DEVELOPMENTAL NEUROPSYCHOLOGY, *15*(3), 327–349

Idiom Comprehension in Children and Adults With Unilateral Brain Damage

Daniel Kempler

Department of Otolaryngology
School of Medicine and School of Gerontology
University of Southern California

Diana Van Lancker

Department of Neurology
University of Southern California

Virginia Marchman

School of Human Development
University of Texas at Dallas

Elizabeth Bates

Departments of Psychology and Cognitive Science
University of California, San Diego

The comprehension of literal and familiar idiomatic (nonliteral) expressions was assessed in (a) a group of adults with left hemisphere (LH) or right hemisphere (RH) brain damage, (b) a group of children who suffered perinatal brain damage to either the left or right hemisphere, and (c) a control group of healthy children and adults. The normal developmental data showed an expected dissociation between literal and idiomatic phrase comprehension, with idiomatic expressions being learned significantly later. The data from adults with brain damage replicated previous findings of a double dissociation along hemispheric lines, with idiomatic expressions being more impaired by RH than LH damage. In contrast with the adults, the children with focal brain damage showed no association between side of brain damage and comprehension of either familiar idiomatic or literal language. The data support a theory of developmental plasticity of language functions in both the LH and RH.

Requests for reprints should be sent to Daniel Kempler, Speech Pathology OPD 2P52, LAC+USC Medical Center, 1200 North State Street, Los Angeles, CA 90033. E-mail: kempler@hsc.usc.edu

The superiority of the left cerebral hemisphere (LH) for production and comprehension of language is practically axiomatic and has been supported by data from both normal and impaired populations (e.g., Bryden, 1982; Goodglass, 1993; Lenneberg, 1967). There are, however, aspects of language that appear to be controlled by the right hemisphere (RH). For instance, overlearned sequences (e.g., counting), swearing, and social interaction formulas may be subserved by the RH in right-handed adults. Evidence supporting the RH bases for certain portions of language comes most convincingly from the selective preservation of these aspects of language after LH stroke or when the LH is temporarily anesthetized as in the Wada procedure (e.g., Kinsbourne, 1971). Van Lancker and Kempler (1987) investigated the hemispheric dominance of another set of linguistic phenomena, namely familiar nonliteral phases as instantiated by idioms and proverbs. Using a picture-pointing comprehension task, they found a double dissociation for literal and familiar idiomatic expressions in a population of LH- and RH-damaged patients: Patients with RH damage (RHD) performed more poorly on idiomatic than literal items, and the opposite pattern was observed in patients with LH damage (LHD). These results extended our understanding of the range of linguistic phenomena that utilize the nondominant RH in the adult and form the basis of the adult–child comparisons that we present later.

In contrast with the relatively clear dissociations that are observed in adult patients with LH or RH injury, the literature on linguistic performance of children with homologous injuries gives very little evidence for specific lesion–symptom mappings (Alajouanine & Lhermitte, 1965; Almli & Finger, 1984; Annett, 1973; Day & Ulatowska, 1979; Hecaen, 1976, 1983; Hecaen, Perenin, & Jeannerod, 1984; Isaacson, 1975; Kohn, 1980; Marchman, Miller, & Bates, 1991; Rasmussen & Milner, 1977; Riva & Cazzaniga, 1986; Riva, Cazzaniga, Pantaleoni, Milani, & Fedrizzi, 1986; Smith, 1984; Vargha-Khadem, Isaacs, Van der Werf, Robb, & Wilson, 1992; Vargha-Khadem & Polkey, 1992; Woods & Teuber, 1978; for another view, see St. James-Roberts, 1979). Although specific lesion–symptom mappings are seldom reported for children with brain damage, several important findings do emerge from the literature. First, most children with early unilateral brain injury go on to achieve levels of language performance that are within the normal range. This does not mean that early brain damage has no effect on language outcomes. However, the impairments that are observed in children with this neurological history are more subtle and less persistent than the outcomes observed in adults with homologous injuries (for reviews, see Eisele & Aram, 1995; Fletcher, 1993; Riva, Milani, Pantaleoni, Devoti, & Zorzi, 1992; Satz, Strauss, & Whitaker, 1990; Stiles, 1995; Stiles & Thal, 1993; Vargha-Khadem & Polkey, 1992), and many children show no impairments at all (Dall'Oglio, Bates, Volterra, DiCapua, & Pezzini, 1994; Feldman, Holland, Kemp, & Janosky, 1992; Vargha-Khadem, Isaacs, Papaleoudi, Polkey, & Wilson, 1991). Results vary from one study to another, depending on the measures used, the age range of interest,

and the inclusionary and exclusionary criteria adopted in the study (e.g., age at onset, etiology, presence of seizures). In some studies, there are no significant differences of any kind between the focal-lesion population and normal controls. In other studies, children with focal brain injury score significantly lower as a group on a number of different language and cognitive measures, compared with controls matched for age, sex, and social class (i.e., brain damage often does exact a cost). However, one conclusion is clear across all these studies: Children with a history of early focal brain injury, as they develop, rarely meet the criteria required for a diagnosis of aphasia.

Second, there has been an absence of clear-cut differences between children with LH versus RH injury. To be sure, some studies do report differences in the predicted direction, especially for the effects of LH damage on expressive language, particularly for tasks that involve subtle morphosyntactic contrasts (e.g., Aram, Ekelman, Rose, & Whitaker, 1985; Aram, Ekelman, & Whitaker, 1986, 1987; Aram, Meyers, & Ekelman, 1990; Dennis, 1980, 1988; Dennis & Kohn, 1975; Dennis, Lovett, & Wiegel-Crump, 1981; Dennis & Whitaker, 1976, 1977; but see Bishop, 1983). However, the LH findings are often complicated by other factors. For example, Aram and Eisele (1994b) suggested that damage to anterior subcortical structures may be the strongest predictor of residual language and cognitive deficits in both LH- and RH-lesioned children. A small group of LHD children with anterior subcortical damage do present with more language-specific deficits than RHD children with comparable damage (Aram & Eisele, 1994a, 1994b; Aram, Rose, Rekate, & Whitaker, 1983; Eisele & Aram, 1995). Reilly, Bates, and Marchman (1998) reported a small but reliable disadvantage in production of complex syntax for LHD children under age 5 but no effects of lesion site whatsoever in children above age 5. The issue is complicated even further by occasional findings in the opposite direction, that is, a significant disadvantage for children with RHD on some receptive language tasks (Eisele & Aram, 1993, 1994; Thal et al., 1991; Trauner, Chase, Walker, & Wulfeck, 1993; Wulfeck, Trauner, & Tallal, 1991).

Earlier reports on recovery of language in children with focal brain injury led some investigators to conclude that the two hemispheres are initially equipotent for language (Lashley, 1950, 1951; Lenneberg, 1967; for some related comments, see Caplan & Hildebrandt, 1988; Kennard, 1936). On this view, the familiar pattern of LH specialization does not emerge until some point after language has been acquired. Indeed, Lenneberg went so far as to suggest that the acquisition of language may be the cause rather than the effect of lateralization. Most modern investigators dispute this claim, because there is at least some evidence for early differences in lateralization and for early LH specialization for processing speech stimuli. Such evidence includes those studies that do show a disadvantage for children with LHD (cited previously), but it also includes neuroanatomical studies demonstrating structural differences between the LH and RH at birth, in the first years of language learning, or both, with special reference to perisylvian cortex

(Geschwind & Levitsky, 1968; Witelson & Kigar, 1988), together with electrophysiological studies suggesting a differential response of the LH to speech sounds in normal infants (Molfese, 1989, 1990; Molfese & Segalowitz, 1988).

The purposes of this research are, first, to replicate Van Lancker and Kempler's (1987) findings with an expanded and improved assessment measure[1] and, second, to compare the adult data with data from children who have suffered unilateral brain damage early in life. The direct comparison between child and adult brain-damaged groups allowed us the rare opportunity to examine the different effects of brain damage in childhood versus adulthood on the same measure and to explore developmental plasticity for an aspect of language processing that was (to the best of our knowledge) never studied before from this point of view.

GENERAL METHOD

The Familiar and Novel Language Comprehension Test (FANLC) uses a picture-pointing comprehension procedure that does not require a verbal explanation or metalinguistic comment as part of the response. The task is easily administered to normally developing children as young as 3 years but is also appropriate for normal and brain-damaged adults. The test includes procedurally identical literal and idiomatic comprehension tests, using items that are matched in phrase length, word frequency, and overall grammatical structure.

The test consists of 40 items: 20 familiar idiomatic phrases and 20 literal sentences (see Appendix).[2] The 20 idiomatic expressions were selected to be highly recognizable (i.e., familiar) to healthy adults. The foils (wrong answers) for the idiomatic items include two choices that are related to individual words in the stimulus sentence and one other foil that is related to the figurative meaning of the familiar phrase. For instance, for the idiomatic item shown in the top of Figure 1, "She's got him eating out of her hand," the correct choice shows a man showering a woman with gifts and affection (lower right panel); two foils include representations of individual words (in one a bird is eating from a bird feed bin, and in the other a girl is eating out of her own hand); and the fourth picture shows a man ignoring a woman (i.e., she does not have him eating out of her hand). There is no depiction of a correct literal interpretation (i.e., a picture of a man eating out of a woman's hand). For the novel portion of the task, 20 literal sentences were constructed to match the idioms in overall length (number of words), surface grammatical structure, and word frequency. In the literal portion, the foils are grammatical permutations of the stimulus sentence (e.g., subject–object reversal and adjective misassignment; see Figure 1).

The test is administered individually. Each participant is seated alone with an experimenter in a quiet room. The participant is shown a set of four line drawings and asked to select the one that matches a sentence read aloud by the examiner. For the idiom portion of the task, participants are told that they might recognize some of the sentences that are read by the experimenter. Two sample items are used to demonstrate the task prior to administering the test items. On each sample item, the participant is shown the correct answer (if it was not already chosen), and in all

[1]Van Lancker and Kempler (1987) compared comprehension of 18 idioms with comprehension of 10 literal sentences. In addition to having relatively few and an uneven number of stimuli on each subtest, the novel sentences were not matched to the idioms in length, word frequency, or grammatical structure. The test used in this study (described next) included more items, and the literal and idiomatic items were matched on several linguistic parameters.

[2]The familiar stimuli were not chosen to represent specific types of nonliteral expressions (e.g., proverbs, idioms, social interaction formulas). Note also that it is not always obvious to which category a familiar expression belongs, and some expressions may belong to more than one category.

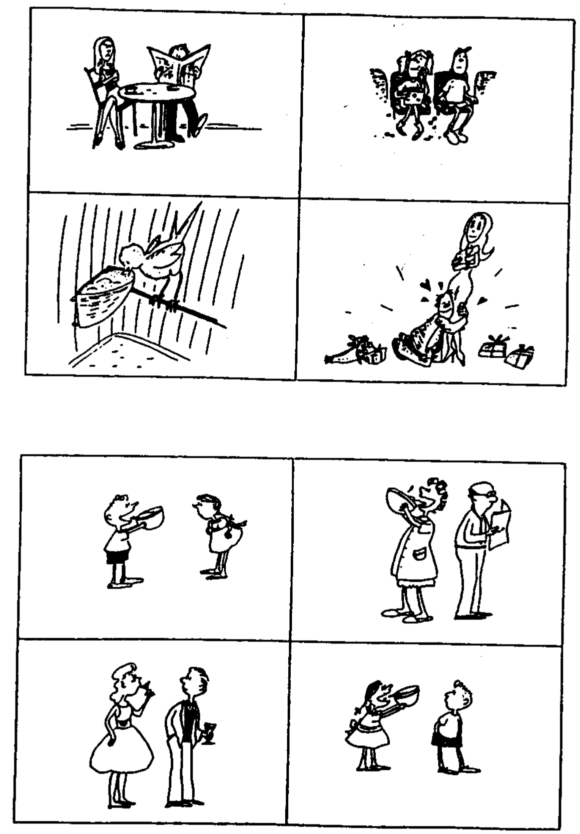

FIGURE 1 Picture array for the idiomatic phrase "She's got him eating out of her hand" (upper panel) and the literal phrase "He sees her drinking from a bowl" (lower panel).

cases, an alternative phrasing of the target sentence was provided (e.g., "That's right! 'He's got his head in the clouds' is another way to say 'He's daydreaming.'"). Prior to the literal portion of the task, the participants are told that they are simply to choose the picture that best matches the sentence read by the experimenter. During the testing, neutral but encouraging feedback is provided for all test items (e.g., "uh huh," "good answer!"). The order of administration of the two portions of the task is counterbalanced, and, when possible, separated by another non-picture-pointing task.

EXPERIMENT 1: ADULT BRAIN-DAMAGED PARTICIPANTS

Participants

Participants were 41 adults with unilateral strokes. Twenty-five had lesions in the LH (*M* age = 58 years), and 16 had RH lesions (*M* age = 65 years). All lesions were considered to be of rapid onset; brain tumors, progressive central nervous system disease, and severe seizure disorders were exclusionary criteria. Side of brain injury was confirmed by neurologic examination and available radiologic reports (CT scan, MRI). Performance of the adult brain-damaged group was compared to data from 42 healthy older adults (ages = 40–79 years, *M* = 61 years), who performed essentially at ceiling (*M* = 97% correct; all normal participants scored 85% correct or better on both tests). The LHD patients were referred to our clinics due to aphasia and hence were known to have a language problem; the RHD participants were recruited by virtue of their RHD, not because of any known language processing or production problems.

Results

A 2 (literal vs. idiomatic) × 2 (LHD vs. RHD) analysis of variance (ANOVA) revealed no main effect of lesion side, $F(1, 39) = 1.5$, $p = .23$, but a significant main effect of phrase type, $F(1, 39) = 5.34$, $p = .02$, reflecting slightly better performance on literal phrases. Most important, there was a significant Phrase Type × Lesion Side interaction, $F(1, 39) = 55.79$, $p < .0001$, reflecting better performance by LHD participants on idiomatic items and better performance by RHD participants on literal sentences. Post hoc comparisons showed that the interaction represents a true double dissociation; the LHD group was significantly worse than the RHD group on the literal phrases, $t(39) = 2.7$, $p = .005$, and the RHD group was significantly worse than the LHD group on the idioms, $t(39) = 5.5$, $p = .001$. The data are presented in Figure 2.

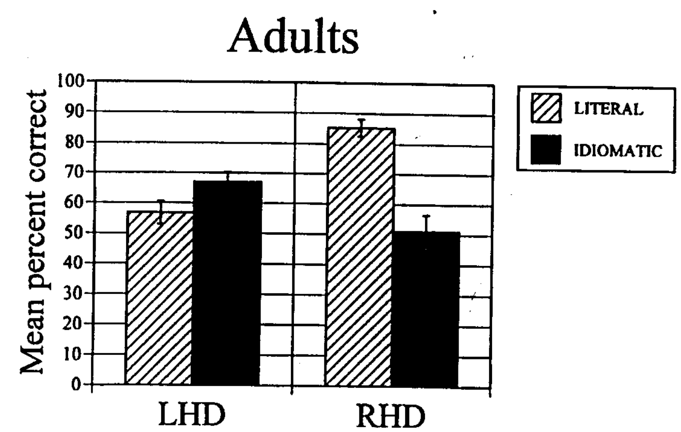

FIGURE 2 Comprehension (mean percent correct and standard error) of adults with left hemisphere damage (LHD) versus right hemisphere damage (RHD) for literal and idiomatic phrases.

Discussion

The double dissociation suggests that literal and idiomatic language are mediated by different cerebral structures in the adult. This replicates and extends previous findings (e.g., Myers & Linebaugh, 1981; Van Lancker & Kempler, 1987; Winner & Gardner, 1977) with additional participants and another protocol. The basis of the superiority of the LH for speech and literal language is well known, and several coherent theories have been put forth to explain this phenomenon (e.g., Kimura, 1976; Kimura & Archibald, 1974). The basis of the RH dominance for idiomatic language is not as well studied.

To consider why the RH may preferentially support the learning and use of idiomatic language, it helps to consider the distinguishing properties of these expressions along with the known strengths of RH cognitive processing. Familiar nonliteral expressions, including speech formulas ("What's up?" and "What a small world!"), idioms ("I've got a bone to pick with you"), and proverbs ("You can't teach an old dog new tricks") share three characteristic features that distinguish them from literal expressions and make them prime candidates for RH processing: stereotyped form, conventional contextualized meaning, and intrinsic affective content.

Stereotyped form refers to the structural properties of the expressions, including relatively fixed word order (e.g., "She's got him eating out of her hand" not "It's out of her hand that he's eating"), unique lexical items (e.g., "I'll be *hornswaggled!*"), words that cannot be replaced with a synonym (e.g., "I'd like to give you a piece of my mind" but not "I'd like to bestow upon you a morsel of my mentation"), and a limited range of prosodic patterns (e.g., "He's living *high* on the *hog*" not "He's *living* high on the hog"). Because of stereotyped form, idiomatic expressions for the most part are produced and understood as unitary elements, not as a concatenation of words combined by grammatical rules (Van Lancker, Canter, & Terbeek, 1981). For instance, "The farmer kicked the bucket" means "The farmer died," and substitutions of lexical items or grammatical permutations make the (intended) idiomatic meaning impossible, as in "The farmer kicked the pail" or "The bucket was kicked by the farmer."

Although the meanings of familiar nonliteral expressions are not generally transparent from lexical and grammatical analysis, they are complex, rich in detail, and tightly bound to nonlinguistic and linguistic contexts. Appropriate use requires understanding sociolinguistic considerations of register and other pragmatic features of discourse. For example, the utterance "While the cat's away, the mice will play" appropriately refers to a situation that involves subordinates who do not obey the rules laid out by others in a position of relative authority when the authority is absent; and the expression "What a small world" is appropriate only when the speaker is surprised by a chance meeting with an acquaintance.

Last, the majority of familiar nonliteral expressions contain intrinsic affective content. On the one hand, literal expressions have the opportunity to be neutral. For instance, "the cat is on the mat" has no intrinsic emotional significance and needs special intonation or additional words (e.g., "The darn cat is on the mat again!") to imbue it with emotional content. In contrast, most familiar expressions inherently contain emotive significance, such as "I'd like to give you a piece of my mind," which automatically expresses anger and frustration, or "Just in the nick of time," which unavoidably conveys relief.

Our neuropsychological account draws a parallel between these three characteristics of idiomatic expressions and the preferential processing abilities of the RH. The RH has been shown to be particularly involved in processing whole forms without analysis (Bogen, 1969; Bradshaw & Nettleton, 1983; Bryden, 1982), understanding contextual information and semantic inference (Brownell, Potter, Bihrle, & Gardner, 1986; Molloy, Brownell, & Gardner, 1990), and processing emotional information (Cimino, Verfaellie, Bowers, & Heilman, 1991; Gainotti, Caltagirone, & Zoccolotti, 1993; Wechsler, 1973). The finding that damage to the RH appears to selectively disrupt comprehension of familiar nonliteral expressions, whereas LHD preferentially impairs comprehension of literal expressions, supports a RH hypothesis of idiomatic language processing.

EXPERIMENT 2: DEVELOPMENT IN NORMAL CHILDREN

Before we compare adults and children with homologous LH or RH lesions, it is important to examine the different developmental trajectories that normal children display while learning to comprehend literal versus idiomatic phrases. The literature to date on the acquisition of metaphors, idioms, and other nonliteral expressions suggests that these forms develop relatively late compared with semantically and syntactically transparent literal expressions (e.g., Ackerman, 1982; Gibbs, 1987; Levorato, 1993; Nippold, 1985; Prinz, 1983). In this experiment, we assessed these developmental differences with the FANLC to provide normative information for the interpretation of findings with brain-injured children.

Participants

Normative (control) participants were 250 healthy children, adolescents, and young adults between the ages of 3 and 19 years. All were native speakers of Standard American English and none had documented brain injury, depression, or speech or language difficulties. Each participant was administered the FANLC in the standard manner (as described previously). For analyses, participants were grouped by age in years.

Results

Figure 3 presents the mean performance in each age group for the literal and idiomatic portions of the FANLC. Literal language comprehension is above chance (chance = 25%) from the earliest test age (only three children—1% of the sample—performed at or below chance on the literal items). Performance on the literal subtest continued to improve across the age groups, reaching adult levels (> 90% correct) at 8 years of age. In contrast, a total of 62 children (25%) performed at or below chance on the idiomatic items. Only at 8 years of age, when they reached near-ceiling level on the literal items, did children reliably perform better than chance on idiomatic expressions. The comprehension of the idiomatic items gradually improved with age, reaching adult levels of performance at 15 years. Therefore, it is not until well into adolescence that performance on both types of expressions finally reached a level that is indistinguishable from performance by adult native speakers. Until that point (15 years), there was a dissociation between the two types of expressions, with literal expressions being better understood than idiomatic phrases in every age group.

A multivariate analysis of variance (MANOVA) revealed a significant within-subject main effect of task, $F(1, 13) = 714.14$, $p < .001$, indicating that children did considerably poorer overall on the idiomatic compared to the literal items. This trend was substantiated by the fact that 91% of these participants performed better on the literal than the idiomatic items. A significant Age Group × Task interaction, $F(13, 248) = 31.68$, $p < .001$, offered further evidence that these two aspects of language comprehension follow different developmental trajectories. In this case, the interaction was because idiomatic language comprehension re-

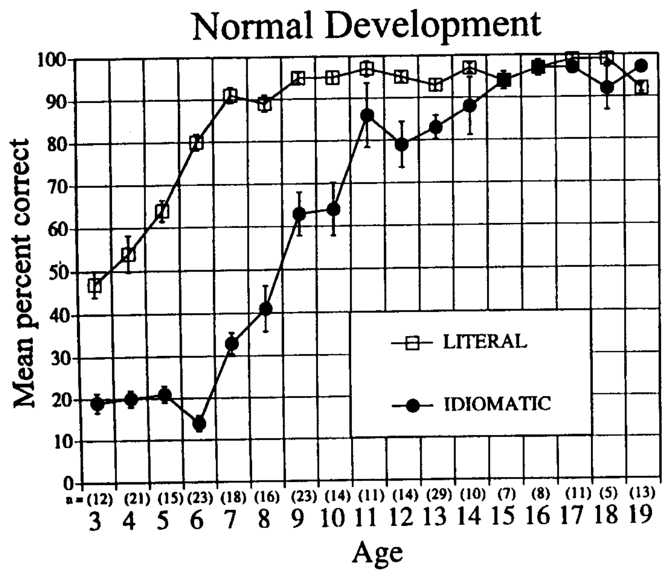

FIGURE 3 Comprehension (mean percent correct and standard error) of literal and idiomatic phrases of 250 normally developing children, adolescents, and young adults between 3 and 19 years of age. The number of participants tested at each age is given in parentheses.

mained at chance during the time that children were developing literal comprehension abilities. Idiomatic language abilities improved only after the children performed at ceiling on the literal phrases.

Discussion

These findings for normal children are compatible with studies of the development of metaphor and proverbs, reflecting the relatively late development of nonliteral language (e.g., Nippold & Haq, 1996; Nippold, Leonard, & Kail, 1984; Nippold & Martin, 1989; Nippold, Martin, & Erskine, 1988; Winner, 1988). By middle childhood, many children can accurately comprehend most literal and some nonliteral language, although it is a considerably longer time before they can do both with the same degree of accuracy as adult speakers.

Two different types of explanations can be constructed to account for these data: (a) The dissociation appeared because the two types of language are acquired by different cognitive (and neurological) mechanisms, or (b) idiomatic expressions are more difficult to understand than matched literal sentences, because they are relatively rare, particularly when compared with individual words and specific (common) grammatical structures. Evidence for two distinct cognitive mechanisms might be inferred from the adult brain-damage data, which suggested that

these two aspects of language are subserved by different neurocognitive substrates. If literal and nonliteral language are differentially mediated by the LH and RH, respectively, then differential maturation rates of these two hemispheres may account for developmental dissociations. In fact, there is some evidence that the LH and RH mature at different rates (e.g., Corballis & Morgan, 1978). This assumes that the RH and LH preferences are there from birth and predicts that literal and nonliteral language would be differentially disrupted by early LHD versus RHD (similar to the adult pattern). This position can be tested with the child brain-damaged group, to which we now turn.

EXPERIMENT 3: DEVELOPMENT IN CHILDREN WITH FOCAL BRAIN INJURY

Participants

Participants in this study were 29 children with unilateral brain injury acquired before 6 months of age. Eighteen had lesions in the LH, 11 in the RH. Mean age at testing was 8 years ($SD = 1.2$; range = 5–10 years). There was no age difference between the children with LHD versus RHD, $t(27) = -0.086, p > .05$. All lesions were considered to be of rapid onset; brain tumor, arteriovenous malformations, progressive central nervous system disease, and severe seizure disorders were exclusionary criteria. Location and extent of brain injury were confirmed by CT or MRI. Each participant was administered the FANLC in the standard manner (as described previously). Further information about these participants is provided in Table 1.

Results

Percentage correct scores for the LHD and RHD children are presented in Figure 4. A 2 (literal vs. idiomatic) × 2 (LHD vs. RHD) ANOVA showed no effect of side of lesion, $F(1, 27) = 1.5, p = .23$. There was a significant effect of task, $F(1, 27) = 74.8$, $p = .0001$, reflecting worse performance overall on the idiomatic phrases but no Task × Group interaction, $F(1, 27) = 1.5, p = .23$. In other words, independent of lesion side, all the children performed more poorly on the idiomatic than literal items.

As we saw in Experiment 2, this developmental disadvantage for idiomatic items was also observed in children who were neurologically intact. How does performance by children with focal brain injury compare with normally developing controls? To facilitate comparisons across age groups and across tasks, taking into account the range of normal performance at these ages, percentage correct scores for the brain-damaged groups were converted to z scores. The z scores for each individual participant were based on the mean and standard deviation of normal performance for his or her age group and for literal and idiomatic phrases, respectively. Figure 5 displays mean z scores for children with LH versus RH lesions.

TABLE 1
Children With Focal Lesions

Participant	*Sex*	*Side of Lesion*	*Lobes Involved*	*Hemiparesis*	*Handedness*	*Age at Test*
GC	M	Left	T	Right	Left	8
SK	M	Left	NA	Right	Left	6
LE	F	Left	P, O	None	Right	8
KQ	M	Left	T	None	Left	8
JQ	F	Left	T, P, O	NA	NA	9
ES	M	Left	F	Right	Left	5
SB	M	Left	P	Right	Left	10
DV	F	Left	F, T, P, O	NA	NA	9
RG	F	Left	F	None	Right	8
JP	M	Left	F, T, P, O	Right	Left	8
PA	F	Left	F, T, P, O	Right	Left	8
MS	M	Left	F, T, P	Right	Left	8
NP	F	Left	T	Right	Left	8
AS	M	Left	F, T, P	None	NA	9
MD	M	Left	F, T, P, O	None	NA	7
AG	M	Left	F	None	Left	8
LL	F	Left	P	Right	Left	6
AM	M	Left	T, P, O	Right	Left	7
RD	F	Right	F, T, P	Left	Right	9
PJK	M	Right	F, T, P	Left	Right	10
AP	M	Right	F, T, P	NA	Right	7
JD	F	Right	T, P	None	Left	8
CT	M	Right	F, T, P, O	Left	Right	7
SW	F	Right	F, T, P, O	Left	Right	6
AS	F	Right	F, T, P, O	Left	Right	8
MG	M	Right	P	Left	Right	8
NS	M	Right	F	Left	Right	8
EM	F	Right	P	Left	Right	9
MB	M	Right	F, P	Left	Right	6

Note. For Lobes Involved, F = frontal; T = temporal, P = parietal; O = occipital. NA = data not available.

A 2 (literal vs. familiar) × 2 (LHD vs. RHD) ANOVA using the age-corrected z scores revealed a main effect of phrase type (lower z scores on literals than idioms), $F(1, 27) = 28.7, p < .0001$, but no significant effect of lesion side, $F(1, 27) = 1.3, p = .27$, and no Lesion Side × Phrase Type interaction, $F(1, 27) = 1.4, p = .17$. These findings mirror the results obtained with raw scores in two respects: (a) There is no overall difference between LHD and RHD children in level of performance, and (b) there is no double dissociation between literal and idiomatic phrases in children with LH versus RH lesions. However, the z score analysis revealed a pattern of performance that was not apparent with raw scores: Relative to normal controls, the brain-injured children were delayed on literal phrases but showed no delay whatsoever on idiomatic phrases. In fact, the average z score on idiomatic phrases was 0.054 for LHD children and –0.119 for RHD, indicating age-appropriate performance. By contrast, the brain-injured children performed below normal controls in the comprehension of literal phrases, with mean z scores of –2.271 for RHD and –1.201 for LHD. The relatively poorer performance on lit-

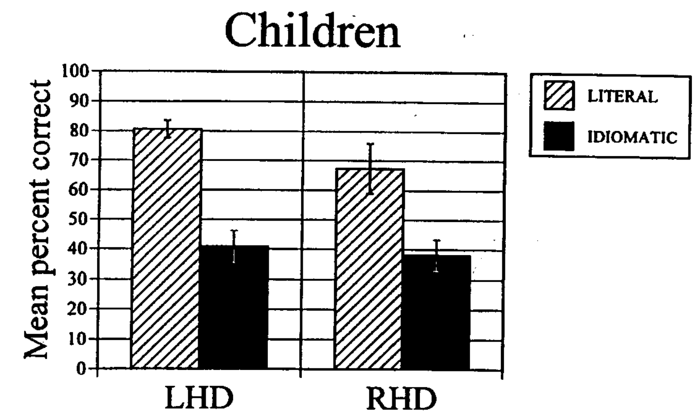

FIGURE 4 Comprehension (mean percent correct and standard error) of children with left hemisphere damage (LHD) versus right hemisphere damage (RHD) for literal and idiomatic phrases.

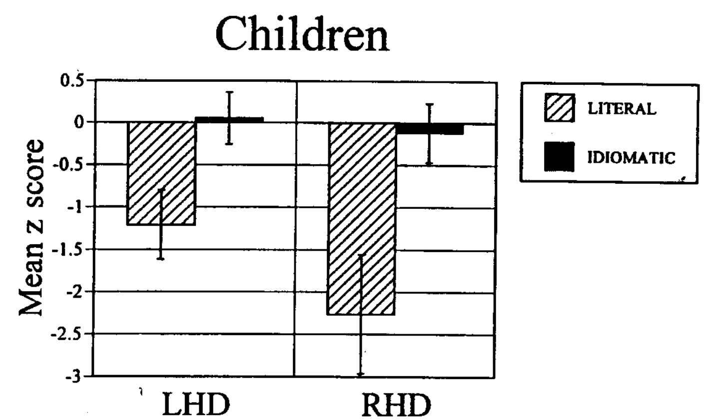

FIGURE 5 Comprehension (z score and standard error) of children with left hemisphere damage (LHD) versus right hemisphere damage (RHD) for literal and idiomatic phrases, converted to z scores, based on healthy age-matched children.

eral (than idiomatic) utterances revealed by the z score analysis could potentially be attributed to the fact that normal children were not above chance on the idiomatic items until 7 years of age. That is, it is possible that the normal performance of the brain-damaged children on idiomatic phrases could be due to the fact that the normal and brain-damaged children are all at chance (basically guessing) during this period of development. To address this concern, we reanalyzed the data, including only children 8 years and older, ages at which normal children are above chance on the idiom task. The performance of this subgroup of 20 brain-damaged children (13 with LHD, 7 with RHD), was the same as the larger group: a main effect of phrase type, $F(1, 18) = 15.5, p < .001$, no effect of lesion side ($F < 1$), and no interaction, $F(1, 18) = 1.8, p = .19$. Therefore, although these data can be considered preliminary where the idiomatic phrases are concerned (because our brain-damaged children were still in the age range where normal children are developing knowledge of idiomatic expressions), differences between individuals with perinatal LHD and RHD are not apparent in these data.

Extrapolating from the adult aphasia literature, we might have expected significantly worse performance on literal phrases for children with LHD. Instead, the data in Figures 4 and 5 indicate a slightly greater delay for the RH sample in comprehension of literal expressions. This trend runs in precisely the opposite direction from what we would expect based on studies of adults, but it is compatible with recent reports indicating that RHD children are more impaired in comprehension tasks (Bates et al., 1997; Eisele & Aram, 1993, 1994, 1995; Thal et al., 1991). Because the ANOVA did not yield a main effect of group or a Group × Task interaction, this trend should be interpreted with caution. However, we did permit ourselves a post hoc t test comparing LHD and RHD children on comprehension of literal expressions. The result missed significance by a two-tailed test, $t(27) = 1.72$ $p = .096$.[3]

We conducted a series of ancillary analyses for the brain-damaged children, asking whether differences in performance might reflect differences in lesion size or intrahemispheric lesion site. Previous studies of children with early focal brain injury yielded little or no evidence for specific effects of lesion site or size on performance in language tasks, and this study was no exception. We found no evidence for effects of lesion size and no effects of frontal, temporal, or parietal involvement. However, studies by Reilly et al. (1998) and Bates et al. (1997) showed that specific effects of lesion site can be observed in children under 7 years of age. Because this study concentrated on children over 7 (only 5 of the 29 children were under 7), the period in which normal children master idiomatic forms, we may have fallen outside of the developmental window in which specific effects of lesion site are observed.

[3]The same difference would be significant by a one-tailed test, but, of course, we are not entitled to use a one-tailed test when we have two completely contradictory predictions!

Discussion

Children with early focal brain injury did not display the double dissociation between literal and idiomatic expressions that we observed in adults with homologous injuries. Performance by LHD and RHD children was strikingly similar; insofar as the two groups diverged at all, they diverged in precisely the opposite direction from brain-injured adults (i.e., worse performance on literal phrases in RHD children vs. worse performance on literal phrases in LHD adults). It appears that the specialization of function observed in LHD and RHD adults is not present early in life. This leaves us with one final question: Do children fare better than adults with homologous injuries?

COMPARISON BETWEEN ADULTS AND CHILDREN AND GENERAL DISCUSSION

A direct comparison of children and adults with focal lesions was carried out by transforming the adult percentage correct scores into z scores as well. An omnibus MANOVA, 2 × 2 × 2 (Age × Side × Phrase Type) revealed a main effect of age, $F(1, 66) = 63.6, p < .0001$, and a three way Age × Side × Phrase Type interaction, $F(1, 66) = 40.69, p < .0001$. The age effect reflects substantially worse performance by adults than children (when compared with normal performance for their age). The interaction documents that lesion side is relevant for adults but not for children (see Figure 6).

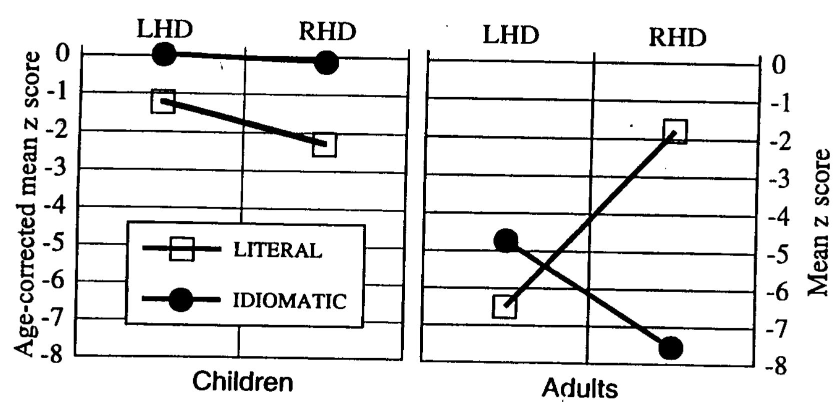

FIGURE 6 Comprehension (z score) of children with left hemisphere damage (LHD) right hemisphere damage (RHD; left panel) compared to adults with LHD and RHD (right panel).

To the best of our knowledge, this is the first time that age-corrected scores for brain-injured children and adults have been compared side by side on the same language measures (with the possible exception of studies using a single measure of verbal IQ across the life span). It is clear from Figure 6 that the effects of focal brain injury are far less serious in children (leading to *z* scores between 0 and –2) than they are in adults (where *z* scores averaged –6.5 for LHD adults on literal phrases and –7.8 for RHD adults on familiar phrases). Of course, we would obtain a very different picture if raw scores had been used: Absolute performance of brain-damaged children who are still acquiring their language was comparable to many adults with focal brain injury (Figures 2 and 4). If our brain-injured children stayed at the same level for the rest of their lives, they would eventually qualify for a diagnosis of aphasia. However, the small set of longitudinal studies that we currently have in hand for children with focal brain injury suggest that development continues throughout the life span, so that the average difference between brain-injured children and age-matched normal controls stays within the same range through development (Bates, Vicari, & Trauner, 1999; Losh, Reilly, & Bates, 1996; Rasmussen & Milner, 1977).

When the child data were compared to the adult brain-injured data (Figure 6), we saw very clearly that children developed language functions better than adults recovered them, regardless of lesion side. One possible explanation for this is that the time post-onset has been longer for the children; that is, they have had a longer time to recover from their injures. In fact, the time post-onset for the children was substantially longer (5–10 years, compared to $M = 14$ months for adults). However, most of the adults that we tested had settled into a chronic state, and there is little evidence in our data for variation in performance as a function of months or years post-onset (correlation between months post-onset and adult performance on idioms = .27, literals = –.14). Furthermore, it is difficult to quantify post-onset recovery time during a period in which normal children are still acquiring their language (i.e., the children are not in a "steady state"). For these reasons, we doubt that the difference between children and adults can be ascribed to any simple variable like time post-onset.

A more striking and telling difference between the children and the adults is the fact that the children and adults differed in the effects of lesion side: The Age × Lesion Side interaction in the adult data did not appear if injuries occurred in childhood, providing further evidence for the developmental plasticity of language functions. Research on brain-injured adults has raised the possibility that literal and idiomatic forms are processed by partially dissociable brain systems (i.e., the dual mechanism approach). The fact that idiomatic phrases are mastered many years after literal phrases in normally developing children is compatible with the dual mechanism approach. We therefore might have expected to find evidence for two dissociable forms of learning in children with damage to either the LH or RH. However, the absence of a LH–RH difference in the developmental focal-lesion sample provides little support for a simple dual mechanism view.

Can we explain these findings with a single language-learning mechanism? A general language-learning mechanism that relies on frequency information would have a more difficult time acquiring familiar nonliteral expressions simply because of the rarity of each expression in parallel to the protracted development for irregular grammatical forms and rare words. Some evidence for a single language-learning mechanism for both rare and frequent occurrences comes from a connectionist model of English past-tense morphology in which both the number of exposures to a particular lexical item, as well as exposure to different classes of forms, were found to be predictive of behavioral dissociations between regular and irregular verbs (Plunkett & Marchman, 1991). Using this model, we found different trajectories of learning for the two verb classes. The import of these findings lies in the fact that these dissociations were not attributed to two different mechanisms, but rather to differences in the frequency and distribution of relevant exemplars in the input to the language learner. If correct and if applicable to nonliteral expressions as well as grammatical morphemes, the developmental gap between literal and idiomatic language may not reflect separable and dissociable learning mechanisms, but rather natural dissociations between categories of linguistic input arising within a single learning mechanism. The different course of acquisition would be related to the frequency with which speakers are exposed to particular instances of a familiar nonliteral expression. Prior research has demonstrated that frequency (as gauged by familiarity ratings) does affect the learning of at least one type of nonliteral expression: Frequently used proverbs are learned earlier than rare proverbs (e.g., Nippold & Haq, 1996; Nippold & Taylor, 1995). However, the role of frequency in learning other types of nonliteral expressions, such as speech formulas and idioms, is not clear.

Other developmental factors may be at work as well, including a number of proposed "cognitive prerequisites" for nonliteral language interpretation that develop between 7 and 12 years of age. This stage of development, which coincides with the emergence of classical Piagetian concrete operational thought, is marked by full reversibility in thinking, including, for instance, understanding the relativity of viewpoints in social relationships. Proverbs and idioms initially require substituting one participant for another to arrive at the appropriate meaning. In "While the cat's away, the mice will play," for example, cognitive flexibility is necessary to determine the potential referents of *cat* and *mice.* In addition to operational thought, general conceptual maturity and experience with particular situations are also necessary to understand the complex, often emotionally charged, and social meanings associated with many familiar expressions. For instance, to fully understand "She's got him eating out of her hand," a child would have to understand not only that it is a nonliteral expression, but know also something of the politics of human relationships.

Phrase frequency and cognitive factors may contribute to the relatively late development of nonliteral expressions in normal children, but still do not explain the presence of a left–right difference in brain-injured adults and the absence of such a difference in children with homologous injuries. Although it is possible that the characteristic division of labor that we see in adults is the product rather than the cause of normal development, this distribution of labor presumably emerges from initial differences between the two hemispheres in the way information is processed. The evidence that we have presented here, together with other evidence from children with focal brain injury, lead us to conclude that these initial biases are relatively small and are only indirectly related to the final product.

SUMMARY AND CONCLUSIONS

We have demonstrated that the comprehension of literal and familiar nonliteral expressions develop in different periods of childhood. Although the bulk of literal language is mastered by age 8, the development of familiar nonliteral language competence barely begins before age 8 and is not completed until after age 15. These data are similar to earlier work in the field, documenting that idiomatic language is not fully acquired until adolescence. Our data go beyond existing data by using a relatively large set of familiar nonliteral expressions, a broad age range, and a direct literal comparison task. The relatively late development of familiar phrase comprehension may be attributable to (a) sufficient exposure to particular expressions, (b) conceptual maturity necessary to understand the complex meanings of these expressions, and (c) physical development of the RH substrate.

Data gathered from brain-injured participants can reveal the neurological bases of nonliteral language. In particular, because adults with RHD appear to have a relatively selective deficit in understanding idiomatic (vs. literal) expressions, we can conclude that the RH is preferentially involved in processing this particular type of language in the normal adult. This stands in contrast to the large body of data demonstrating the primacy of the LH in most other areas of language ability but is consistent with what we know about the processing preferences of the adult RH. The data from children with focal brain damage demonstrate that the adult pattern of deficits after LHD and RHD (LHD = literal language impairment; RHD = nonliteral language impairment) does not appear in children. One explanation for these noneffects in children is that both of these language functions (literal and idiomatic) can be subserved by the undamaged areas of the brain in either the LH or the RH. That is, the common adult patterns of hemispheric specialization for a broad range of language functions, although clearly preferred, are not the only option and are not inevitable.

ACKNOWLEDGMENTS

Partial support for this project came from the Center for the Study of the Neural Bases of Language (NINDS P50 NS22343) directed by Elizabeth Bates, Cross-Linguistic Studies of Aphasia (NIDCD RO1–DC00216) awarded to Elizabeth Bates, and from a fellowship to Virginia Marchman from the San Diego McDonnell–Pew Center for Cognitive Neuroscience.

We appreciate the help of Karen Klein, Veronica Nguyen, and Sara Jensen-Fritz in testing participants. Drawings are by Susan A. Black.

REFERENCES

Ackerman, B. P. (1982). On comprehending idioms: Do children get the picture? *Journal of Experimental Child Psychology, 33,* 439–454.

Alajouanine, T., & Lhermitte, F. (1965). Acquired aphasia in children. *Brain, 88,* 553–562.

Almli, C., & Finger, S. (1984). *Early brain damage.* New York: Academic.

Annett, M. (1973). Laterality of childhood hemiplegia and the growth of speech and intelligence. *Cortex, 9,* 4–33.

Aram, D. M., & Eisele, J. A. (1994a). Intellectual stability in children with unilateral brain lesions. *Neuropsychologia, 32,* 85–95.

Aram, D. M., & Eisele, J. A. (1994b). Limits to a left-hemisphere explanation for specific language impairment. *Journal of Speech and Hearing Research, 37,* 824–830.

Aram, D. M., Ekelman, B. L., Rose, D., & Whitaker, H. (1985). Verbal and cognitive sequelae following unilateral lesions acquired in early childhood. *Journal of Clinical & Experimental Neuropsychology, 7,* 55–78.

Aram, D. M., Ekelman, B. L., & Whitaker, H. (1986). Spoken syntax in children with acquired unilateral hemisphere lesions. *Brain and Language, 27,* 75–100.

Aram, D. M., Ekelman, B. L., & Whitaker, H. (1987). Lexical retrieval in left- and right-brain-lesioned children. *Brain and Language, 28,* 61–87.

Aram, D. M., Meyers, S. C., & Ekelman, B. L. (1990). Fluency of conversational speech in children with unilateral brain lesions. *Brain and Language, 38,* 105–121.

Aram, D. M., Rose, D. F., Rekate, H. L., & Whitaker, H. A. (1983). Acquired capsular/striatal aphasia in childhood. *Archives of Neurology, 40,* 614–617.

Bates, E., Thal, D., Trauner, D., Fenson, J., Aram, D., Eisele, J., & Nass, R. (1997). From first words to grammar in children with focal brain injury. *Developmental Neuropsychology, 13,* 447–476.

Bates, E., Vicari, S., & Trauner, D. (1999). Neural mediation of language development: Perspectives from lesion studies of infants and children. In H. Tager-Flusberg (Ed.), *Neurodevelopmental disorders* (pp. 533–581), Cambridge, MA: MIT Press.

Bishop, D. V. M. (1983). Linguistic impairment after left hemidecortication for infantile hemiplegia? A reappraisal. *Quarterly Journal of Experimental Psychology, 35A,* 199–207.

Bogen, J. E. (1969). The other side of the brain: II. An appositional mind. *Bulletin of the Los Angeles Neurological Societies, 324,* 191–219.

Bradshaw, J. L., & Nettleton, N. C. (1983). *Human cerebral asymmetry.* Englewood Cliffs, NJ: Prentice Hall.

Brownell, H. H., Potter, H. H., Bihrle, A. M., & Gardner, H. (1986). Inference deficits in right brain-damaged patients. *Brain and Language, 27,* 310–312.

Bryden, M. (1982). *Laterality: Functional asymmetry in the intact brain.* New York: Academic.

Caplan, D., & Hildebrandt, N. (1988). *Disorders of syntactic comprehension.* Cambridge, MA: MIT Press.

Cimino, C., Verfaellie, M., Bowers, D., & Heilman, K. (1991). Autobiographical memory: Influence of right hemisphere damage on emotionality and specificity. *Brain and Language, 15,* 106–118.

Corballis, M., & Morgan, M. (1978). On the biological basis of human laterality: I. Evidence for a maturational left–right gradient. *Behavioral and Brain Sciences, 1,* 261–269.

Dall'Oglio, A., Bates., E., Volterra, V., DiCapua, M., & Pezzini, G. (1994). Early cognition, communication and language in children with focal brain injury. *Developmental Medicine and Child Neurology, 36,* 1076–1098.

Day, P. S., & Ulatowska, H. K. (1979). Perceptual, cognitive, and linguistic development after early hemispherectomy: Two case studies. *Brain and Language, 7,* 17–33.

Dennis, M. (1980). Capacity and strategy for syntactic comprehension after left or right hemidecortication. *Brain and Language, 10,* 287–317.

Dennis, M. (1988). *Language and the young damaged brain.* Washington, DC: American Psychological Association.

Dennis, M., & Kohn, B. (1975). Comprehension of syntax in infantile hemiplegics after cerebral hemidecortication. *Brain and Language, 2,* 472–482.

Dennis, M., Lovett, M., & Wiegel-Crump, C. (1981). Written language acquisition after left or right hemidecortication in infancy. *Brain and Language, 12,* 54–91.

Dennis, M., & Whitaker, H. A. (1976). Language acquisition following hemidecortication: Linguistic superiority of the left over the right hemisphere. *Brain and Language, 3,* 404–433.

Dennis, M., & Whitaker, H. (1977). Hemispheric equipotentiality and language acquisition. In S. J. Segalowitz & F. A. Gruber (Eds.), *Language development and neurological theory* (pp. 93–106). New York: Academic.

Eisele, J. A., & Aram, D. M. (1993). Differential effects of early hemisphere damage on lexical comprehension and production. *Aphasiology, 7,* 513–523.

Eisele, J. A., & Aram, D. M. (1994). Comprehension and imitation of syntax following early hemisphere damage. *Brain and Language, 46,* 212–231.

Eisele, J. A., & Aram, D. (1995). Lexical and grammatical development in children with early hemisphere damage: A cross-sectional view from birth to adolescence. In P. Fletcher & B. MacWhinney (Eds.), *Handbook of child language* (pp. 664–690). Oxford, England: Blackwell.

Feldman, H., Holland, A., Kemp, S., & Janosky, J. (1992). Language development after unilateral brain injury. *Brain and Language, 42,* 89–102.

Fletcher, J. M. (1993). Afterword: Behavior–brain relationships in children. In S. H. Broman & J. Grafman (Eds.), *Atypical cognitive deficits in developmental disorders: Implications for brain function* (pp. 297–326). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Gainotti, G., Caltagirone, C., & Zoccolotti, P. (1993). Left/right and cortical/subcortical dichotomies in the neuropsychological study of human emotions. *Cognition and Emotion, 7,* 71–93.

Geschwind, N., & Levitsky, W. (1968). Human brain: Left–right asymmetries in temporal speech region. *Science, 161,* 186–187.

Gibbs, R. W. (1987). Linguistic factors in children's understanding of idioms. *Journal of Child Language, 14,* 569–86.

Goodglass, H. (1993). *Understanding aphasia.* San Diego: Academic.

Hecaen, H. (1976). Acquired aphasia in children and the ontogenesis of hemispheric functional specialization. *Brain and Language, 3,* 114–134.

Hecaen, H. (1983). Acquired aphasia in children: Revisited. *Neuropsychologia, 21,* 581–587.

Hecaen, H., Perenin, M., & Jeannerod, H. (1984). The effects of cortical lesions in children: Language and visual functions. In C. Almli & S. Finger (Eds.), *Behavioral biology of early damage* (Vol. 1, pp. 277–298). New York: Academic.

Isaacson, R. L. (1975). The myth of recovery from early brain damage. In N. G. Ellis (Ed.), *Aberrant development in infancy* (pp. 1–26). New York: Wiley.

Kennard, M. (1936). Age and other factors in motor recovery from precentral lesions in monkeys. *American Journal of Physiology, 115,* 138–146.

Kimura, D. (1976). The neural basis of language *qua* gesture. In H. Whitaker & H. A. Whitaker (Eds.), *Studies in neurolinguistics* (Vol. 2, pp. 145–156). New York: Academic.

Kimura, D., & Archibald, Y. (1974). Motor functions of the left hemisphere. *Brain, 97,* 337–350.

Kinsbourne, M. (1971). The minor cerebral hemisphere as a source of aphasic speech. *Archives of Neurology, 25,* 302–306.

Kohn, B. (1980). Right-hemisphere speech representation and comprehension of syntax after left cerebral injury. *Brain and Language, 9,* 350–361.

Lashley, K. S. (1950). In search of the engram. In *Symposia of the Society for Experimental Biology. No. 4. Physiological mechanisms in animal behaviour* (pp. 454–482). New York: Academic.

Lashley, K. S. (1951). *Central mechanisms in behavior.* New York: Wiley.

Lenneberg, E. H. (1967). *Biological foundations of language.* New York: Wiley.

Levorato, M. C. (1993). The acquisition of idioms and the development of figurative competence. In C. Cacciari & P. Tabossi (Eds.), *Idioms: Processing, structure and interpretation* (pp. 101–128). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Losh, M., Reilly, J. S., & Bates, E. (1996, June). *Language development: Neural plasticity in children with early focal brain injury.* Poster presented at the eighth annual meeting of the American Psychological Association, San Francisco.

Marchman, V. A., Miller, R., & Bates, E. A. (1991). Babble and first words in children with focal brain injury. *Applied Psycholinguistics, 12,* 1–22.

Molfese, D. (1989). Electrophysiological correlates of word meanings in 14-month-old human infants. *Developmental Neuropsychology, 5,* 70–103.

Molfese, D. (1990). Auditory evoked responses recorded from 16-month-old human infants to words they did and did not know. *Brain and Language, 38,* 345–363.

Molfese, D. L., & Segalowitz, S. J. (1988). *Brain lateralization in children: Developmental implications.* New York: Guilford.

Molloy, R., Brownell, H., & Gardner, H. (1990). Discourse comprehension by right-hemisphere stroke patients: Deficits of prediction and revision. In Y. Joanette & H. Brownell (Eds.), *Discourse ability and brain damage: Theoretical and empirical perspectives* (pp. 113–130). New York: Springer-Verlag.

Myers, P., & Linebaugh, C. (1981). Comprehension of idiomatic expressions by right-hemisphere-damaged adults. In R. H. Brookshire (Ed.), *Clinical aphasiology: Conference proceedings* (pp. 254–261). Minneapolis, MN: BRK.

Nippold, M. A. (1985). Comprehension of figurative language in youth. *Topics in Language Disorders, 5*(3), 1–20.

Nippold, M. A., & Haq, F. S. (1996). Proverb comprehension in youth: The role of concreteness and familiarity. *Journal of Speech and Hearing Research, 39,* 166–177.

Nippold, M. A., Leonard, L. B., & Kail, R. (1984). Syntactic and conceptual factors in children's understanding of metaphors. *Journal of Speech and Hearing Research, 27,* 197–205.

Nippold, M. A., Martin, S. A., & Erskine, B. J. (1988). Proverb comprehension in context: A developmental study with children and adolescents. *Journal of Speech and Hearing Research, 31,* 19–28.

Nippold, M. A., & Martin, S. T. (1989). Idiom interpretation in isolation versus context: A developmental study with adolescents. *Journal of Speech and Hearing Research, 32,* 59–66.

Nippold, M. A., & Taylor, C. L. (1995). Idiom understanding in youth: Further examination of familiarity and transparency. *Journal of Speech and Hearing Research, 38,* 426–433.

Plunkett, K., & Marchman, V. (1991). U-shaped learning and frequency effects in a multi-layered perception: Implications for language acquisition. *Cognition, 38,* 43–102.

Prinz, P. M. (1983). The development of idiomatic meaning in children. *Language and Speech, 26,* 263–272.

Rasmussen, T., & Milner, B. (1977). The role of early left brain injury in determining lateralization of cerebral speech functions. *Annals of the New York Academy of Sciences, 299,* 355–369.

Reilly, J., Bates, E., & Marchman, V. (1998). Narrative discourse in children with early focal brain injury. *Brain and Language, 61,* 335–375.

Riva, D., & Cazzaniga, L. (1986). Late effects of unilateral brain lesions before and after the first year of life. *Neuropsychologia, 24,* 423–428.

Riva, D., Cazzaniga, L., Pantaleoni, C., Milani, N., & Fedrizzi, E. (1986). Acute hemiplegia in childhood: The neuropsychological prognosis. *Journal of Pediatric Neurosciences, 2,* 239–250.

Riva, D., Milani, N., Pantaleoni, C., Devoti, M., & Zorzi, C. (1992). Gli esiti a distanza delle lesioni cerebrali emisferiche congenite ed adquisite [Long term consequences of congenital or acquired hemispheric cerebral lesions]. In A. Benton, H. Levin, G. Moretti, & D. Riva (Eds.), *Neuropsicologia in età evolutiva* (pp. 185–197). Milano, Italy: FrancoAngeli.

Satz, P., Strauss, E., & Whitaker, H. (1990). The ontogeny of hemispheric specialization: Some old hypotheses revisited. *Brain and Language, 38,* 596–614.

Smith, A. (1984). Early and long-term recovery from brain damage in children and adults: Evolution of concepts of localization, plasticity, and recovery. In C. R. Almli & S. Finger (Eds.), *Early brain damage* (pp. 299–324). New York: Academic.

St. James-Roberts, I. (1979). Neurological plasticity, recovery from brain insult, and child development. In H. W. Reese (Ed.), *Advances in child development and behavior* (pp. 253–319). New York: Academic.

Stiles, J. (1995). Plasticity and development: Evidence from children with early focal brain injury. In B. Julesz & I. Kovacs (Eds.), *Maturational windows and cortical plasticity in human development: Is there reason for an optimistic view?* (pp. 217–237). Reading, MA: Addison-Wesley.

Stiles, J., & Thal, D. (1993). Linguistic and spatial cognitive development following early focal brain injury: Patterns of deficit and recovery. In M. Johnson (Ed.), *Brain development and cognition: A reader* (pp. 643–664). Oxford, England: Blackwell.

Thal, D. J., Marchman, V. A., Stiles, J., Aram, D., Trauner, D., Nass, R., & Bates, E. (1991). Early lexical development in children with focal brain injury. *Brain and Language, 40,* 491–527.

Trauner D., Chase, C., Walker, P., & Wulfeck, B. (1993). Neurologic profiles of infants and children after perinatal stroke. *Pediatric Neurology, 9,* 383–386.

Van Lancker, D., Canter, G., & Terbeek, D. (1981). Disambiguation of ditropic sentences: Acoustic and phonetic cues. *Journal of Speech and Hearing Research, 24,* 330–335.

Van Lancker, D., & Kempler, D. (1987). Comprehension of familiar phrases by left- but not by right-hemisphere damaged patients. *Brain and Language, 32,* 265–277.

Vargha-Khadem, F., Isaacs, E. B., Papaleoudi, H., Polkey, C. E., & Wilson, J. (1991). Development of language in 6 hemispherectomized patients. *Brain, 114,* 473–495.

Vargha-Khadem, F., Isaacs, E., Van der Werf, S., Robb, S., & Wilson, J. (1992). Development of intelligence and memory in children with hemiplegic cerebral palsy: The deleterious consequences of early seizures. *Brain, 115,* 315–329.

Vargha-Khadem, F., & Polkey, C. E. (1992). A review of cognitive outcome after hemidecortication in humans. In F. D. Rose & D. A. Johnson (Eds.), *Recovery from brain damage: Advances in experimental medicine and biology: Vol. 325. Reflections and directions* (pp. 137–151). New York: Plenum.

Wechsler, A. (1973). The effect of organic brain disease on recall of emotionally charged versus neutral narrative texts. *Neurology, 73,* 130–135.

Winner, E. (1988). *The point of words: Children's understanding of metaphor and irony.* Cambridge, MA: Harvard University Press.

Winner, E., & Gardner, H. (1977). The comprehension of metaphor in brain-damaged patients. *Brain, 100,* 717–729.

Witelson, S., & Kigar, D. (1988). Asymmetry in brain function follows asymmetry in anatomical form: Gross, microscopic, postmortem, and imaging studies. In F. Boller & J. Grafman (Eds.), *Handbook of neuropsychology* (Vol. 1, pp. 111–142). Amsterdam: Elsevier.

Woods, B., & Teuber, H. (1978). Changing patterns of childhood aphasia. *Annals of Neurology, 3,* 272–280.

Wulfeck, B., Trauner, D., & Tallal, P. (1991). Neurologic, cognitive and linguistic features of infants after focal brain injury. *Pediatric Neurology, 7,* 266–269.

APPENDIX
Familiar-Idiomatic and Literal Phrases From the Familiar and Novel Language Comprehension Test

Familiar Phrases	*Literal Phrases*
1. While the cat's away, the mice will play.	Whenever the sun sets, the dog barks.
2. I'd like to give you a piece of my mind.	The dog's trying to give her a ride on the wagon.
3. She took a sudden turn for the worse.	He's racing a truck against a horse.
4. Just in the nick of time.	Almost to the bottom of the mountain.
5. It's like talking to a brick wall.	She tried jumping over the striped cat.
6. I've got a bone to pick with you.	He's got a picture to show of her.
7. He's saving up for a rainy day.	She's looking down at her black cat.
8. When our ship comes in.	Then her dog walks in.
9. She's got him eating out of her hand.	He sees her drinking from a bowl.
10. Keep your nose to the grindstone.	Follow your sister to the dinner table.
11. He's living high on the hog.	He's sitting deep in the bubbles.
12. He's turning over a new leaf.	He's chasing after a white duck.
13. Sticks and stone will break my bones, but words will never hurt me.	The nails are under the square, and the hammer is in the circle.
14. I'll get back to you later.	He jumped up to her suddenly.
15. The truth, the whole truth and nothing but the truth.	The clown, the small clown, and not the one near a girl.
16. That's enough to drive a man to drink.	It's easy to teach a dog to swim.
17. It seems like just yesterday.	He kisses the thin lady.
18. Why don't you pick on somebody your own size?	Where are they not showing each other their own hats?
19. Cat got your tongue?	Who's following the dog?
20. How about a little peace and quiet around here?	Show me the apple and large banana above a square.