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Representations of Unattended Stimuli in Learning Disabled Children: Concrete or Abstract

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REPRESENTATIONS OF UNATTENDED STIMULI IN LEARNING DISABLED CHILDREN: CONCRETE OR ABSTRACT?

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Abstract

Studies of repetition priming show that learning disabled (LD) children use more concrete representations of information than non-learning disabled (NLD) children (Brown, Lorsbach, & Carey, 1993; Cermak, 1983). The present study examined whether changes in surface form and spatial location in a negative priming paradigm affect inhibitory processes of LD and NLD children differently. LD and NLD fifth grade students (N = 19 children in each group) were given a task in which a series of letter pairs (a prime and a to-be-ignored distractor) were presented. In the inhibition condition, the distractor from the first trial became the target in the subsequent trial, while the neutral condition subsequently contained new letters. Letters were additionally manipulated with respect to location and case. The LD group were slower to name targets located in the same location as the prime distractor, regardless of identity, demonstrating inhibition on the basis of location. Both groups demonstrated a case sensitivity to the inhibition conditions, contradicting previous data suggesting that inhibition operates on the abstract characteristics of the ignored stimulus (Tipper & Driver, 1988; Tipper MacQueen & Brehaut, 1988; Connelley & Hasher, 1993).

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Chapter I

Literature Review

A basic tenet of education asserts that skill in performance is acquired with practice. While some learning is dependent on several exposures to the relevant material (Newell & Rosenbloom, 1981), other cases show that facilitated skill can occur after the repetition of a single event. For example, increases in speed and accuracy have been shown upon reading a recently read word for the second time (Carr, Brown, & Charalambous, 1989; Jacoby & Brooks, 1984; Logan, 1988, 1990; Scarborough, Cortese & Scarborough, 1977).

Learning disabled (LD) children are known to encounter a variety of problems that reduce their ability to benefit from practice. A number of studies have shown that LD children fail to use those strategies that facilitate memory, such as rehearsal (Bauer, 1977a,b), organization (Bauer, 1979; Gelzheiser, 1984), and semantic processing strategies (Ceci, 1983; Lorsbach & Gray, 1985).

Moreover, LD children have difficulty generalizing previously learned knowledge to new situations. Katz (1986) showed that poor readers can write words they have just seen from memory, yet cannot read the same words. LD children may be taught strategies to improve memory, but confine the use of those strategies to the learning materials and do not generalize them to other learning and memory activities (Blackman & Goldstein, 1982; Gelheizer, 1984).

It has been suggested that LD children experience greater difficulties than NLD children on tasks that place demands on their semantic processes (Ceci, 1983; Lorsbach & Gray, 1987), which may account for deficits in memory performance and lowered ability to generalize information. Active rehearsal and other elaborative encoding strategies that transfer verbal information from short term to long term memory are deficient in LD children and may, in turn, be responsible for their slow acquisition and recall (Bauer, 1979). Lorsbach and Gray (1985) showed that LD children do not spontaneously incorporate semantically related information in their rehearsal activities, but rather rely on more visual and acoustical cues.

It has been shown that LD children fail to process or make use of incoming information on a semantic level. For example, the performance of LD children was comparable to NLD children when categorization tasks were based on perceptual features, but was deficient when the concept was based on more abstract dimensions, such as colors or shapes versus animals (Friedman, 1984). In a recall task using category membership to prime target words, Ceci (1983) showed that both LD and NLD subjects processed auditory information on a semantic level with a comparable level of automaticity. However, unlike the NLD subjects, the LD subjects failed to make use of more purposive semantic processing in the same task.

The ability to generalize information relies upon successful classification, storage and retrieval of the relevant details of an event. Models have been proposed that describe how mental representations are formed to improve subsequent performance in adult subjects. One class of models, the episodic or "instance-driven" accounts, argues that practice benefits are derived from specific, concrete memories of an encounter with the stimulus (Jacoby & Hayman, 1987; Logan, 1988; Masson, 1986, Whittlesea & Brooks, 1988). Speed of retrieval in a reading task, according to this view, relies on the degree of similarity between the current and past representation, and predicts, for example, that changes in context (from the written page to the blackboard) or type font (from "READ" to "read") reduce facilitation by changing the perceptual characteristics of the stimulus.

The repetition priming paradigm demonstrates that when a word has been read in the recent past, the speed and accuracy of reading the same word subsequently is improved (Scarborough, Cortese & Scarborough, 1977). Use of the repetition priming paradigm in reading tasks has provided considerable evidence that practice benefits are based on the retrieval of more concrete, perceptual aspects of a remembered stimulus. Changes in surface form have been shown to reduce repetition benefit from the first reading of a word to the second, as evidenced by a switch from one letter case to another, or by a change in font (Jacoby & Hayman, 1987). Similarly, changes in modality can interfere with facilitation. In a lexical decision task, Kirsner and Smith (1974) presented words and non-words auditorily or visually. In those trials where the second presentation of a word was displayed in a different modality than the first, repetition benefit was reduced.

Reduced benefit of repetition can also result from contextual changes in the stimulus. Levy and Kirsner (1989) found benefit reduction with the presentation of words as part of a continuous text, followed by the words presented in isolation. Bainbridge, Lewandowsky, and Kirsner (1993) showed that changing the sense in which a word is used from one sentence to another (e.g., "robbed the *bank*", "sat along the *bank*") also reduced facilitation.

In contrast to instance-based performance, a second set of models predicts that practice benefits accrue as the result of more abstract representations. According to this view, conceptual information, while initially drawn from specific instances, provides the basis for transfer of prior knowledge to a new event. Thus, in those instances where retrieval of stimuli relies on more abstract information, neither changes in the surface characteristics, nor in context, diminishes the benefit of practice. For example, Carr, et al. (1989) showed that changes in surface form of real- and pseudo-word texts (handwritten to typed font or vice versa) from the first reading to the second did not interfere with the facilitation of reading times.

Likewise, a change in task from the presentation of the prime to the target phase does not diminish the benefit of abstract transfer from prime to target. Facilitation was found across handwritten vs. typed surface form changes of a list of words and pseudowords (Brown & Carr, 1993), despite a task change from word naming to lexical decision and vice versa. Carlson, Alejano, and Carr (1991) showed that, under certain circumstances, the context in which repeated information was presented failed to diminish effects of facilitation (while under other circumstances it did not). When subjects were directed to process the first reading of a coherently presented text for meaning, subsequent reading of the text in its coherent or scrambled form was facilitated, but not if the text in the first presentation was scrambled. When instructed to process the same variations of text at a lexical level, a second reading was facilitated, regardless of the variation of text in the first reading.

The substantial evidence supporting each of the two models suggests that adult subjects may use some combination of both concrete and abstract methods to encode and retrieve memories. A number of hybrid formulations have been proposed to account for the variability of effects across surface form and context. Roediger and Blaxton (1987) argued that different task demands account for the differences in the locus of repetition benefit. Similarity of surface details between study and test of a stimulus facilitate benefit in those tasks that depend more on perceptual identification (e.g., rereading a list of unfamiliar words) and decreases in importance in tasks that require more conceptual encoding (e.g., generating words freely recalled from a list).

As we have seen, Carlson, Alejano, and Carr (1991) found that focus upon the lexical level of words in a text invites repetition benefits across changes in context, while focus on semantic levels constrains the circumstances under which benefit can accumulate. Brown and Carr (1993) argued that the relative typicality of targets determine the amount of repetition benefit accrued across changing surface characteristics: the more unique the target event, the greater the reliance will be upon retrieval of the particular instance for the benefit of transfer. Greater typicality, on the other hand, will summon more abstract representations.

Attention to the perceptual characteristics of stimuli, to the exclusion of meaningful categorical membership or semantic levels, may lower memory performance (Craik & Lockhart, 1972). As a result, difficulties in generalization under certain circumstances may result from perceptions of stimulus events as unique. In fact, there is considerable evidence to suggest that LD children may rely primarily on concrete perceptual memories for the representation of information in memory.

In a false recognition procedure, for example, Lorsbach and Gray (1985) showed that LD boys encode the structural visual attributes of a word, to the exclusion of more semantic properties. Cermak (1983) found that LD boys, in a letter matching task, could push a button indicating that two identical letters or numbers were the same (A,A), but identification significantly slowed relative to NLD boys, if the letters changed surface form (A,a). Similarly, Brown, Lorsbach, and Carey (Nov., 1993) found differences between LD and NLD populations in a speeded word-naming task. Fifth grade LD children had slower reaction times than NLD children between primes and targets across changes in font (e.g., READ-read).

In order to examine the reliance of LD children on concrete as opposed to abstract representations of information, the present experiment made use of a negative priming paradigm (Tipper, 1985; Tipper & Cranston, 1985). In a negative priming task, participants are shown a pair of stimuli and asked to identify one member of the pair and ignore the other. In immediate sequence on a subsequent trial, the ignored distractor from the first trial now becomes the target to be identified. Responses to the target items are slowed in comparison to the control trials, where the subsequent target is not the same stimulus as the previous distractor. This inhibition of response has been interpreted as evidence that during selection of the prime, the distractor in the prime trial is suppressed. The suppressed information is thereby made more difficult to quickly access in the following trial.

Negative priming has been reported for a wide variety of stimuli and tasks, including pictures and/or words (Tipper, 1985; Tipper & Baylis, 1987; Tipper, Bourque, Anderson, & Brehaut, 1989; Tipper & Driver, 1988), letters (Tipper & Cranston, 1985), and Stroop items (McDowd & Oseas-Kreger, 1991; Tipper, et al., 1989). Evidence suggests that the effect of inhibition operates on the abstract characteristics of the ignored stimulus, and is unimpeded by changes in surface form and context.

Tipper and Driver (1988), for example, showed that inhibition occurs across pictures and words, even in conditions where the relationship between stimuli is solely semantic (e.g., a picture of a cat as the ignored prime, paired with the word "dog" as the target). Tipper, MacQueen and Brehaut (1988) found that inhibition occurs regardless of a change in the output modality across prime and probe (e.g. verbal vs. manual responses). Furthermore, for young adults, an ignored prime that changes location for the target trial is inhibited at the new location, as well (Connelly & Hasher, 1993).

Because there is evidence to suggest that age-related differences occur in the ability of other populations to suppress irrelevant information, it is reasonable to suspect that LD children may have similar difficulties. Tipper, et al. (1989), for example, showed that 7-year old children demonstrated interference to effects of inhibition compared to adults in a Stroop color naming task, where distractor words in the prime display were the same as the subsequent target ink color. Likewise, aging adults failed to show an inhibition effect in a letter reading task under the same circumstances as young adults (Hasher, Stoltzfus, Zacks & Rypma, 1991; Hasher & Zacks, 1988; McDowd & Oseas-Kreger, 1991).

Additionally, there is evidence to suggest that both very young and very old populations fail to suppress abstract representations of the stimuli. In a picture presentation task comparing young children and adults (Tipper, et. al., 1989), the children showed no effect of negative priming when the distractor moved to a new location compared to a neutral condition. Aging adults failed to show suppression to the identity of a distractor in a letter reading task, but showed suppression to its location (Connelly & Hasher, 1993). That is, participants suppressed a same or different letter target when it appeared in the same location as had the distractor, but failed to suppress the same letter target when it moved to a new location.

Posner and Cohen (1984) hypothesized a mechanism, called the inhibition of return, which biases the participant against visually returning to locations from which target information has already been extracted. Under these circumstances, the participant will show an effect of inhibition towards any (same or different) stimuli that appears in the same location as had the actual prime (non-distractor). Connelly and Hasher extended this paradigm, postulating a "location inhibition function," which constrains attention away from those locations where the distractor previously appeared on adjacent trials, as evidenced by a slowed response to all ignored stimuli, again, regardless of identity. Both of these locationally inhibitory mechanisms evidently allow the viewer to search for information in new locations.

Indeed, there is evidence to support the notion that there are separate inhibitory systems for identity and location of an item. Neuropsychological studies suggest the presence of at least two separate inhibitory systems (Ungerleider & Mishkin, 1982), and are supported by evidence on the one hand showing that the identity of letters can be reported correctly in the absence of accurate localization (Butler, 1980; Mewhort & Leppmann, 1985), and reports on the other that targets in visual search may be localized without being identified (Sagi & Julesz, 1984).

In the examination of inhibition effects in LD children, one might expect to find similar processing deficits such as those found in younger and older populations. However, Brown, Lorsbach and Simpson (1990) found very different results with LD children, using a negative priming paradigm. In this experiment, LD children showed an effect of inhibition (that is, they were slower naming same-letter stimuli than different), as long as the previously ignored distractor appeared in the same location on the next trial. Their ability to suppress same letter information, however, disappeared when the target changed locations. It is notable that, in this instance, LD children did not demonstrate an inhibition of location. That is, they did not suppress neutral target letters at the same location as the distractor.

In this context, LD children may be using a concrete representation of the unattended stimuli; that is, a 'B' in one location may have a discrete mental representation differing from the representation of a 'B' in another location. The fact that LD children fail to inhibit a target when it changes location, however, does not necessarily mean that they are "globally" instance-driven with respect to other changes in the context or surface form of the stimuli. Rather, it is conceivable that they are storing abstract information about the letter 'B', but somehow do not make use of the same information about location as do NLD children.

The present experiment was designed to further explore the representational tendencies of the LD child in the context of a negative priming paradigm. Using a task similar to Brown, et. al. (1990), each trial consisted of a prime trial, followed by a target trial. Both primes and targets included the presentation of two letters, side by side. Subjects were asked to name the prime letter (printed in red) as quickly as possible, and to ignore the distractor letter (printed in blue). The control condition had two new letters on the subsequent target trial. In the inhibition condition, the ignored blue distractor letter from the prime phase became the red target letter to be identified in the subsequent target trial.

A manipulation of location constituted a replication of Brown, et al.(1990): the distractor letter from the prime phase either stayed in the same position or moved to the other position for the target. A final manipulation of case match distinguished this experiment from the conditions set up by Brown, et al. Letters were presented across prime and target phases in upper and/or lower case, and fully crossed with location.

Abstract information was represented by the identity of the distractor (prime phase) and target (target phase), while concrete perceptual information was represented by a change in the case of the distractor from the prime to the target trials. If LD children tend to rely on a more globally abstract representation of information in processing stimuli, then like the NLD children, it was predicted that they would inhibit the same letter targets regardless of a change in location or case.

Those inhibition trials in which the distractor remained in the same location on the subsequent target would provide a focus of interest. If, at the same location, LD subjects inhibited matched-case distractors, but failed to inhibit distractors in the opposite case, support would be lent to the view that LD children are inhibiting nonrelevant information, but are relying on more concrete representations with respect to surface form. On the other hand, if LD children were slower to respond to ignored distractors presented in the same location, regardless of identity or case, it would suggest that LD children are inhibiting on the basis of location.

Failure to inhibit same letter information at a different location would further support hypotheses that LD children tend towards a more globally concrete representational system. If LD children are additionally slower to respond to neutral distractors presented at the other location (those that do not match identity), it would suggest that LD children are inhibiting on the basis of an inhibition of return. NLD children, on the other hand, were predicted to display equivalent effects of inhibition, regardless of changes in letter case or location.

Evidence has shown that the relative surface form of the target stimuli can have differential effects on performance outcomes. Brown and Carr (1993) showed, for example, in a speeded pronunciation task across variations in word familiarity (real word vs. pseudo-word) and surface form (typed font vs. hand-written), that abstract benefit from past experience with a word was actually greater when the *current* typography was highly familiar. Jacoby and Hayman (1987), moreover, found evidence to suggest that previously studied words were more easily identified when they were tested for recall in upper case than lower case (regardless of the case of the original study word). Therefore, it was predicted that the target case may well have an effect on the performance for both groups. Specifically, it was predicted that participants may well be slower in the lower case target condition than when the target case is capitalized.

Chapter II

Method

Participants

Thirty-eight students participated in the experiment, 19 language/learning disabled (LD) and 19 nondisabled (NLD) fifth graders from a public school district in an urban area of the midwest. The mean chronological age for LD children was 11 years, 3 months; SD = 4 months (13 boys, 6 girls). The mean chronological age for the NLD children was 11 years, 3 months; SD = 3 months (12 boys, 7 girls). English was the primary language of each participant. The ethnic composition of the NLD group consisted of four African American, three Hispanic, and 12 Caucasian children. The composition of the LD group consisted of six African American, two Hispanic, one Native American and ten Caucasian children.

The LD children were selected based on the fact that they had been previously identified by the school district as learning disabled, specifically in the areas of expressive and/or receptive language, as designated by the criteria set forth in Rule 51 of the Administrative Code of the Nebraska Department of Education (Dec. 5, 1992). Additionally, the LD children were currently receiving special educational services at the time of their participation in the study.

The presence of a learning disability in the selected pool of LD subjects was verified on the basis of two criteria. The first consisted of a review of the district's records and verified that each child was of average intelligence as demonstrated by a score of above -1 and less than +1 standard deviation (M Verbal IQ = 78.19, SD = 11.08, M Performance IQ = 96.81, SD = 5.77, and M Full Scale IQ = 84.58, SD = 8.08) on an individually administered Wechsler Intelligence Scale for Children-Third Edition (WISC-III) (Wechsler, 1991). The second criteria verified that each child's standard score in one or more academic areas, including at least one area representative of expressive or receptive language, was 1.3 or more standard deviations (20 standard score points) below the child's assessed cognitive ability level, with those scores falling at or below a standard score of 90 points (administered to the LD children by the investigator). The mean standard scores for the LD participants in reading and arithmetic on the Wide Range Achievement Test-Revised (WRAT) (Jastak & Wilkinson, 1984) were 67.00 (SD = 7.05) and 76.74 (SD = 6.83), respectively. The mean scale scores for the LD participants on the Block

Design and Vocabulary subtests of the WISC-III were 8.31 (*SD* = 1.89) and 5.5 (*SD* = 2.5), respectively.

The selection of NLD subjects comprised a group that excluded children who were either currently receiving remedial services or who had been designated gifted and/or talented. Subtests of the WISC-III (Wechsler, 1991) and the WRAT (Jastak & Wilkinson, 1984) were administered to the NLD participants by the investigator. The mean standard scores obtained for NLD participants in reading and arithmetic achievement on the WRAT were 97.36 (*SD* = 8.72) and 104.37 (*SD* 11.03), respectively. The mean scale scores obtained on the Block Design and Vocabulary subtest portions of the WISC-III for the NLD population were 10.53 (*SD* = 2.82) and 10.00 (*SD* = 1.8), respectively.

A Student's t-test was performed to compare the performance of the two groups on the WISC-III Block Design and Vocabulary subtests. The LD group scored significantly lower than the NLD group on the Vocabulary subtest (t = 4.77, p < .01), but no significant differences were found between group scores on the Block Design subtest (p > .05). It might be expected that the LD group, with verified difficulties in expressive and /or receptive language, would score lower on the Vocabulary subtest, which has been shown to contribute the highest load on the Verbal IQ factor of the WISC-III (Wechsler, 1991; p. 189). Conversely, the Block Design loads most strongly on the Performance IQ. The fact that the two groups do not have significantly different scores on the Block Design reassures that the two groups are commensurate with respect to their nonverbal level of ability.

A comparison of the two populations on the measures of achievement and cognitive ability accomplished two things: it demonstrated that (1) both groups fell within an average range of intelligence, and (2) that the LD children fell below an average range in one or more measures of academic functioning (reading-vocabulary and/or arithmetic).

Materials and apparatus

Stimuli for the experiment consisted of letters of the alphabet, with the exception of those that are identical in upper and lower case (e.g., 'C' and 'c') and 'Q', which closely resembles 'G'. The letters were presented equally often across conditions: as prime, distractor and target, in upper and lower case, and in the left and right positions of trial pairs. Twelve lists of stimuli were constructed, each containing 192 trials. The selection and assignment of letters were randomized, with the exception of combinations of letters that form words, such as "TO", "be", "iF" or "An", which were not included. The 12 stimulus lists were assigned randomly without replacement to subjects in both populations.

The presentation of stimuli and response collection was accomplished with a Gateway 2000, driven by Micro Experimental Laboratory software (Schneider, 1990). Vocalization latencies of each participant were obtained by interfacing the microcomputer with a microphone and a Micro Experimental Laboratory voice-operated relay. Participants were seated approximately 55 cm from the monitor, where each pair of letters subtended 2 degrees vertically and 8 degrees horizontally. Each upper case letter subtended roughly 2 degrees horizontally; the lower case letters subtended approximately 1 degree horizontally.

Procedure

Letters requesting permission for participation in this study were sent home with all prospective children. Informed written consent for participation was obtained from parents, as well as permission to examine the files of the LD children to obtain IQ scores, along with the scale scores on the WISC-III Block Design and Vocabulary subtests. In addition, assent was obtained from both groups of children for the purposes of conducting the cognitive and achievement measures as outlined above, as well as for their participation in the study.

Each participant was initially presented with 12 practice trials, representing each condition of the experiment. Subsequently, each participant was presented with the 192 real trials, each consisting of the consecutive display of two sets of letter pairs. Each pair of letters consisted of a red letter (target) and a blue letter (distractor). Participants were instructed to name the red target letter in each pair as quickly as possible without sacrificing accuracy, and to ignore the blue letter.

Each trial began with a 1000 ms fixation cross followed by a delay of 500 ms. The first letter pair then appeared and remained on the screen for 1000 ms or response (whichever came first). One thousand ms after the onset of the first letter pair, the second pair was presented. Latencies for the second response was recorded by the voice-key. The accuracy of the response for each trial was manually recorded on the keyboard by the investigator: errors in the accuracy of either the first or second responses were coded as naming errors; errors due to mechanical errors were coded separately.

Eight conditions were represented equally across all 192 trials. The conditions, defined by the relationship of letter pairs within a trial, were as follows:

1. Inhibition-same-matching: The distractor letter from the first pair appeared as the target in the second pair; same location, matching case.

2. Inhibition-same-opposite: The distractor letter from the first pair appeared as the target in the second pair; same location, opposite case.

3. Neutral-same-matching: Random pairs of letters were presented, with the distractor position from the first pair becoming the target position in the second pair; matching case.

4. Neutral-same-opposite: Same as the neutral condition above; opposite case.

5. Inhibition-different-matching: The distractor letter from the first pair appeared as the target in the second pair; different location, matching case.

6. Inhibition-different-opposite: The distractor letter from the first pair appeared as the target in the second pair; different location, opposite case.

7. Neutral-different-matching: Random pairs of letters were presented, same location, matching case.

8. Neutral-different-opposite: Same as the neutral-different condition above, opposite case.

All of the neutral distractor letters in the target trials were new with respect to prime-distractor pairs of letters in the preceding trials. Figure 1 shows examples of the stimulus types represented in the four inhibition conditions.

Figure 1. Examples of the types of inhibition trials. Red letters represent the prime stimulus to be named; blue letters represent the distractors.

Inhibition Conditions	Priming Trial		Target Trial	
1. Same Location; Matching Case	A (red)	R (blue)	D (blue)	R (red)
2. Same Location; Opposite Case	A (red)	R (blue)	D (blue)	r (red)
3. Different Location; Matching Case	A (red)	R (blue)	R (red)	D (blue)
4. Different Location; Opposite Case	A (red)	R (blue)	r (red)	D (blue)

Chapter III

Results

Median reaction times (in milliseconds) of correct response naming latencies on the target trials were computed for each subject across the eight conditions of interest. Medians were chosen as a measure because they are insensitive to the large differences in response variance of LD children and their tendency toward outlying scores. The five-factor design was analyzed using a 2 x 2 x 2 x 2 x 2 ANOVA. Naming latencies were analyzed with respect to inhibition ('inhibition' vs. 'neutral' represented by same or different identity letters, respectively), location (same or different), case (matching or opposite) and target case (upper or lower) as within-subject variables. Groups (LD, NLD) were analyzed as a between-subjects variable.

The target trials in which naming or procedural errors occurred in either the prime or target presentations were excluded. Naming errors occurred when the participant incorrectly identified a letter, while mechanical errors occurred when the voice key activated prematurely (due to such factors as extraneous touch or noise), or not at all (due to an overly soft voice, or to orientation away from

Table I. Means of Median Reaction Times (RTs, in Milliseconds) and Accuracy Rates (in Percentage Error).

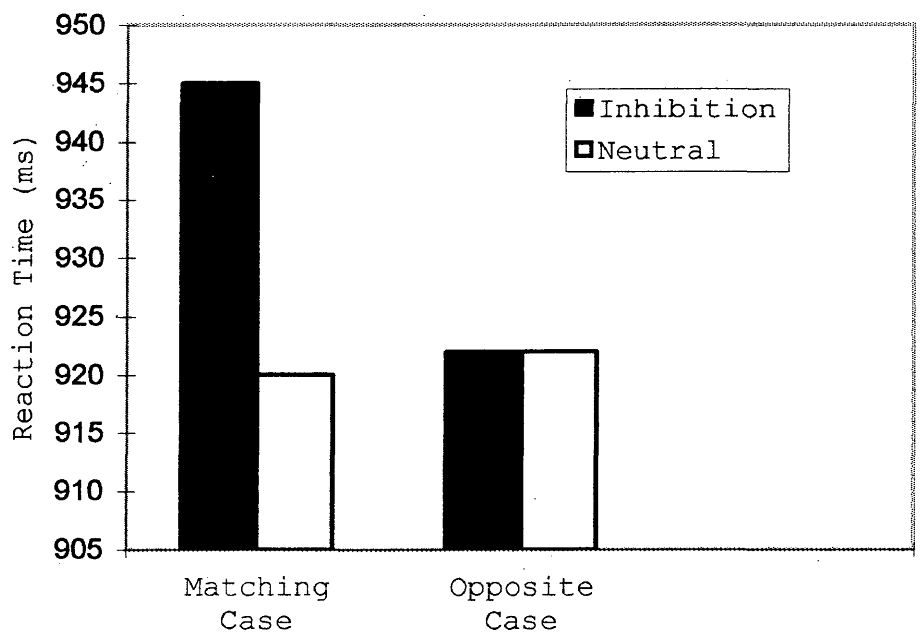
	NLD				LD			
	INHIBITION LETTER		NEUTRAL LETTER		INHIBITION LETTER		NEUTRAL LETTER	
EFFECT	RT	%Error	RT	%Error	RT	%Error	RT	%Error
sameloc/matchcase/targcap	854.37	5.3	844.68	6.3	1026.63	3.7	1024.16	7.4
sameloc/matchcase/targlow	906.16	5.3	853.26	2.1	1084.16	6.8	991.68	4.7
sameloc/oppcase/targcap	859.05	3.7	866.05	6.3	1018.05	5.2	1020.84	6.8
sameloc/oppcase/targlow	883.37	8.4	875.00	5.8	1001.31	10.0	1001.58	6.8
diffloc/matchcase/targcap	844.05	5.7	834.47	4.2	970.89	7.9	953.74	4.7
diffloc/matchcase/targlow	882.05	2.1	862.74	5.8	998.53	9.5	995.95	8.9
diffloc/oppcase/targcap	838.10	3.7	859.74	3.7	943.74	6.3	939.79	5.8
diffloc/oppcase/targlow	868.79	8.9	844.79	7.9	966.63	12.1	973.84	9.5

the microphone). Latencies greater than 1700 ms (presumed attention lapses) and less than 300 ms presumed anticipatory guesses) were also discarded. An analysis of the error rates for accuracy was conducted separately.

Table 1 shows the mean naming latencies and associated error rates for the conditions of this analysis and significant interactions. The analysis of naming latencies revealed that there was no main effect of inhibition, as was predicted. The LD group was significantly slower across all conditions than the NLD group by an average of 133.43 ms, $F(1,18) = 15.91$, $MSe = 170{,}102.82$, $p < .01$. Participants were slower at the same location than the different location, $F(1,18) = 12.06$, $MSe = 13{,}957.72$, $p < .01$. In addition, participants were slower to name lower target case letters than upper, $F(1,18) = 6.74$, $MSe = 7{,}483.98$, $p < .05$.

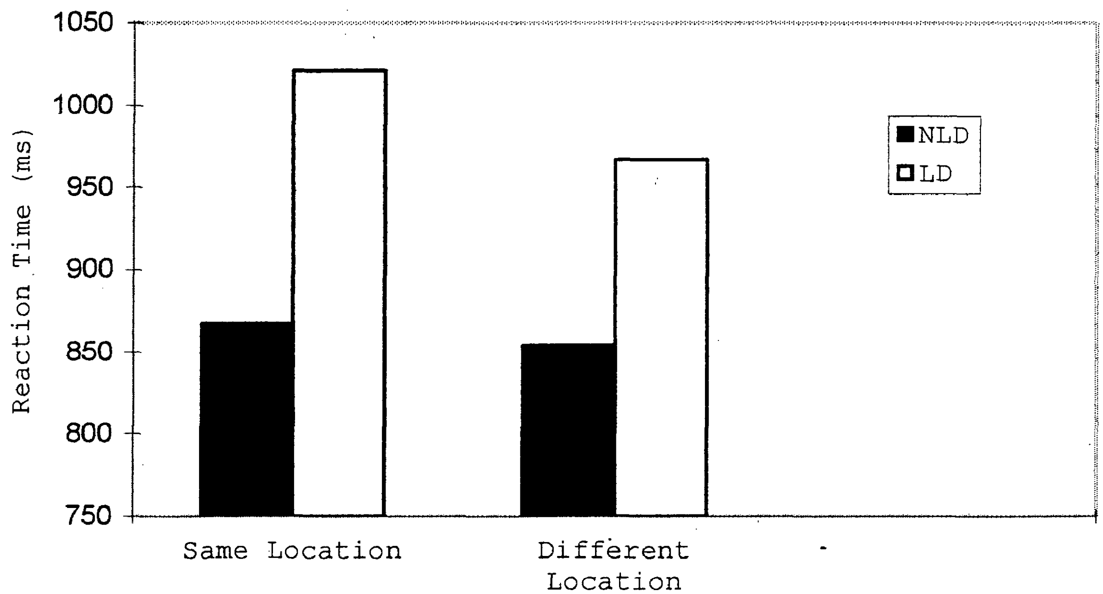
A significant inhibition x case interaction was found, $F(1,18) = 5.21$, $MSe = 4{,}963.35$, $p < .05$. Tests for simple effects indicated that both groups were significantly slower to name the same letter than a different letter when the case matched, regardless of location ($F(1,18) = 7.02$, $MSe = 7184.24$, $p = .01$. On the other hand, the amount of inhibition observed in the both locations did not differ significantly when the same letter appeared in the opposite case on the subsequent trial. Thus, negative priming was obtained for both groups; that is, LD and NLD participants both inhibited identification of an identical letter, but only as long as it remained in the matching case (see Figure 2).

Figure 2. Negative Priming: Inhibition x Case Interaction.



The group x location interaction was significant ($F(1,18) = 4.30$, $MSe = 13,957.72$, $p < .05$) and was analyzed further by testing the effects of group at each location (see Figure 3). Simple effects tests indicated that the LD participants were significantly slower in the same location than in the different, $F(1,18) = 15.39$, $MSe = 13,957.72$, $p < .01$, and were significantly slower than the NLD group at

Figure 3. Inhibition of Location: Group x Position Interaction

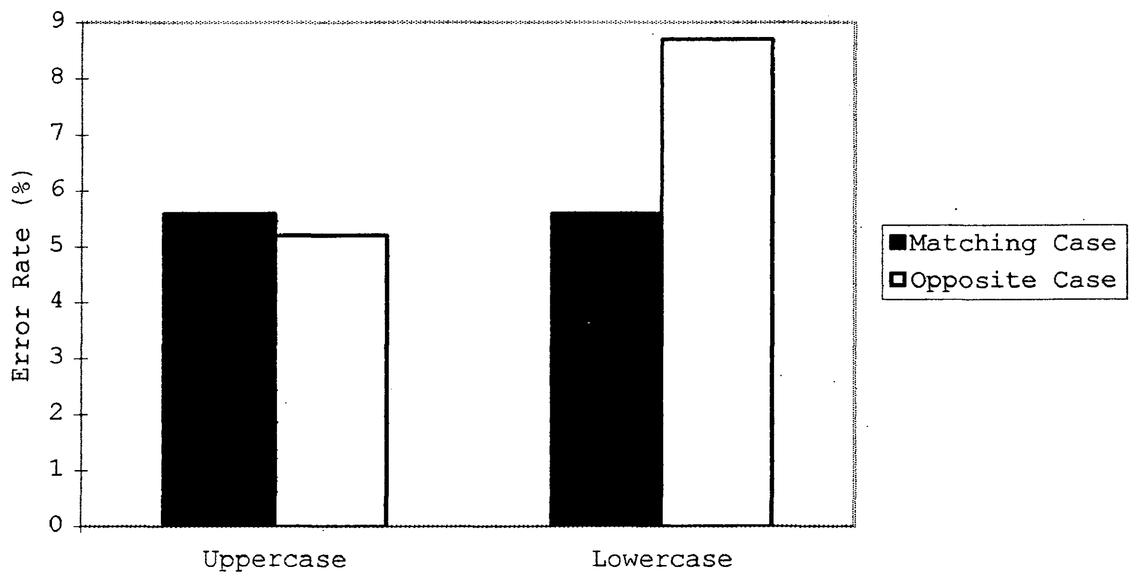


the same ($F(1,18) = 20.26$, $MSe = 88185.48$, $p = .00$) and different ($F(1,18) = 10.22$, $MSe = 95875.06$, $p = .00$) locations. On the other hand, the performance of the NLD group was comparable at same and different locations ($p > .10$). Thus, LD participants inhibited all letters to a greater extent at the same location as the distractor than different location, regardless of the identity of the letter or of a change in case. This pattern is suggestive of suppression on the basis of an inhibition of location.

An analysis of the accuracy rates was conducted to detect any speed-accuracy trade-offs as an explanation for latency effects. The LD group made more errors than the NLD group across cells, $\underline{F}(1,18) = 4.09$, $\underline{MSe} = 1.39$, $\underline{p} = .05$ (7.3 errors compared to 5.3 errors, respectively). Both groups were slower to name and made more errors when naming lower case targets, $\underline{F}(1,18) = 10.79$, $\underline{MSe} = .43$, $\underline{p} < .01$. A significant main effect for case was also found in the analysis of accuracy ($\underline{F}(1,18) = 6.54$, $\underline{MSe} = 3.82$, $\underline{p} = .01$), showing that participants made fewer errors when naming same case letters.

There was a significant case x target case interaction in the accuracy rates ($\underline{F}(1,18) = 8.95$, $\underline{MSe} = .52$, $\underline{p} < .01$) (see Figure 4). Participants made more errors when the case changed (prime to target phase) from upper to lower case than when it changed from lower to upper, $\underline{F}(1,18) = 17.11$, $\underline{MSe} = .41$, $\underline{p} = .00$, regardless of the identity of the letters. Additionally, they made fewer errors when the prime and target were both lower case, $\underline{F}(1,18) = 16.73$, $\underline{MSe} = .522$, $\underline{p} = .00$. Therefore, when the target changed from lower to upper case, there was increased interference in the ability of either group to identify the target.

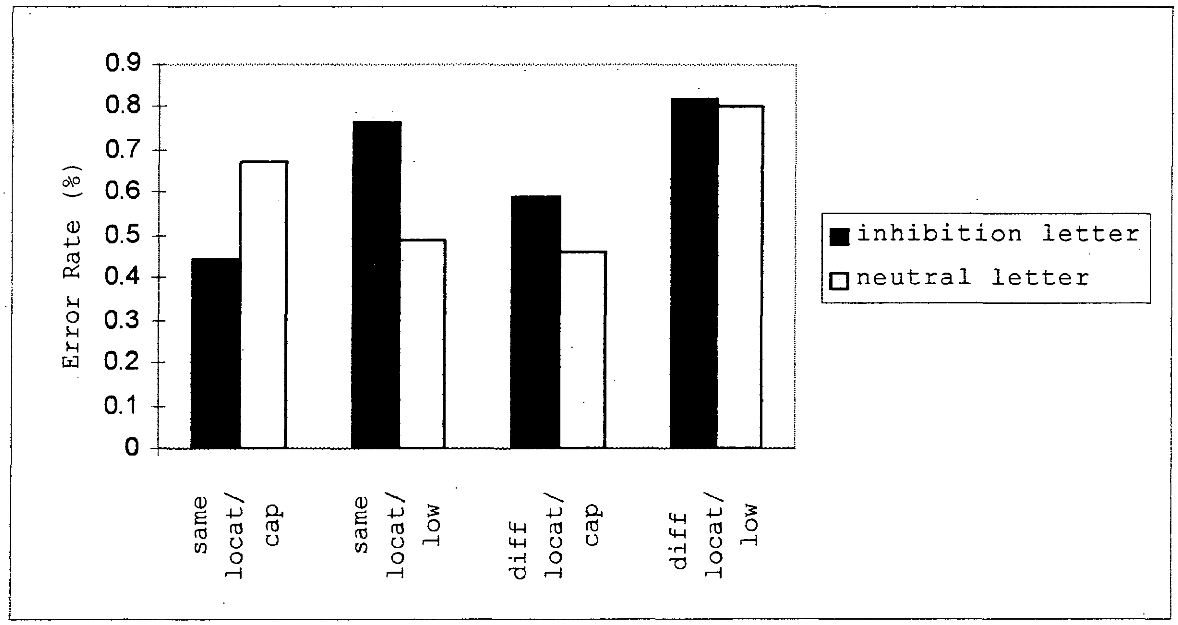
Figure 4. Case x Target Case Interaction: Accuracy Rates (in Percentage Error).



There was a significant three-way interaction of inhibition x location x target case in the analysis of accuracy rates ($F(1,18) = 5.31$, $MSe = .68$, $p < .05$), which affords a closer examination of the effects of case on letter recognition from prime to target phases (see Figure 5). A Duncan's pairwise comparison indicated that lower case targets, in the same or different location, accrued more errors than upper case targets in the same location.

Therefore, lower case targets were generally more difficult to accurately identify, compared to their uppercase counterparts.

Figure 5. Inhibition x Location x Target Case Interaction: Accuracy Effects (in Percentage Error).



Chapter IV

Discussion

LD children demonstrate deficiencies in their ability to generalize learned information from one situation to another (Katz, 1986; Blackman & Goldstein, 1982; Gelheizer, 1984). There is considerable evidence to suggest that they use more concrete, perceptually-based memories for the representation of information than do NLD children (Brown, et al., Nov., 1993; Cermak, 1983; Lorsbach & Gray, 1985). Because there is evidence to suggest that the inhibition effect operates on the abstract characteristics of the ignored stimulus (Tipper, 1985; Tipper & Cranston, 1985), a negative priming task was used to test the representational tendencies of LD children.

It was demonstrated by Brown, et al. (1990) that LD children fail to inhibit same identity distractor information with respect to location. In their study, the LD group inhibited same identity distractors that remained in the same location, but not those that moved to a new location. The NLD group, on the other hand, inhibited same identity distractors at both same and different locations. This particular study did not, however, manipulate for an alteration of surface form, and it was therefore not possible to know whether the LD child's deficit is specific only to location. Rather, it is possible that LD children possess a more globally concrete representational system.

To examine this possibility, the present experiment was designed to replicate the manipulations of Brown, et al. (1990), but added a manipulation of case, and fully crossed this new condition with location. It was predicted that should the LD participants rely on more concrete representations with respect to surface form and location, they would fail to inhibit a target distractor in the opposite case at the same location, as well as fail to inhibit matching or opposite case targets at a new location. Based on the performance of normal adults in similar studies (Connelly & Hasher, 1993; Fuentes & Humphreys, 1996), the NLD participants were expected to display equivalent effects of inhibition, regardless of changes in letter case or location.

The results showed that despite what might be expected, there was no main effect of inhibition for either the LD or the NLD group; rather, inhibition for both groups occurred as a function of case (for a list of predictions and outcomes, see Table 2). That is to say, regardless of location, both groups were slower to name same-identity letters when the case matched from distractor to target than when the case changed. This sensitivity to case would suggest that the mental representations mediating inhibition are at least partially constrained by the perceptual characteristics of the stimulus for each of these groups. However, these findings partially upset predicted outcomes: first, it was unexpected that the LD group would inhibit across a change in location; secondly, it was unexpected that surface effects would make a difference for the NLD children.

For the LD group, this pattern of inhibition across location but not case presents an unexpected contradiction of Brown, et al. (1990). Both the Brown study and the present experiment were very similar across several crucial features: 1) they each presented letter sets of prime and distractor letters, followed by either neutral (different identity) or inhibition (same identity) trial conditions, 2) they each manipulated for location, 3) they were both speeded tasks, with similar demands (name the target, ignore the distractor), and 4) the ages and grade level of the LD and NLD children in both studies were comparable. The obvious critical exception to the Brown, et al. design,

Table 2. Predictions and Outcomes for LD and NLD Groups.

PREDICTIONS		OUTCOMES	
BASIS FOR INHIBITION	INTERACTIONS	LD	NLD
EPISODIC BASIS FOR INHIBITION	Population x Inhibition x Location x Case: • group inhibits at same location/ matched case • no inhibition at same location/ opposite case • no inhibition at different location/matched or opposite case	Inhibition x Case: ⇒ inhibited same location/matched case ⇒ no inhibition at same location/opposite case ◊ inhibited at different location/matched case, but not different location opposite case	Inhibition x Case: ⇒ inhibited same location/matched case ◊ same as LD (contradicts adult literature) ◊ same as LD (contradicts adult literature)
INHIBITION ON THE BASIS OF LOCATION	Population x Location: • regardless of identity or case, group is slower in same location of distractor than in different location	Population x Location: ⇒ slower to respond to all same and different identity letters at same location, regardless of case.	◊ no control condition in which to determine whether inhibition on the basis of location was found
INHIBITION OF RETURN	Population x Location: • regardless of identity or case, group is slower in different location of the distractor than in the same	◊ no control condition in which to determine whether inhibition of return was found	◊ no control condition in which to determine whether inhibition of return was found
ABSTRACT BASIS FOR INHIBITION	Population x Inhibition • inhibits at same and different locations, regardless of case	Inhibition x Case: ◊ inhibits matching case at both locations ⇒ but not opposite case	Inhibition x Case: ⇒ inhibits matching case at both locations ◊ but not opposite case

LEGEND: ⇒ = consistent with prediction ◊ = not predicted included in the present study, was the manipulation for case.

Nonetheless, in the present study, the LD group inhibited same identity/matching case letters when the location changed, whereas those in the Brown study did not. It is difficult to explain why such disparate results were achieved in the two studies. Because few other studies manipulate specifically for a change in location and case, the information is far from complete. However, supposing that the present results are representative of the performance of LD children, the picture they present is not totally inconsistent with the predicted outcome for that group. It would appear that LD children are able to inhibit nonrelevant information, but are relying to some extent on more concrete representations with respect to surface form. According to these data, a change in case represents a sufficient alteration of the perceptual characteristics of the stimulus to disrupt the inhibitory process.

There is support for the notion that LD children find it difficult to transfer abstract information across a change in case. Brown, et al., (1993) in a speeded word-naming task, found that repetition priming benefits were reduced more for LD children than NLD children across a change in case. Cermak (1983) conducted a study comparing LD and NLD children on a speeded letter judgment task and involving a manipulation of case. The participants were divided in half and each were asked to examine and classify successive pairs of letters (AA, Aa, AB) along one of two dimensions: 1) identify whether the letters are physically identical or different; or 2) identify whether the letters have same or different names. The LD children were slower than the NLD children to name upper and lower case letters of the same identity as semantically related, than to classify those same letters as physically different.

Regarding the location issue, it was reasonable to predict that the LD child would not inhibit the same letters in a new location, given a similar finding in Brown, et al. (1990). Additionally, as discussed elsewhere, there is evidence to suggest that individual differences exist in the patterns of responses to inhibition stimuli, particularly in very young and very old populations. In both the Tipper, et al. (1989) and the Connelly and Hasher study (1993), the population in question failed to inhibit perceptually identical stimuli when it moved to a new location. Such a pattern suggests that the identity of the stimuli does not transfer, or that the representation of the stimuli in one location is somehow perceived as independent of its representation in another. The results of the present study, however, showed that for the LD group, the basis of transfer of the stimuli, whether it was abstract or perceptual, was not altered with a change in location.

It is perhaps more surprising to find that the performance of the NLD children was also mixed with respect to the representational basis of inhibition. Like the LD group, the NLD group inhibited at same and different locations as long as the case matched, but not when the case changed. The fact that inhibition did not operate exclusively on the abstract characteristics of the ignored stimulus for the NLD group contradicts a host of previous findings with normal adult populations (Tipper, 1985; Tipper & Cranston, 1985; Tipper & Driver, 1988; Tipper, et al., 1988; Connelly & Hasher, 1993).

The abstract basis for transfer from the ignored distractor to the target is well documented not only for orthographically similar stimuli (across letters to letters, words to words, and pictures to pictures), but also across widely dissimilar tasks and stimuli (Tipper, 1985; Tipper & Cranston, 1985; Tipper & Driver, 1988; Driver & Tipper, 1989; Tipper, et al., 1988, Tipper, et al., 1990). As previously discussed, Tipper and Driver showed that the effect of inhibition held strong from words to pictures and from pictures to words, even when the content was only semantically related (e.g.; a picture of a cat to the printed word 'dog'). Because these stimuli represent a complete lack of surface form similarity, a case change in contrast, portrayed in an easily readable type font, would appear to present a relatively minor surface variation.

However, it is notable to observe that in the negative priming study done by Tipper and Driver (1989), a word to word condition did not receive the same transfer across semantically-related stimuli that pictures to words or pictures to pictures received. Ignored repetition of identical words was inhibited, but words that were semantically related were not. While the task demands for Tipper and Driver were quite different from those for the present study (the participants were asked to name the category to which the exemplar belongs, as opposed to naming the object itself), nonetheless, perhaps there is something about letters and/or words, and by extension case, affecting transfer of identity under certain conditions.

An effect of interest in the present experiment that is perhaps related to current discussion was the finding that lower case targets, in the same or different location, accrued more errors than upper case letters for both the LD and NLD group. Lower case targets additionally caused more error when the case changed from the prime to target trials. The implication is that lower case letters are more difficult to identify, or do not benefit as readily from either repetition or conceptual transfer, as do upper case letters. Jacoby and Hayman (1987) found evidence to suggest that previously studied words were more easily identified when they were tested for recall in upper case than lower case (regardless of the case of the original study word).

Indeed, in a study similar to the present one, Fuentes and Humphreys (1996) incorporated a case change in a negative priming paradigm in order to compare the performance of normal young adults to that of an individual with parietal lobe damage. The task involved identifying a target letter, flanked by two matching distractor letters. In the condition where case was manipulated, the prime distractors were presented in lower case, followed by the distractor target presented in upper case. The young adults showed an effect of inhibition when the identity of the matching distractors became the target in the next round, regardless of a case match or change. The manipulations in this study resembled the present one, in that the distractor both moved location *and* changed case from the prime to the target trials. However, Fuentes and Humphreys did not provide for a manipulation of case in the opposite direction; that is, they did not test for transfer from upper to lower or from lower to lower cases.

Given the inconsistent and contradictory evidence across related studies (Brown, et al., 1990; 1993), and the insufficiency of similar investigations into patterns of inhibition across case changes in a negative priming paradigm, it is difficult to interpret the performance shown here by either the NLD or LD populations. Poor transfer across a change in case may be due to anomalies associated exclusively with the processing of lower case fonts, rather than difficulty with the transfer of conceptual information about the stimulus, per se. On the other hand, lack of a clear pattern in the inhibition studies may be reflective of a similar conflicts in the priming literature (for discussions, see Carr & Brown, 1990 and Brown & Carr, 1993), where the effects across tasks, surface changes and changes in modality have also been remarkably inconsistent. Such variability of outcome would suggest that factors as yet unidentified may be responsible for the unpredictability of performance.

Carr and Brown (1990) hypothesized that abstract and episodic processes may in fact both be contributing to the benefit accrued in repetition, depending on the level of focal attention needed to process the prime and target information. Brown and Carr (1993) showed, for example, that by increasing the power in a speeded pronunciation task across variations in word familiarity (real word vs. pseudo-word) and surface form (typed font vs. hand-written), it was possible to detect an asymmetric transfer of surface form specificity. That is, the abstract benefit from past experience with a word did not just depend on the relative familiarity of typography in the prime condition. Rather, past experience (whether familiar or unfamiliar) that was brought to bear on a word currently being processed was actually greater when the *current* typography was highly familiar.

It is easy to imagine, by extension, that insufficient power in many of the studies (including the present one) on inhibition with adults and children may obscure effects that are actually there, rendering analyses subject to Type I error. Perhaps differences in performance across changes in surface form have not been detected in the past, suggesting that which accrues to repetition benefit may not be as abstract as previously thought. It is unfortunate that provision was not made in the present experiment to sufficiently measure inhibition of return and inhibition of location in the NLD and LD groups. To do so, it would have been necessary to include a condition where the neutral target letter shows up in a third location independent the position of the prime distractor in same and different locations. It is against performance at this third (neutral) location that the relative inhibition of each group at the same (indicative of an inhibition of location) and different (indicative of an inhibition of return) locations could have been measured, establishing a baseline.

The NLD group performed comparably on neutral targets at same and different locations. Because there was no neutral location to provide a baseline, it cannot be determined whether they had comparable inhibition at both locations due to the two types of inhibition, or did not inhibit at all at either location. On the other hand, the performance of the LD group on neutral targets was sufficiently different at the same and different locations, as well as from the performance of the NLD group at each location, to suggest that the LD children do indeed inhibit on the basis of location. That is, in contrast to their own performance to the different position and to the NLD group at either position, the LD group was slower to name inhibition and neutral targets at the same location as the prime distractor. These findings also contradict the Brown, et al.(1991) study, wherein the LD group did not inhibit neutral stimuli at the same location. While it is difficult to interpret these findings in light of inconsistent and insufficient data, the results are intriguing and may qualify previous results. The suggestion is that LD children may have developmental delays or deficits in those mechanisms relevant to selective attention and locational information.

As discussed previously, there are developmental differences demonstrated in the ability of very young and very old populations to inhibit stimuli based on identity compared to young adult populations (Tipper, et al., 1989; Connelly & Hasher, 1993). Yet, both groups have been shown to inhibit with respect to location. There is evidence to suggest that the behavioral dissociation between suppression of identity and location in select populations may be tied to the neural mechanisms of selective attention, specifically, the two cortical visual pathways. The ventral pathway is specialized for the processing of identity, while the dorsal pathway is associated with the processing of spatial location (Harter & Aine, 1984). Connelly and Hasher (1993) have suggested that multiple inhibitory mechanisms associated with these separate pathways may exist and develop at different rates. The evidence presented on younger and older populations supports their argument that the inhibition of spatial location represents a "first-in/last-out" type of developmental process, with inhibition of identity developing later in youth and diminishing earlier in later life.

Further investigation with NLD children at developmental intervals throughout the primary and secondary grades would help to clarify issues that may be playing a role in the growth and change of inhibitory mechanisms. Assuming that the pattern of inhibition shown by NLD children in this study is accurate, it is conceivable, for example, that that movement from relatively concrete representational systems to increasingly abstract may develop incrementally over time. Such a movement could be detected using the same task across age gradients and might account for the total lack of transfer of abstract information in early childhood, to the uneven development of transfer across location, but not case, in later childhood. Because LD children represent one of several populations that illustrate generalized representational deficits, establishing the developmental progression of inhibitory mechanisms with NLD children may cast, by comparison, decrements in the LD child's performance into a more meaningful light.

In summary, evidence of the performance of LD children as compared to NLD children in a negative priming task does not form a conclusive picture. That we find discrepancies, is not, perhaps, surprising. While it is known that certain children have significant difficulties learning in particular areas, it is exceedingly difficult to pinpoint a given population that consistently meets reliable criteria for verification of a disability. Disparities exist in definitional, diagnostic and verification criteria of learning disabilities across local, state and national arenas. Indeed, each individual with a given learning disability is unique with respect to strengths and weaknesses. Moreover, because test performance may significantly shift over time, reverification of a learning disability with a given individual may not occur. In the future, it will be important to continue to refine our conceptions of learning disabilities, in order to more surely align our search for causes and treatments.

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