

On accounting for deficiencies in order memory associated with reading difficulty: A reply to Tallal

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ADDRESS FOR CORRESPONDENCE

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In response to Tallal's critical comments on our paper (Katz, Healy & Shankweiler, 1983), we will review the findings that suggest that deficiencies in using a phonetic memory strategy underlie the inferior order memory of children with reading disability. We will then examine the alternative explanations of the order memory deficits suggested by Tallal, which, it will be seen, do not prove satisfactory.

Since children with reading disability have known deficiencies in using a phonetic memory strategy (see e.g., Liberman, Shankweiler, Liberman, Fowler & Fischer, 1977; Shankweiler, Liberman, Mark, Fowler & Fischer, 1979), we sought to obtain evidence that their difficulty in retaining the order of items may be a consequence of such deficiencies. To test this possibility we needed a way to infer the coding strategy used by good and poor readers. A paradigm developed by Healy (1975, 1977) was adopted for this purpose. The paradigm had the additional advantage of displaying stimuli in such a way as to dissociate temporal order and spatial order. On the basis of earlier findings with this paradigm (Healy, 1975, 1977, 1978, 1982), we supposed that good and poor readers would differ on temporal order recall, since this task had been shown to depend on the use of phonetic coding. For spatial order recall, "we had no clear basis for expecting performance to vary with reading ability, because Healy has shown that phonetic coding is not the preferred strategy when this aspect of order memory is tested" (p. 231). Of course, these expectations were necessarily tentative, because the two tasks had never before been presented to young children under the specific conditions of the experiment in question; i.e., with a three-item memory load presented at a rate of 1 per sec.

processing was used on both tasks by good readers does not negate the fact that poor readers were impaired on the tasks, nor does it allow the interpretation that the impairment could be attributed solely to phonetic processing difficulties. To do that it would be necessary to demonstrate that poor readers were *not* impaired on a rapidly presented ordering task in which phonetic memory strategies have been shown not to affect performance by good readers. This is precisely the condition anticipated by Healy et al. but unfortunately not achieved in this study.

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The results of our experiment indicated that the poor readers were inferior to the good readers on both temporal order recall and spatial order recall, as Tallal correctly points out. However, she misinterprets our data when she describes our two order recall tasks as “differentiated by the extent to which phonetic memory strategies were employed.” In fact, we had a direct measure of the involvement of phonetic coding – viz., the conditional percentages of phonetic errors – and that measure clearly indicated that the good readers were coding phonetically in spatial order recall as well as temporal order recall. “When an error was made, it was more likely to be a phonetic error for the good readers than for the poor readers on both temporal order recall and spatial order recall, as the interaction between reading ability and recall type was not significant. Thus, it would seem that on both tasks the good readers, more often than the poor readers, were coding in a phonetic manner” (p. 238).

Despite the feasibility of using a phonetic strategy on both recall tasks, our findings further indicated that the poor readers nevertheless preferred non-phonetic coding strategies: temporal-spatial pattern coding (p. 243) and visual coding (p. 240). Using these nonphonetic strategies, the poor readers were not able to attain the level of performance of the good readers on either recall task. Thus, the expectation that poor readers are likely to be inferior to good readers in situations in which a phonetic strategy is optimal was supported.

It is true, of course, that our finding of phonetic coding on spatial order recall is a departure from the results Healy (1975, 1977) obtained with adult subjects. As we discussed (p. 246), the discrepancy could be attributed to either of the two changes in procedure that were made when the task was adapted for children: slowing the rate of stimulus presentation or reducing the number of stimulus items. Alternatively, the discrepancy could be due to the different ages of the subject populations tested. We favored the rate explanation, suggesting that the slow presentation rate may have allowed the children sufficient time to recode the letters phonetically in their spatial positions. (For example, subjects seeing *F* in the third position, then *P* in the first position, and finally *V* in the second position, might recode the sequence as *P-V-F*, ordering them in accord with their spatial arrangement.) Indeed, this argument was supported by the finding of a significant interaction between recall type and retention interval when the conditional percentages of phonetic errors were analyzed (p. 245). At the short retention interval, the conditional percentage of phonetic errors was greater for temporal order recall than for spatial order recall, but at the long interval, this pattern tended to reverse. Apparently, the additional time in the longer retention interval allowed the phonetic coding of the letters in their spatial positions. We assumed that the slower presentation rate was responsible for this interaction. By this argument, increasing the presentation rate would decrease the opportunity for phonetic recoding in spatial order recall, possibly reducing the good readers' advantage on this task.

Tallal cites studies (e.g., Tallal, 1980) which found that differences in errors between good and poor readers increase with faster presentation rates for nonverbal stimuli. She would like to generalize this result to our spatial order recall task to predict that the difference between good and poor readers should increase with

increases in the rate of presentation. The studies cited, however, are not necessarily relevant to the task in question. None of them tested purely spatial order recall using stimulus items that were patently verbal (the printed letters *F*, *P*, and *V*) as we did. To date, the effect of presentation rate has not been manipulated in this spatial order recall paradigm. It is, nonetheless, an empirical question that could be resolved through further experimentation.

Although we attribute the differences between good and poor readers on memory for order to underlying differences in the use of phonetic codes, there are other possibilities. Tallal implies by the title of her article that the primary deficit of poor readers is in temporal processing. If this were the case, poor readers should be inferior to good readers on tasks that require temporal processing, such as temporal order recall, but not necessarily on nontemporal tasks, such as spatial order recall. (This was the very prediction suggested by us, but for different reasons.) In our experiment, however, the poor readers were as deficient on the spatial task as on the temporal task (p. 236 and Table 3) even though the spatial task placed no demand on temporal-processing ability.

Could poor readers have a general deficit in sequencing ability or, as Tallal suggests, in the ability to process "simultaneous or rapidly occurring successive events"? Although this possibility is not excluded by the data in question, it is inconsistent with other findings in the literature that examined memory for the order of items presented simultaneously (Katz, Shankweiler & Liberman, 1981) or presented successively (Holmes & McKeever, 1979). In those studies, good and poor readers did not differ in their ability to remember the order of items that are particularly difficult to code phonetically but are easily discriminable visually, such as unfamiliar faces or nonsense designs. In contrast, good and poor readers were clearly different in their retention of items easily codable phonetically, such as printed words or drawings of common objects. Furthermore, in studies testing ordered recall (Liberman et al., 1977; Mann, Liberman & Shankweiler, 1980; Shankweiler et al., 1979), the deficiency of poor readers relative to good readers was clearly related to the phonetic characteristics of the stimuli. On items that were not phonetically confusable, there was a large difference between the reading groups, but on phonetically confusable items, there was little or no difference. These studies support the argument that poor readers' difficulty remembering order *is* a manifestation of underlying deficiencies with phonetic processing.

An explanation of memory deficit based on phonetic coding cannot be expected to account for all the cognitive differences between good and poor readers that may exist. Other differences have been identified in the literature (e.g., Wolford & Fowler, 1983). Moreover, the nature of the differences appears to vary with the age of the children (Olson, Davidson, Kliegl & Davies, 1984) and with various aspects of task structure (e.g., Hall, Wilson, Humphreys, Tinzmann & Bowyer, 1983). Though in need of further elaboration and refinement, the phonetic coding hypothesis gives a good account of the findings of our experiment and forms a coherent basis for interpreting a variety of findings in the research literature that implicate differences between good and poor readers in processing language.

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