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Phonological deficits, a source of asymmetries between developmental and acquired dyslexia.

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The similarities between acquired and developmental reading disorders have been a matter of considerable debate over the last decade (eg., Baddeley, Ellis, Miles, and Lewis, 1982; Frith, 1985; Holmes, 1978; Marcel, 1980; Marshall, 1984; 1989). The issue is an interesting one for a number of theoretical and practical reasons that are straightforward. One theoretical reason is that comparisons between developmental and acquired language disorders stimulate reflections on the biological basis of language. Indeed, there is no doubt that reading disorders somehow offer us a window on the underlying language processing architecture. Somehow, yes. But how?

There are two major reasons why inferences from reading impairments to the biological representation of language and its functional architecture are problematic. First, it is at present unclear if the biological endowment for language supporting the processing of spoken language also supports written language. Another cause for concern is the inferential indeterminacy introduced by the study of language disorders

as opposed to normal functioning. We briefly consider these two aspects before turning to a possible asymmetry between acquired disorders and developmental dyslexia: phonological disorders of spoken language processing present in developmental dyslexia only.

Reading and modularity.

Recent theoretical positions on the biology of language have focused on the modularity of the cognitive architecture of linguistic competence. Yet, the relevance of the modularity view for explaining reading ability, and *a fortiori* reading acquisition and reading disorders is far from clear. If we go by the list of criteria given by Fodor (1983), written language processing seems to qualify as a modular process: its functioning is fast and mandatory, as demonstrated by Stroop interference and semantic priming, it proceeds through largely unaccessible intermediate representations, it is probably encapsulated and it shows highly specific breakdown patterns after brain lesion (Bertelson and de Gelder, 1990). Yet the discrepancies between speaking and reading have long been noted (Liberman, Cooper, Shankweiler, and Studdert-Kennedy, 1967), a major one being that the development of reading acquisition does not display the autonomy of a modular, endogenously controlled process.

Disorders and the indeterminacy of inference.

What inferences about the modularity of language can we expect to draw from the observation of developmental reading disorders? The extent to which a theory is underdetermined by the available facts is a longstanding cause of concern in philosophy of science. The kind of underdetermination that occurs in cognitive science is somewhat peculiar. It concerns not just facts vs. theories but also the relation between behavioral facts and a system's information processing competence. Moreover, when the inferences from behavioral facts to the system's competencies concern the causes of a developmental failure, the situation is even more critical. We noted above that the development of reading capacity does not display the autonomy of a process mainly under endogenous control unlike speech acquisition. As a matter of fact, reading acquisition confronts one with the possibility that new skills are learned by building upon and possibly penetrating modular competence.

If so, neither theories of the initial state of the language module nor models of normal adult reading process can be exclusive guides for research on developmental disorders. Theories of the adult reading process allow a more refined diagnosis of reading disorders, acquired as well as developmental (eg., Seymour, 1986). Take the example of impaired phonological skills, where subjects have difficulties performing simple segmentation operations like first consonant deletion. In the case of acquired disorders, the rationale of explaining this disorder by reference to the functional architecture of the reading process procedure is obvious. Presumably, a partial impairment of this architecture following brain damage causes the observed segmentation difficulties. In the case of developmental disorders such an explanation is highly problematic since we are probably dealing with cases where the functional architecture for skilled reading did not get properly implemented. The asymmetry disappears when one argues that the basic functional components of the reading process have to be preformed in the sense that there have to be universals of written language and reading (Marshall, 1989).

Another route to understand developmental reading disorders consists in focusing on the critical abilities needed for successful reading acquisition. Research on critical abilities has pointed unambiguously to the importance of phonological awareness (eg., Bertelson, 1986; Morais, Bertelson, Cary, and Alegria, 1986; Yopp, 1988). The emergence of phonological awareness and related skills is not a matter that has received much attention in models of the stages of reading (Frith, 1985; Morton, 1989). Admittedly, the issue is of limited importance for tracing the course of normal reading acquisition. The assumption is that normal reading development has elementary phonological awareness as its take-off platform. Later on more elaborate phonological awareness and segmentation skills develop in interaction with early reading acquisition.

The notion that there is a specific platform of linguistic capacities from where initially literacy training takes off is supported by comparative studies of phonological awareness in populations with different degrees of literacy (Bertelson and de Gelder, 1990). However, what sense can we make of the fact that retarded readers have difficulties with phonological awareness tasks (Morais, Cluytens and Alegria, 1984; Seymour, 1986; Snowling, Stackhouse and Rack, 1986). In other words, why does

extensive literacy training sometimes fail? Might it be that for retarded readers the take-off platform for literacy training was not the same?

Before turning to this question we remark that the notion of phonological deficits needs to be handled with caution. Comparative studies of phonological awareness and segmentation skills of pre-readers (Content, Kolinsky, Morais, and Bertelson, 1986), of illiterates (Bertelson, de Gelder, Tfouni, and Morais, 1989; Morais, Bertelson, Cary, and Alegria, 1986) and of non-alphabetic chinese logographic readers (de Gelder, Vroomen, and Bertelson, 1990) offer evidence for the heterogeneity of metaphonological abilities. Developmentally, at least two different components must be distinguished. Explicit segmental analysis (eg., deletion of the first consonant) does not emerge spontaneously while analysis into syllables and appreciation of phonological similarities (eg., the ability to detect rhymes) do. The latter appear to be much less dependent of the literacy status of the subjects while the former are acquired in interaction with explicit training and the acquisition of alphabetic literacy. Studies of phonological skills of developmental dyslexics have not systematically made the distinction (Content, Morais, Kolinsky, Bertelson, and Alegria, 1986). If there is a developmental heterogeneity of metaphonological abilities, it does no longer make sense to expect that all metaphonological abilities will be impaired to the same extent or that a single deficit will underlie all of them. The critical issue is to determine which phonological skills are impaired in reading retarded populations.

We compared the performance on rhyme vs. segmental analysis tasks in populations with reading deficits: a population of young developmental dyslexics (compared with reading age and chronological age controls) and a population of adult dyslexics (de Gelder and Vroomen, in press). The dyslexic subjects do read words but have serious difficulty reading non- words. They show good performance on rhyme judgement tasks but their performance on tasks requiring deletion of a first consonant is poorer than that of the two control groups. This finding supports a phonological deficit hypothesis and reflects the developmental heterogeneity of metaphonological skills noted above. Rhyme judgments are based on intuitions of overall phonetic similarity (Bertelson and de Gelder, 1989; de Gelder, 1990) and do not require that a segmented representation of speech be available. In contrast, being a good reader and being able to analyze words segmentally are closely related, the difference

between the groups show up in tasks were (unlike rhyme judgement) a segmented representation of speech is needed.

In the past, the notion that in some cases of developmental dyslexia a phonological dysfunction might be responsible has been criticised partly because the observed deficits seem like an odd collection indeed (eg., delayed speech acquisition, articulatory difficulties, verbal memory problems; see Frith, 1985). The distinction between phonological skills requiring a segmented representation and others not requiring such, is a first step towards bringing a phonological deficit hypothesis in focus. In this context it is important not to confuse the above contrast with the much used distinction between implicit and explicit, unconscious or conscious processes and representations (eg., Marcel, 1983). The critical issue is that of the representations involved in the different capacities lumped together as phonological awareness. We submit that on this occasion the distinction between conscious, explicit processes vs. unconscious, implicit processes is a red herring. It has been argued that tasks requiring initial consonant deletion engage a kind of conscious and explicit representations not required in normal reading or in metaphonological process like rhyme judgement. On this account failure to perform well on explicit segmentation tasks would signal a conscious phonological processing deficit only. The theoretical potential of the notion of a phonological deficit in developmental dyslexia would be restricted to the conscious representations and processes which might be either different from the unconscious ones (Marcel, 1983), or simply irrelevant for the explanation of the disorder (Marshall, 1989).

To test this argument empirically, we designed a free sound classification task where subjects could either show a preference for a dutch non-word ('pim') sharing overall phonetic similarity with the first word ('bien') or prefer a third word ('bas') sharing a common phoneme with the first. Both, young retarded readers and adult developmental dyslexics predominantly make overall phonetic similarity judgments (de Gelder and Vroomen, in press).

The persistent bias against phoneme based judgments after years of reading training and remedial tutoring in dyslexic populations is very striking indeed. Faced with this result we conjectured that failure to develop segmental analysis and to take advantage of alphabetic training might be due to an underlying phonological deficit, as

might happen if subjects had weak or unstable phonological categories. In an experiment testing this possibility we found that retarded readers show a less categorical perception of auditory speech (de Gelder and Vroomen, 1988). Moreover, when tested for speech perception in the visual modality, requiring the subjects to lip-read, we observe an impairment in the ability to discriminate visually presented speech. As we can consider the auditory and the visual modality as a two input modalities for spoken language (Summerfield, 1987; Massaro, 1987; Campbell, 1989), data from visual speech perception in the dyslexic strengthens the suggestion that in some dyslexic subjects a specific impairment in segmented phonological representation might stand in the way of efficient alphabetic instruction.

These observations suggest that in some cases of developmental dyslexia there might be a subtle lag in the development of the speech perception code. As evidence on the early development of speech perception builds up (Miller and Jusczyk, 1989), such a hypothesis becomes increasingly suggestive. The functional architecture supporting the reading process is an interface (between biological endowments for spoken language and a written representation of language) which gets constructed over a long period of phonological development stretching from the early construction of a lexicon to written language acquisition. In competent readers, normal development ultimately provides a platform presenting the intertwined phonological abilities: perception of phonetic categories, phonemic segmentation, reading, and attentional strategies all hang together.

The existence of phonological deficits would go some way towards explaining why in some cases of developmental dyslexia literacy training fails to be successful. It would also force us to look more carefully at comparisons of normal readers, cases of developmental and cases of acquired reading disorders. Observations of impaired phonological segmentation have been made in cases of acquired phonological dyslexia (see Shallice, 1988, for an overview). However, it seems unlikely that impaired segmentation skills observed in acquired dyslexia would relate to a developmental phonological deficit. Indeed, there are almost no data available that would support the hypothesis of a speech code impairment and that would explain the observed segmentation and non-word reading deficits in cases of acquired dyslexia. And to the contrary, a case of acquired phonological dyslexia has been reported

(Bisiacchi, Cipolotti, and Denes, 1989) which presents severe impairment of non-word reading while auditory identification and discrimination are normal and while there is normal phonemic segmentation.

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