulties with parents that may in turn allow some adolescents to form more secure relationships with others. Additionally, in more autonomous relationships children may be able to develop self- and emotional regulation strategies that are divergent from those utilized in the parent–child relationship and that promote even more positive interpersonal relationships.

Taken together, these theories suggest that positive alternative relationships may be compensatory in nature, providing adolescent children with additional and divergent information regarding themselves and their world. These experiences may set the stage for adjustments in adolescents’ representations of relationships and

may provide them with opportunities for greater skills development and positive relationship formation. Additionally, the increased cognitive capacities and autonomy that emerge in adolescence may provide children with the perspective and space necessary to truly reevaluate their early relationships and self-perceptions.

#### E. THE IMPACT OF GENDER ON SOCIAL AND EMOTIONAL DEVELOPMENTAL OUTCOMES

The links between affective relationships and self-regulation may be more salient for boys than for girls and, therefore, we examine relations separately by gender. Beginning in preschool, boys, for reasons of biological differences and/or socialization differences, may more than girls have problematic issues with regulation and control of emotions and impulses (Maccoby, 1998). For example, boys are more likely than girls to engage in high-arousal, rough-and-tumble play. Boys who can make a smooth transition between rough-and-tumble to calm play are more popular with both sex peers than boys who find this difficult (Gottman, Guralnick, Wilson, & Swanson, 1997). Similarly, boys who can constructively cope with anger are rated as more socially competent (Eisenberg, Fabes, Nyman, & Bernzweig, 1994). Therefore, preschool teachers may be differently attentive to boys than to girls and/or use different socialization techniques with them.

Furthermore, experiences within child care differ for girls and boys. Maccoby (1998) suggests that by the third year of life, girls and boys separate into two cultures with different play styles, different play themes, and perhaps, most important for our exploration, different relations to the world of adults. Girls' groups tend to be more oriented to interacting with teachers and more responsive to the reaction of the teachers to their behavior. Boys tend to orient themselves to other boys and to be more interactive, attentive to, and responsive to the reactions of other boys. Maccoby (1998) argues that in terms of rules of conduct specific to gender, the peer group is a more powerful socializing agent than adults, either parents or teachers. She analyzes large bodies of biological, psychological, anthropological, and sociological evidence to conclude that children, early in development, separate into gender segregated peer groups. Within these peer groups children develop the social behaviors and interaction styles specific to their gender.

#### F. SUMMARY OF ISSUES TO BE EXPLORED

We explored four issues central to development in this analysis: (1) the continuity of social and emotional competence over major developmental transitions; (2) compensatory relationships (both concurrent and predictive) within networks of affective relationships with peers and caregiving adults; (3) the long-term influence of variations in one social context for development, early child care, and (4) the influence of gender. We believe that it is clear from the introduction that a

single developmental theory was not sufficient to provide explanatory hypotheses for these issues across a lengthy developmental period. By finding our own pathway through these issues we hoped to contribute to theory building.

## II. Method

### A. PARTICIPANTS

#### 1. *Children and Their Families*

Originally 94 children, their mothers, their primary child care provider, and their peers participated in this study. We had six data collection periods: (1) first birthday, (2) point of entry into child care between the ages of 18 months and 3½ years, (3) age 4, (4) age 9, (5) age 12, and (6) age 14. Our sample for this analysis was limited to 77 children. All these children were seen at their first birthday; at age 4; and in at least two of the three data collection periods at ages 9, 12, and 14. Only 10 children missed more than one of these three data points. All 77 children in the analytic sample who were enrolled in child care prior to age 4 were seen at the second data collection point.

The families of these children were primarily European American (90%), with two parents in the home (87%), and middle class (assessed by parental education and income). In all families the mother was the primary caregiver, and therefore we used her in all cases as the home-based adult attachment figure.

Between ages 4 and 14, 15 children moved and could not be located. Three to five families who could be located at each data collection period declined to participate. The children lost to attrition and to nonparticipation and the children assessed at ages 9, 12, and 14 were not significantly different in terms of demographics (family structure, ethnicity, maternal education, and parental occupation), child care history (age entered care, type of arrangement, and quality of care), maternal attachment category, teacher attachment security scores collected at age 12 months and 4 years, and in peer interaction and friendship scores at age 4 years.

#### 2. *Child Care Experiences*

Because we considered child care an important social setting for socialization we collected detailed child care information at each data collection point prior to school entry. We defined child care as any arrangement in which a nonparental caregiver provided care for the child for at least 10 hours a week. Full-time child care was defined as more than 20 hours per week. Child care history was collected from the families from the time the children were 12 months old until the children entered elementary school. The children who participated in the study entered child care between the time they were 2 and 50 months old ( $M = 24.7$  months,  $SD = 14.7$  months).

Only 30% of the sample had two or more changes in child care teacher between the time they entered child care and the time they went on to kindergarten. Another 20% had no teacher changes and the remaining children had one teacher change. Measures of child care history (age entered care, hours in care, changes in teacher, and child care quality) were not associated with social interaction or friendship with peers in middle childhood and adolescence.

## B. PROCEDURES AND MEASURES

Procedures and measures of the toddler, preschool, and middle childhood portion of the longitudinal study have been elaborated elsewhere (Howes, 1998; Howes & Hamilton, 1992; Howes, Matheson *et al.*, 1994; Howes & Phillipsen, 1998; Howes & Tonyan, 2000). Table I summarizes the measures and the informant (placed in parentheses) for the child assessments over the longitudinal study. Full citations for the measures are included in the text rather than the table.

### 1. Attachment Relationship Quality with Mother and Teacher

*a. Toddler and preschool.* Children were seen with their mothers in the Strange Situation at 12 months. Attachment categories were derived by standard procedures (Ainsworth *et al.*, 1978). At age 4 years all children participated in a playgroup session with unfamiliar peers (Howes, Matheson *et al.*, 1994). At the conclusion of the playgroup, mother-child reunions were scored for attachment category using the Cassidy and Marvin (Cassidy, 1988) procedure. In the current analyses we used only the secure and insecure categories as assessed at both time points. Sixty-four percent of the children were secure at 12 months and 73% at 4 years.

Within 6 months of first entering child care and again at 4 years old children were observed interacting with their provider in their child care arrangement. Attachment security between the child and child care caregiver was assessed using the Waters Attachment Q-Set (Waters, 1990). Security scores were calculated from the Q-Set. Following procedures derived from a cluster analysis of Q-Set items, each child was classified into an attachment category (Howes & Hamilton, 1992). Children in the secure category were low in avoiding, high in secure base, and high in comfort seeking. Children in the insecure category were low in avoiding, high in difficult negotiations, or low in positive negotiations or high in avoiding, low in secure base, and low in comfort seeking. We classified 62% of the children as secure with their first teachers and with their teacher at age 4 years.

*b. Middle childhood.* Children's perceptions of their relationships with their mother and teacher were assessed with the Children's Expectations of Social Behavior Questionnaire (Rudolph, Hammen, & Burge, 1995). The measure requires that children encode typical interpersonal transactions, formulate an understanding of the situations, and generate predictions about likely outcomes. It is

TABLE I  
Measures Used in the Longitudinal Study

Attachment quality		Peer relations friendship	Social interaction	Self regulation
Mother-child	Teacher-child			
Middle adolescence (14 years)				
Kern Security Scale (child)		Bukowski (child)		Zill (parent) Achenbach (child)
Early adolescence (12 years)				
SAT (rated)	—	Bukowski (child)		Zill (parent)
Kern Security Scale (child)				
Middle childhood (9 years)				
Rudolph (child)	Rudolph (child) Pianta (teacher)	Bukowski (child)	Rudolph (child) Asher (teacher)	Zill (parent)
Preschool (4 years)				
Separation (rated)	AQS (observed)	Block and Block (teacher)	Aggression Withdraw Play (observed)	Shields and Cicchetti (teacher)
Toddler (12–30 months)				
Strange Situation (rated)	AQS (observed)	—	Aggression Withdraw Play (observed)	

*Note.* Rated and observed refer to independent raters and observers. Child, parent, and teacher refer to self-perceptions.

based on theoretical assumptions about the importance of interpersonal expectations in the formation of relationships (Bowlby, 1982). Children are provided with 20 hypothetical vignettes describing interpersonal situations (e.g., “you ask your mom to take you to a movie,” “you are having trouble learning how to do a math problem and ask for help,” and “you are teased by peers and your best friend does not defend you”). Ten vignettes are tied to each social partner—mother, teacher, and, peer. Three possible responses are provided: a supportive, comforting or accepting response; an indifferent, avoidant, or withdrawing response; and a hostile, critical, or rejecting response, coded as 1, -1, and -2, respectively. The child is asked to select the most likely response to each vignette. Scores are summed to form a single score for each partner. The measure originally was developed by Rudolph *et al.* (1995) for mothers and peers. For this study, we adapted some of

the vignettes designed for mothers so that structure and, wherever possible, content was parallel. For example, both the mother and teacher forms have a vignette based on giving the adult a gift, asking for help, and responding to sad feelings. The adaptations were piloted with children not in the sample. Interviews with the pilot children indicated that the teacher vignettes were plausible situations.

Rudolph *et al.* (1995) report Cronbach's  $\alpha$ s of .74 for mother, 1-month test-retest reliabilities of .86, and 5-month test-retest reliabilities of .82. In the current study Cronbach's  $\alpha$ s were .78 for mother and .83 for teacher. Rudolph *et al.* (1995) report that interpersonal schema scores for mothers are significantly associated with other measures of cognitive representations of interpersonal relations and with dysfunctional social behavior and less positive status in the peer group.

Teachers completed the Pianta Student-Teacher Relationship Scale (Pianta & Steinberg, 1992). This measure contains 30 questions rated on a 5-point scale (e.g., "It is easy to be in tune with what this child is feeling" and "When this child arrives in a bad mood I know we are in for a long and difficult day"). Pianta suggests three subscales to capture negative and positive teacher representations of the teacher-child relationship. These subscale scores are associated with children's classroom and home behaviors (Pianta & Steinberg, 1992). In the current study we used two of the subscales—close ( $\alpha = .75$ ) and conflictual ( $\alpha = .81$ ) teacher perceptions of the teacher-child relationship.

We used K-Ward cluster analysis to create categories of positive (secure) child-mother and child-teacher relationships at age 9. We used the Rudolph *et al.* measure to create the child-mother relationship categories. Seventy percent of the children had positive (secure) child-mother relationships. We used the two Pianta subscales, close and conflictual, and the Rudolph *et al.* measure to create the child-teacher relationship categories. Forty-nine percent of the children had positive child-teacher relationships.

*c. Adolescence.* At age 12 participating children were interviewed using the Separation Anxiety Test for adolescents (Main, Kaplan, & Cassidy, 1985). The SAT asks children to respond to a series of standardized questions concerning six separation pictures (e.g., "parents leave for two weeks" and "the teenager runs away from home"). The SAT measure yields ratings on several dimensions: emotional openness; dismissing; self-blame; resistance, preoccupied; displacement of feelings; and coherence; as well as a security category. Scores on the SAT in previous research have correlated with earlier attachment quality in the Strange Situation.

At both ages 12 and 14 we also used the Kerns Self Report Security Scale to assess children's perceptions of security with their mothers (Kerns, 2000). Children with higher scores on this measure also are more accepted by peers, have more reciprocated friendships, and described themselves as lonelier than children who rated their child-mother relationship as less secure (Kerns, Klepac, & Cole, 1996).

Teacher–child relationship measures were not collected in early adolescence because the children no longer had primary teachers in self-contained classrooms.

We again used a K-Means cluster analysis to create categories of child–mother relationships. At age 12 we used both the SAT ratings and the Kerns total security score. At age 14 we used only the Kerns score. At age 12, 54% of the child–mother relationships were in the secure category. At age 14, 62% of the child–mother relationships were in the secure category.

## 2. Peer Social Interaction and Friendship Quality

*a. Toddler and preschool.* Between 2 and 6 months after children first began child care, we observed peer interaction in child care. Independent observers used the Howes Peer Play Scale (Howes & Matheson, 1992) and the Baumrind Preschool Behavior Q-Set (Baumrind, 1968) were used to assess complexity and content of peer interaction in both toddler and preschool periods. As toddlers and again as preschoolers, children were observed with their familiar peers on two separate days. Each child care observation lasted an hour. Visits were scheduled during times when the child was free to interact with both adults and peers. During each visit the observer coded three 5-min samples of social behaviors, a total of six per child. The samples were evenly spaced throughout the observation. During the 5-min coding period, the complexity and content of the child's play with peers was coded at 20-s intervals. As preschoolers, each child also was seen in a 2-h play group. The play groups were composed of four unfamiliar children all within 1 month of their fourth birthday. Preschool child care teachers completed the California Child Q-Set (Block & Block, 1980). Each child in the sample had a different teacher.

All observers were blind to the hypotheses of the study. Different observers collected the toddler, preschool, and play group data. Interobserver reliability was established to an 85% exact agreement criterion prior to data collection. Interobserver reliability was reestablished at the midpoint of each data collection period. Interobserver reliabilities on individual behaviors ranged from .89 to .93 (median = .91) in the toddler period, from .91 to .97 (median = .96) in preschool child care, and from .90 to .92 (median = .91) in the play group.

Three measures represented toddler social behavior with peers: complex play, aggressive, and withdrawn (Howes, Phillipsen, & Hamilton, 1993). Complex play was the percentage of the observation period spent in complementary or cooperative pretend play. These play structures involve action or symbolic role reversals and are associated with other measures of social competence with peers (Howes & Matheson, 1992). The other two measures, aggressive and withdrawn, were composite variables derived from the Peer Play Scale and the Q-Set. We formed these composite scores by first converting all scores to standard scores and then summing them. We used alpha values to evaluate the reliability of the composite variables. Aggressive ( $\alpha = .85$ ) was composed of the percentage of the observation

period spent in physical or verbal hostile initiations, the percentage of the observation period spent in fights, or the percentage of observed peer initiations met with hostile acts; and four items from Q-Set: destructively impetuous and impulsive, requires a great deal of adult supervision when playing with peers, cannot be trusted, and bullies other children. Withdrawn ( $\alpha = .73$ ) was the percentage of the observation period in solitary play and two items from Q-Set: timid with other children and apprehensive.

Four measures represented social competence with peers as preschool-age children: complex play, aggressive, withdrawn, and prosocial. Complex play ( $\alpha = .66$ ) was a composite formed by summing two standard scores: the percentage of time engaged in cooperative or complex pretend play with familiar peers and with unfamiliar peers. Aggressive ( $\alpha = .79$ ) was a composite variable formed by summing standard scores from the Peer Play Scale (three scores all from observations of familiar peers, percentage of observation period spent in physical or verbal hostile initiations, percentage of observation period in fights, and percentage of peer initiations met with hostile acts), the Baumrind Preschool Q-Set (four items, identical to the toddler period), and one item from California Child Q-Set (acts in an aggressive manner). Withdrawn ( $\alpha = .84$ ) was a composite variable formed by summing standard scores from the Peer Play Scale (two items, percentage of observation in solitary play with familiar peers and with unfamiliar peers), two items from Preschool Q-Set (timid with other children and apprehensive), and one item from California Child Q-Set (withdraws from peer interaction). Prosocial ( $\alpha = .64$ ) was a composite variable formed by summing three items from the Preschool Q-Set (nurturant or sympathetic to other children, understands other children's position in interaction or altercation, and hits only in self-defense or does not hit at all) and two items from the California Child Q-Set (gets along well with peers and considerate of peers). One item from the California Child Q-Set (asking about close friendships) was used in the current analysis as the measure of preschool friendship quality. We used a K-Means cluster analysis to create two categories of high and low friendship quality from the preschool friendship score. Fifty-five percent of the children had positive friendships.

*b. Middle childhood.* Measures of social interaction with peers were derived from teacher reports using the Cassidy and Asher (1992) teacher assessment of social behavior questionnaire. Each child in the sample had a different teacher. The teacher is asked to rate on 5-point scales the social behavior of the target child in relation to the other children in her class (e.g., "This child is mean to other children"). Cassidy and Asher derive four subscales of which we used three in the current study. The subscales were prosocial ( $\alpha = .73$ ; e.g., "This child is nice and friendly to other children," "This child is cooperative with other children," and "This child is helpful to other children"), shy ( $\alpha = .68$ ; e.g., "This child is shy



with other children,” and “This child seems afraid of other children,” and “This child does not play with other children”), and aggressive ( $\alpha = .67$ ; e.g., “This child is mean to other children,” “This child starts fights,” and “This child hurts other children”).

*c. Middle childhood and adolescence.* The Friendship Quality Scale (Bukowski, Hoza, & Boivin, 1994) was used at age 9 and again at ages 12 and 14 to assess the child’s perception of his or her best friendship. This measure is completed with reference to a specific child, in this case named by the mother and the child as a best friend. The measure includes 23 questions rated on a 5-point scale; e.g., “I think about my friend when my friend is not around.” Bukowski *et al.* (1994) derived five subscales from this measure with  $\alpha$ s ranging from .71 to .86 for each subscale. The subscales are closeness, security, help, companionship, and conflict. We again used K-Means cluster analysis to create categories of children with positive and less positive friendship relationships using the Bukowski subscales. Sixty-five percent of the children at age 9, 54% of the children at age 12, and 79% of the children at age 14 were classified as having positive friendships. We also used a principal components factor analysis to create a single composite measure of friendship quality at age 14. This factor accounted for 84% of the variance. As expected, closeness, security, help, and companionship loaded positively on the factor and conflict negatively.

### 3. Self-Regulation

*a. Preschool.* Preschool teachers completed the California Child Q-Set (Block & Block, 1980) when the children were 4 years old. We used a composite measure of 10 items from this measure to reflect emotional regulation. Scores could range from 0 to 90. High scores indicate more competent regulation. This measure was devised by Shields and Cicchetti (1997) and predicts children’s social and emotional adjustment over time.

*b. Middle childhood and adolescence.* When the children were 9, 12, and 14 years old their mothers completed the Zill Behavior Problem Index (Zill, 1988). The questionnaire presents 28 behavior problems (e.g., cheats or tells lies) and asks the mother to mark on a 3-point scale how often this has been true in the past 3 months. Each child receives an average item score on which a high score indicated many behavior problems. Previous work on large samples by Zill (1988) found Cronbach’s  $\alpha$  levels of .91 and associations between behavior problem scores and other measures of child well-being (Peterson & Zill, 1986; Zill, 1988). In the current study the measure of behavior problems had  $\alpha$ s of .81 (age 9), .80 (age 12), and .82 (age 14). At age 14 children completed the child report versions of the Child Behavior Checklist (Achenbach & Edelbrock, 1983). We also used a principal components factor analysis to create a single composite measure of

self-regulation at age 14 using the child and parent report measures. This factor accounted for 89% of the variance.

#### 4. *Child Care History*

*a. Quality.* When the children were 4 years old their classrooms were observed using the Early Childhood Environmental Rating Scale (ECERS; Harms & Clifford, 1980). Each classroom was observed for a total of 2 h spaced over an entire day. Interobserver reliability on ECERS items ranged from  $\kappa = .82$  to  $\kappa = .96$ , median =  $.89$ . ECERS scores can range from 1 to 7 with a score of 3 or above indicating acceptable care and scores of 5 or above indicating good care. The average ECERS score was 4.05 ( $SD = .53$ ). Five percent of the children were in child care centers with unacceptable scores and 7% were in child care centers with good scores.

*b. Age of entry.* The age when the child first entered child care was recorded based on information provided by the mothers at their annual interview, beginning when the children were 12 months. This information was updated annually until the children went to kindergarten. Forty-four percent of the children entered child care before their first birthdays, 35% between the ages of 1 and 4 years and 10% as 4-year-olds.

*c. Child care changes.* Mothers described the children's child care arrangements annually and provided us with the name of the child care caregiver at each annual interview. We used this information to estimate the cumulative number of child care changes that a child had experienced. This is a conservative measure of changes because a maximum of one change per year could be recorded and therefore we did not account for children who experienced more than one caregiver change during the year. Sixty-two percent of the children who attended child care had one to two changes in child care arrangement and 80% had at least one and as many as three changes in child care caregiver.

*d. Child care intensity.* Twenty-eight percent of the children in child care began full-time child care before their first birthdays and continued in full-time care until they attended kindergarten. Another 6% of the child care attendees began full-time care as preschoolers. The rest of the children attended part time.

### III. Results and Discussion

We organized our analyses around our four central issues of continuity of social and emotional competence and social relationships over major developmental transitions, compensatory relationships (both concurrent and predictive) within

networks of affective relationships with peers and caregiving adults, long-term influence of variations in early child care experiences, and gender. We report our results first for continuity and then for compensatory relationships within networks. Within each of these major sections we include analyses of child care experiences and gender. We also include discussion points specific to the issue within each section.

#### A. CONTINUITY OF SOCIAL AND EMOTIONAL COMPETENCE AND OF RELATIONSHIP QUALITY

##### 1. Friendship Quality and Self-Regulation at Ages 4 and 14

*a. Gender.* As we had expected from Maccoby's theoretical framework, gender differences in emotion and self-regulation and in friendship quality emerged in preschool and were very salient by midadolescence. At age 4 ratings of emotional regulation were significantly higher for girls ( $M = 64.31$ ,  $SD = 11.28$ ) than for boys [ $M = 57.96$ ,  $SD = 12.94$ ;  $t(70) = 1.98$ ,  $p = .05$ ], and girls had higher friendship ratings ( $M = 6.51$ ,  $SD = 2.1$ ) than boys ( $M = 5.16$ ;  $SD = 2.3$ ), although not significantly so. Analysis of the full sample at age 4 suggests different preschool correlates of emotional regulation for girls and boys (Tonyan & Howes, under review). Highly dysregulated girls were less likely to have close friendships, while highly dysregulated boys were more likely to have high scores on aggression.

Again at age 14, girls had higher ratings on the friendship quality composite measure [ $M(\text{girls}) = .37$ ,  $SD = .76$ ;  $M(\text{boys}) = .29$ ,  $SD = 1.05$ ;  $t(70) = 2.82$ ,  $p = .006$ ]. As well, girls had significantly higher ratings on the self-regulation composite measure at age 14 [ $M(\text{girls}) = .26$ ,  $SD = 1.01$ ;  $M(\text{boys}) = -.23$ ,  $SD = .89$ ;  $t(70) = 2.03$ ,  $p = .05$ ].

We examined associations between friendship quality and self-regulation in both developmental periods. Both girls and boys who teachers rated as having closer friendships at age 4 also had higher emotion regulation ratings (girls  $r = .48$ ; boys  $r = .36$ ). But by age 14 the association was present for boys ( $r = .45$ ) but not for girls ( $r = -.08$ ). This suggests further divergence in the experiences of girls and boys. Alternatively, because girls have relatively higher scores in both friendship quality and self-regulation, correlations are less valuable for capturing associations between their scores.

*b. Child Care Experiences.* Belsky (1988) proposed that early entry into child care may increase behavior problems. He argued that the experience of daily separation from the primary caregiver (usually the mother), particularly during the first year of life, may directly result in children internalizing an insecure model of relationships and therefore indirectly result in behavior problems. Other researchers suggest that the detrimental influence of early child care was limited to children enrolled in poor-quality care (Howes, 1990; Phillips, McCartney, Scarr, & Howes,

1987). The empirical support for these associations between child care and later behavior problems is mixed. Several studies of child care and/or maternal employment suggest an association between child care and an increase in behavior problems (Baydar & Brooks-Gunn, 1991; Belsky & Eggebeen, 1991; Haskins, 1985; Rubenstein, Howes, & Boyle, 1981; Vandell & Corasaniti, 1990) but others do not find an association (Helgland & Rix, 1990; Howes & Olenick, 1986; Network, 1998; Park & Honig, 1991; Schwartz, Strickland, & Krolick, 1974). Few of the extant studies examined multiple dimensions of child care as predictors of behavior problems. And no study conducted within the context of child care in the United States followed children into adolescence. In this study when we examined relations between measures of friendship quality and self-regulation and measures of child care history, we found no significant correlations. That is, history of child care in the preschool years was unrelated to friendship quality and self-regulation later in development. Although no single study—particularly a study such as this one of children from a particular type of family—can definitively decide the issue, the result of no associations between early or adolescent self-regulation and child care history is inconsistent with the claim that early child care results in impaired social relationships and disordered behavior.

## 2. *Stability of Relationships over Time*

We generated several different descriptive statistics for the stability of relationship quality over assessment periods. We examined the probability that a child who had a positive relationship in one period would continue to have a positive relationship in the next period. We calculated the percentage of children with different patterns of relationship quality stability and we summed the total number of positive relationships over time. The descriptive statistics are in Table II. In the 10 cases with missing data at one age period (9, 12, or 14) we extrapolated between assessment periods for each individual child. That is, if the relationship was positive at 9 and 14 and missing at 12 we considered it positive at 12. If the relationship was positive at 9, missing at 12, and negative at 14, we assigned it negative at 12 because 12 and 14 were closer together in time.

We examined the data separately for girls and boys. There were no differences in patterns by gender of child so the data were combined for girls and boys. We then used *t* tests to compare gender differences in total number of positive relationships within each category of relationship (mother, teacher, and friend). Where we found significant gender differences we report them below.

We used correlations to examine relations between number of positive relationships within each category of relationship (mother, teacher, and friend) and measures of child care history. Unlike the gender analysis, there were no significant associations between variations in child care history and total number of positive relationships within each category of relationship.

TABLE II  
Stability of Relationship Quality: Toddler to Adolescents

	Percentage of children	Probability of secure/positive			
		Toddler to 4 age 4	Ages 4 to 9	Ages 9 to 12	Ages 12 to 14
Child–mother relationships		.76	.77	.56	.83
All insecure	3				
Early insecure and intermittent	15				
Early secure and intermittent	18				
Early insecure to secure	18				
Early secure to insecure	20				
All secure (all five periods)	26				
One secure relationship	6				
Two secure relationships	15				
Three secure relationships	35				
Four secure relationships	14				
Child–teacher relationships		.69	.47	—	—
All insecure	16				
Early insecure and intermittent	9				
Early secure and intermittent	6				
Early insecure to secure	13				
Early secure to insecure	27				
All secure (three periods)	28				
One secure relationship	25				
Two secure relationships	43				
Friend relationships		—	.60	.57	.96
All low	13				
Early low then intermittent	8				
Early high then intermittent	6				
Early low to high	27				
Early high to low	24				
All high	22				
One positive	24				
Two positive	46				
Three positive	22				

Note. Percentages sum to more than 100 because categories overlap.

*a. Stability of Child–Adult Relationships over Time.* Over three-quarters of the children with secure child–mother relationships at 12 months continued to have secure child–mother relationships at age 4 (see Table II). The probability of a secure child–mother relationship being followed by a secure child–mother relationship in the next assessment period remained high across periods except for a dip between ages 9 and 12. The modal child in the sample was secure with mother during all assessment periods. The modal number of secure child–mother classifications was three of a possible five.

These findings are consistent with Bowlby's theoretical formulation that child–mother attachment relationships tend to be stable over time, due to the increasing inflexibility of the child's working model of relationships. An alternative explanation for this consistency is that we expect mother–child interaction patterns to be reasonably stable over time (Allen & Land, 1999; Thompson, 2000). Many mothers who were able to coconstruct secure child–mother attachment relationships in the toddler period would be expected to continue their sensitive responsive behaviors as their children's developmental challenges changed.

We used different assessment procedures for child–mother attachment across the 13-year span of our study. Although a conceptual exploration of the meaning of the different assessments is beyond the scope of this chapter (see Kerns, 2000, for a review), these changes certainly may have contributed to instability in relationship quality and are the most parsimonious explanation for the dip in proportion of secure children between ages 9 and 12. A more complete study of these issues would involve assessing patterns of mother–child interaction as well as assessing relationship quality. Changes in early adolescence in terms of parenting approach might have created this dip. As well, the developmental challenges or school transitions involved in moving between elementary and high school could contribute to changes in relationship quality. Allen and Land (1999) suggest that developmental challenges and changes create a kind of lawful discontinuity, which is disorganizing and therefore allows for change and reorganization to emerge.

We assessed child–teacher relationship quality in three of the five periods. Relationship quality was more stable during child care than it was across child care to third grade. The modal child had either secure relationships in child care and insecure in third grade or secure across the three periods. The modal number of secure child–teacher classifications was two of a possible three. Again the relative stability of relationship quality is consistent with Bowlby's theoretical formulations.

In building a modified theory of attachment networks it is important to note stability tended to persist even when the person of teacher changed. This suggests a working model specific to teacher relationships rather than to more general child–adult relationships (Howes *et al.*, 1998). This notion of a working model particular to the caregiving function of the adult may have even further specificity. Perhaps there was more stability within child care because the caregiving function of the adult was more similar within child care than across child care to school. Future work may need to assess child–teacher relationships within the elementary school years rather than at one time point. We stopped assessing child–teacher relationships before adolescence because changes in school organization made it difficult to identify which teacher should be considered the most important relationship. We strongly suggest that future researchers attempt to solve this dilemma and assess child–teacher relationship in adolescence as well as childhood.

*b. Stability of Friendship Relationships over Time.* We assessed friendship quality in four of the five assessment periods. The modal child was classified in

the positive friendship group at least half the time. Girls had more positive friendship relationships over time than boys [ $M(\text{girls}) = 2.0, SD = .78; M(\text{boys}) = 1.5, SD = .90; t(70) = 4.01, p = .02$ ]. This is consistent with previous research on gender differences in friendship (Maccoby, 1998).

Overall classification of friendship quality tended to be stable (see Table II). The probability of having a stable positive classification was highest between ages 12 and 14. The modal child moved from less to more positive friendships across time. The relative high stability of friendship quality over time is inconsistent with a perspective that considers early friendships to be playmates without the intimacy associated with older children's friendships (Buhrmester & Furman, 1987; Howes, 1996). However, friendship quality did become very stable in adolescence, a finding consistent with the notion of developmental shifts in the meaning of friendship.

Overall, as in our previous work with these children (Howes & Tonyan, 2000), relationship quality with mothers, teachers, and friendship tended to be both positive and stable. Through our years of contact, these children have constructed and maintained relationships that they and others perceive as warm, sensitive, and promoting of trust. These findings support the basic assumptions of attachment theory that children who experience warm, trusting relationships with primary caregivers tend to perpetuate them (Bowlby, 1982). Even if the mothers of these children tended to create positive home environments by being "good enough" parents at each of the developmental periods, it is unlikely that the child care and elementary school teachers were as uniformly "good enough" to create this positive stability. On the contrary, an explanation, consistent with the working model hypothesis, is that those children fortunate enough to construct positive child-teacher relationships as very young children in child care acted toward each new teacher as if she was ready to construct a positive relationship. Teachers have the task of constructing as many as 20 or 30 new relationships with the children who enter their class each year. Faced with this daunting task and the popular notion that "too many" children begin these relationships as difficult children not ready for school, it is not surprising that children who enter the new child-teacher relationship in a pleasant and positive way tend to perpetuate their positive relationships.

B. COMPENSATORY RELATIONSHIPS, BOTH CONCURRENT AND PREDICTIVE,  
WITHIN NETWORKS OF AFFECTIVE RELATIONSHIPS WITH PEERS  
AND CAREGIVING ADULTS

We now turn to the less fortunate participating children, those who did not experience positive relationships in all parts of their social networks. For these children we asked, if relationships within networks were not uniformly positive, did one type of positive relationship have a compensatory role in the development of positive friendships and self-regulation in middle adolescence?

### *1. Compensatory Relationships over Time*

Based on our analysis of relationship stability we considered children with secure child–mother relationships in at least three assessment periods to have a history of secure child–mother relationships. We considered children with at least two secure child–teacher relationships to have a history of secure child–teacher relationships. Likewise, we considered children with at least two positive friend relationships to have a history of positive friend relationships. We crossed these categories to examine compensatory mother–teacher and mother–friend relationship history.

Fifty-six percent of the children had positive relationship histories with both mother and teacher and 7% had negative relationship histories with both mother and teacher. Therefore, 37% of the children had mother–teacher compensatory relationship histories. Children who had compensatory relationship histories were no more likely to be secure with one adult than the other. Nineteen percent of these compensatory relationship histories were secure with mother and insecure with teacher. The other 18% of the compensatory relationships were insecure with mother and secure with teacher. We used chi-square analysis to examine associations between these adult compensatory relationship patterns and gender or child care history and found no significant associations.

Almost half of the children (49%) had secure mother–child relationship histories and positive friendship histories. Eight percent of the children had insecure mother–child relationship histories and negative friendship histories. The remaining 43% of children had mother–friend compensatory histories. More children (26%) had histories of secure mother–child relationships and low quality friendships than insecure mother–child relationships and positive friendships. Again we used chi-square analysis to examine associations between these adult compensatory relationship patterns and gender or child care history and found no significant associations.

### *2. Mothers and Teachers as Compensatory Child–Adult Relationships*

Our first central question concerning compensatory relationships was whether by middle adolescence histories of one rather than two positive adult relationships would predict positive social and emotional competence. To address this question we used analysis of covariance (with gender as the covariate) to examine differences in friendship quality and self-regulation at age 14 for children with different relationship histories. The descriptive information for these analyses is in Table III.

The interaction between mother and teacher relationship history was significant for friendship quality (see Table III). Children with positive relationships over time with both mother and teacher and those children who had positive relationships with either mother or teacher had higher friendship quality as 14-year-olds than children with insecure relationships with both adults over time.



TABLE III  
 Mother and Teacher Relationship Quality at Age 14 Years

	Relationship with mother				<i>F</i>
	Secure	Relationship with teacher		Insecure	
	Secure <i>M(SE)</i>	Insecure <i>M(SE)</i>	Secure <i>M(SE)</i>	Insecure <i>M(SE)</i>	
<i>n</i>	40	14	13	5	
Friendship quality	5.58 (.16)	4.09 (.30)	3.22 (.43)	.11 (.27)	4.91**
Self-regulation	.29 (.15)	-.59 (.29)	-.14 (.25)	-.61 (.40)	3.49**

*Note.* Analysis of covariance with gender covaried; numbers in table are estimated marginal means: gender of child = 1.55 (self-regulation), 1.54 (friendship).

These findings for friendships quality in adolescence mirror the pattern of compensatory adult relationships and social competence with peers we found for these same children as toddlers (Howes, 1998). Experiencing at least one positive child–adult caregiver relationship, whether it is with mother or teacher, apparently provides a secure base to construct positive friendship relationships. The children in this sample formed their first friendships in the context of a child–teacher relations so it is particularly significant to note that by age 14 child–teacher quality was still an important aspect of their friendship quality.

The interaction between mother and teacher relationship history also was significant for self-regulation, but reflected a different pattern than was found for friendship quality (see Table III). Children who had positive relationships over time with both adult partners had the highest self-regulation scores as 14-year-olds. Children who had secure histories with mothers and insecure histories with teachers and children who had insecure histories with both adults had lower self-regulation scores as 14-year-olds than children with insecure histories with mothers and secure histories with teachers.

The findings for self-regulation are more complex than those for friendship. They suggest that teachers may play a different role than mothers in socializing self-regulation in children. Perhaps this is because teachers must manage the behavior of a group of children in a relatively small and very public space rather than a small number of children within a family. A child who is disruptive in school interrupts the learning of all the children in the class. If teachers can construct positive relationships with children in their class they maximize the cooperative and harmonious relationships as well as opportunities for learning within the entire group. Therefore, the compensatory role of teachers for the development of self-regulation are probably more important than for friendships. Children's friendships as opposed to self-regulation may be more likely to be developed outside of the school setting.

TABLE IV  
 Mother and Friend Relationship Quality at Age 14 Years

	Relationship with mother				<i>F</i>
	Secure		Insecure		
	Relationship with friend				
	High <i>M(SE)</i>	Low <i>M(SE)</i>	High <i>M(SE)</i>	Low <i>M(SE)</i>	
<i>n</i>	35	19	12	6	
Friendship quality	.28 (.17)	-.32 (.21)	.17 (.29)	-.35 (.21)	3.59**
Self-regulation	.27 (.17)	.11 (.21)	-.48 (.25)	-.82 (.41)	3.18**

*Note.* Analysis of covariance with gender covaried; numbers in table are estimated marginal means: gender of child = 1.55 (self-regulation), 1.54 (friendship).

### 3. Mothers and Friends as Compensatory Relationships

Our second central question concerning compensatory relationships was whether by middle adolescence histories of positive friendship would predict positive social and emotional competence when children have histories of insecure mother-child relationships. To address this question we used analysis of covariance (with gender as the covariate) to examine differences in friendship quality and self-regulation at age 14 for children with different relationship histories. The descriptive information for these analyses is in Table IV.

The interaction between mother and friend relationship history was significant for friendship quality (see Table IV). Children with secure child-mother histories and positive friendship histories and children with insecure child-mother histories and positive friendship histories had higher friendship scores as 14-year-olds than children with secure child-mother histories and less than positive friendship histories and children with insecure child-mother histories and less than positive friendship histories. This finding is consistent with our hypothesis that children with insecure child-adult relationships and close friends may use their friendships to compensate for their less than adequate child-mother relationships. Our longitudinal data on both friend and mother relationships suggests that this is not simply an artifact of sociable children remaining good at being friends, but a subgroup of children continuing their positive friendships in the context of difficult relationships at home.

The interaction between mother and friend relationship history also was significant for self-regulation (see Table IV). Children with insecure child-mother relationship histories and either positive or negative friendship relationship histories had the lowest self-regulation scores at 14 years. Children with secure child-mother relationship histories and positive friend histories had higher self-regulation scores than children with secure child-mother relationships and lower

quality friendship histories. Friends seem less able to compensate for child–adult relationships in enhancing self-regulation than teachers. This is consistent with the literature that suggests that very close friends can engage together in highly antisocial activities (Hartup, 1999). In this case we have children who maintain their close friendships and have problematic behaviors.

### C. PREDICTING FRIENDSHIP QUALITY AND SELF-REGULATION AT AGE 14

We examined a series of predictive models using multiple-regression analysis for both friendship quality and self-regulation at age 14 as a final step in our analyses. Because we have a small sample size we first conducted a series of regressions, each exploring a portion of our total explanatory model, and then a final more inclusive model. The planned regressions were conducted separately for the adult attachment network, the friendship network, for child care history, for friendship quality and self-regulation when the children were 4 years old, and compensatory relationships. In most models gender was entered first as a control variable. Finally we used the best predictors from each of our first set of regressions to generate a final inclusive model for each outcome. Because of the number of regressions and the small sample size, we consider these analyses to be suggestive rather than definitive.

#### 1. *Adult Attachment Network*

The first planned model examined child–adult relationships. After gender we entered child–mother and child–teacher relationship history variables (total secure relationships). As a second step we entered first child–mother and child–teacher relationship quality and finally we entered the most contemporaneous child–adult relationship quality (child–mother at age 14 and child–teacher at age 9). This first model was significant for friendship quality ( $R^2 = .37, p = .02$ ). Inspections of the  $\beta$  and partial correlations values suggested that child–mother relationship history ( $\beta = .57$ ) was a better predictor than early ( $\beta = .31$ ) or contemporaneous ( $\beta = .12$ ) child–mother relationship quality. None of the  $\beta$  values for child–teacher relationship quality approached significance. The child–adult relationship model also was significant for self-regulation ( $R^2 = .25, p = .05$ ). Inspections of the  $\beta$  and partial correlations values in this model as well suggested that child–mother relationship history ( $\beta = .40$ ) was a better predictor than early ( $\beta = .00$ ) or contemporaneous ( $\beta = .09$ ) child–mother relationship quality. Again, none of the  $\beta$  values for child–teacher relationship quality approached significance.

These findings provide support for what has been called the hierarchical organization of multiple attachment relationships (Bretherton & Waters, 1985; Howes, 1999). In a hierarchical organization the child's representation of the most salient caregiver, most often the mother, is always the most influential. The salience of cumulative security rather than early or late relationship quality was unpredicted and worthy of further investigation in other samples. We attempted to devise ordinal

rankings of the other categories that reflected attachment over time (see Table II) but none was as powerful predictor as the simple cumulative measure.

### 2. *Friendship Network*

In the second planned predictive model we again controlled for gender and then entered in order: friendship relationship history, 4-year-old friendship quality, and finally friendship quality at ages 9 and 12. The model was significant for friendship quality at age 14 ( $R^2 = .20, p = .05$ ). Inspection of the  $\beta$  and partial correlation values suggested that both friendship quality history ( $\beta = .56$ ) and 4-year-old friendship quality ( $\beta = .47$ ) but not 9-year-old ( $\beta = .16$ ) or 12-year-old friendship quality ( $\beta = .21$ ) predicted 14-year-old friendship quality. This model was not significant for 14-year-old self-regulation and none of the  $\beta$  values approached significance. These findings are consistent with our expectations of stability in relationship quality within relationship type. It is of interest that early as well as cumulative friendship quality were predictive. This highlights the potential importance of early experiences with friends (Howes, 1996).

### 3. *Child Care History*

The third predictive model used child care history measures, controlling for gender. As expected from the preliminary analysis, the model was not significant for either outcome and none of the  $\beta$  values for child care history measures approached significance.

### 4. *Friendships and Self-Regulation at Age 4*

We next tested a model that used friendship quality and self-regulation in child care at age four as predictors. Given our hypotheses regarding friendship formation during child care and the role of gender, in predicting friendship quality at age 14 we entered simultaneously friendship quality at age 4 and the interaction of gender and friendship quality at age 4. The model was significant for friendship quality at age 14 ( $R^2 = .12, p = .05$ ). Inspection of the  $\beta$  and partial correlation values suggested that the interaction of gender and friendship quality at age 4 ( $\beta = .52$ ) but not friendship quality alone at age 4 ( $\beta = .27$ ) predicted friendship at age 14. To further examine this finding we used analysis of variance to compare age 14 friendship quality scores of girls and boys with high and low friendship quality at age 4. The interaction of gender and friendship quality was significant [ $F(2, 70) = 7.97, p = .01$ ]. Girls with high friendship quality as 4-year-olds had higher friendship quality at age 14 than girls with lower friendship quality as 4-year-olds. But boys who were high or low in friendship quality at age 4 were no different at age 14. We also examined predicting friendship quality at age 14 from social competence with peers measures at age 4. The model was not significant.

In predicting self-regulation at age 14 from regulation within child care we entered simultaneously emotion regulation at age 4 and the interaction of emotion

regulation and gender. Using this model we were able to predict self-regulation at age 14 ( $R^2 = .10$ ,  $p = .05$ ). Inspection of the  $\beta$  and partial correlation values suggested that both the interaction of gender and self-regulation at age 4 ( $\beta = .40$ ) and emotional regulation at age 4 ( $\beta = .36$ ) predicted self-regulation at age 14. We used analysis of variance to further examine these results. We compared self-regulation at age 14 in girls and boys high and low in emotional regulation at age 4. The interaction of gender and friendship quality was significant [ $F(2, 70) = 4.32$ ,  $p = .01$ ]. Boys higher in emotional regulation at age 4 were higher in emotional regulation at age 14 than boys lower in emotional regulation at age 4. As well, girls and boys who were higher in emotional regulation as 4-year-olds were higher in self-regulation at 14. We also examined predicting friendship quality at age 14 from social competence with peers measures at age 4. The model was not significant.

These findings are consistent with Maccoby's (1999) theoretical formulation that the world of child care is different for boys and girls. Their presumed different experiences with peers and with teachers may have contributed to the predictability of interactions between behavior and gender at age 4. Children of both genders, of course, enter child care variable in their dispositions toward sociable or problematic behavior. Children who are difficult tend to elicit harsh and unresponsive adult behaviors, while children who are friendly are more apt to form close relationships with their teachers and their peers. But whatever their initial dispositions, all of the children developed their capacity for emotional regulation and developed their close or not-so-close friendships within child care. Certainly child care classrooms provide children with many naturally occurring opportunities to control their impulses: toys and teachers must be shared, accidents happen (e.g., swings are let go and bump into children), and other children have different ideas about how to play. It is probable that teachers directly helped the children develop prosocial strategies (e.g. "use your words instead of hitting"; "Jennie looks sad, how can we help"; "I don't think Kari meant to let the swing hit you"; and "let's fix that bump"). Future research is needed to examine the processes within classrooms that enhance friendship formation and emotional regulation.

### 5. *Compensatory Relationships*

We then examined the predictability of compensatory relationships. In this model we first entered gender and then dummy coded mother-teacher and mother-friend interactions as discussed above. This compensation model significantly predicted 14-year-old friendship ( $R^2 = .19$ ,  $p = .05$ ) and 14-year-old self-regulation ( $R^2 = .22$ ,  $p = .03$ ). This modeling confirms the findings of the analysis of variance for compensation discussed above.

### 6. *Final Inclusive Predictive Model*

We used the predictive pattern of the planned models to generate a final inclusive model for each outcome. In the model to predict friendship quality at age

14, we used child–mother relationship quality history, friendship quality history, the interaction of gender and 4-year-old friendship quality, and the dummy coded mother–friend interactions. The model was significant ( $R^2 = .26, p = .05$ ). Inspection of the  $\beta$  and partial correlation values suggested that 4-year-old gender and friendship quality interaction ( $\beta = .40$ ), friendship quality history ( $\beta = .39$ ), and interaction of mother and friendship relationship ( $\beta = .29$ ), but not child–mother relationship quality history alone ( $\beta = .08$ ), contributed to the prediction. Girls who had positive friendships as 4-year-olds in child care and who maintained positive friendships and secure child–mother relationships were the most likely to report positive friendships in middle adolescence.

In the model to predict self-regulation at age 14 we used child–mother relationship quality history, emotional regulation at age 4, the interaction of gender and 4-year-old emotional regulation, and the dummy coded mother–teacher interactions. The model was significant ( $R^2 = .22, p = .05$ ). Inspection of the  $\beta$  and partial correlation values suggested that 4-year-old gender and emotional regulation interaction ( $\beta = .37$ ), emotional regulation at age 4 ( $\beta = .34$ ), and interaction of mother and teacher relationship quality ( $\beta = .69$ ), but not child–mother relationship quality history alone ( $\beta = .07$ ), contributed to the prediction. For self-regulation, boys who could regulate their emotions at age 4 and who maintained positive relationships with their mothers and teachers were most likely to self-regulate at age 14. This final model tells a complex story of the importance of gender; of early experiences within child care; of relationships with friends over time; and the potential importance of compensatory relationships with mothers, teachers, and friends.

#### IV. Implications for Further Theory Development

Overall the children we have studied between their first birthdays and age 14 are doing well. Most of the children have close friendships and are able to engage in self-regulation, both emotional and behavioral. Perhaps this is not surprising given that they have grown up in relatively affluent homes. However, when we look more closely we see that the pathways through networks of relationships are not simple or straightforward. Children (particularly boys) who have had difficult home relationships but a positive teacher–child relationship are capable of self-regulation. Likewise, children (particularly girls) who have had difficult home relationships but close friends do have close friendships as adolescence.

Many of these children began child care as infants and remained in full-time child care throughout their preschool years. Very few of these child care situations were either very poor or very good in quality. Despite our worries as advocates and researchers about this child care history (Belsky, 1988), there were no discernable influences of child care history per se in the relationship quality of these children. However, their experiences of emotional regulation, of friendship, and of child–teacher relationships within child care do appear to have some predictive influences

on their relationships and self-regulation as adolescence. In summary this analysis tells a complex story—of gender differences, of early and later experiences, and of both primary and compensatory relationships.

Current theoretical formulations suggest close associations between affective relationships with adults, emotional regulation, and friendships. Attachment theory formulations suggest similar antecedent pathways for both self-regulation and friendship relationships. Children who experience secure child–adult attachment relationships are expected to self-regulate in terms of both compliance and emotional regulation (Cassidy, 1994). In this formulation two processes are used to account for the predictive outcome. One process rests on the desires of the child part of the affective partnership. Children who have secure child–adult relationships are expected to act in ways that maintain harmonious adult–child relationships. Therefore they will attempt to self-regulate because they desire to maintain the loving relationship with the person asking them (or expecting them) to regulate their behavior. The other process rests on the capacities of the adult partner. Adults who are capable of constructing secure child–adult attachment relationships are assumed, because of their own state of mind about caregiving and their openness in emotional communication, to as well help children move toward early emotional regulation because they use emotional coaching and other strategies to assist children in achieving emotional regulation.

Children who experience secure child–adult attachment relationships are expected to use the working models derived from these relationships to establish positive relationships with peers (Howes, 1999). If children expect others to be attentive, positive, and enjoyable social partners, then they will act in ways that help establish positive relationships with peers.

Other theoretical formulations (Shonkoff & Phillips, 2000) suggest that being better at behavioral and self-regulation helps a young child be liked by potential play partners and friends. Establishing early friendships is a difficult developmental task due to unsophisticated capacities for communication and social interaction (Howes, 1988). Children who struggle with poorly regulated behaviors and emotions of themselves or their partners have even more difficulty than children who are well regulated in establishing and maintaining patterns of interaction that form the context for friendship development.

Given these theoretical formulations it is not surprising that we found that children who were better at emotional regulation at age 4 also had higher close friendship ratings again at age 4. But by age 14 only boys who were better at self-regulation were also higher in friendship quality ratings. We also found significant predictive associations among affective child–adult relationships and contemporary and longer term regulation and friendships. In our earlier work with these participants we reported that at age 4 children who had higher emotional regulation scores also were more likely to be secure with their mothers (Tonyan & Howes, under review) and children who had closer friendships were more likely to be secure with their teachers (Howes *et al.*, 1994). In the current analysis we found that

self-regulation at age 14 was predicted by the interaction of mother and teacher relationship quality and the interaction of gender and early emotional regulation. We also found that friendship quality at age 14 was predicted by the interaction of mother and friend relationship quality and the interaction of gender and early friendships.

These findings suggest that the current theoretical formulations, primarily from attachment theory, that link affective child–adult relationships, behavioral and emotional regulation, and friendship quality are not sufficient to explain the more complex set of associations found in our work. Gender, the adult person involved in the affective relationship, and friends as well as adults must be considered to fully explain the patterns in our data.

We found, as have many researchers and theory-builders in the past 2 decades, the constructs and measurement tools of attachment theory to be most useful in describing close relationships. We believe that without these attributes of attachment theory we could not have described the close relationships children formed with mothers, teachers in child care and elementary school, and indeed their close friendships with peers. In particular, the attachment theory construct of security has worked well in this longitudinal look at affective relationships of these children.

What would not have worked well if we had been strict attachment theorists is assuming the dominance of the early child–mother attachment relationship. As we found in our planned regression models, we could not predict self-regulation or friendship quality at age 14 from early child–mother attachment security. Children’s history of child–mother attachment rather than early attachment security was a better predictor of both outcomes in the model that only used child–adult attachment relationships as predictors. Self-regulation and friendship quality in adolescence was best predicted by the more complex final inclusive regression model and our analysis of compensatory relationships when we considered other-than-mother affective relationships and gender.

To consider other-than-mother affective relationships and gender, attachment theory must be placed within a larger sociocultural contextual theory. To place attachment theory in a larger sociocultural context in this study is to recognize that participating families used other-than-mother caregivers. We used child care as a context for studying development: By examining relationships and behaviors formed in child care, we increased our explanatory power for understanding social competence a decade later. In the decade and a half since we began this work, we have been able to advance our understandings of how other-than-mother attachment relationships are formed by studying the sociocultural context of child care (Howes, 1999).

Gender and gender in the context of child care is another matter. We did not anticipate the influence of interactions between gender and experiences within child care with friends and emotional regulation when we designed this study, nor did gender emerge as particularly important in our work with this data when the



children were younger (Howes *et al.*, 1994, 1998). It was only when we analyzed our data using gender as a variable, as good developmentalists are taught to do, that these complicated interactions emerged. We suspect that child care teachers in the mid 1980s had a particular set of beliefs about gender and expectations that formed a backdrop for the children's development of emotional regulation and friendships. Following Maccoby (1998), we know that the children in our study were in sex-segregated peer groups with their own rules of conduct for acting out mommy and daddy, firefighter, wonder woman, and evil/wild man. And we suspect that if we were to examine more closely these contexts we might be able to unravel and better understand the predictive interactions between early behaviors and gender. These data are, of course, lost to us. We hope that future researchers will follow these leads.

To place attachment theory in a larger sociocultural context in future work is to go beyond recognizing that participating families used other-than-mother caregivers. Other-than-white affluent families organize the care of children in many ways and infrequently with mother as the only caregiver. Future work to build theory in the area of networks of affective relationships must examine networks of close affective relationships with adults—mothers, fathers, grandmothers, aunts, and close adult friends and with children—peers in and out of child care, cousins, siblings, and close family friends. We hope that this work will point future researchers in productive directions.

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