Short-term memory development: Differences in serial position curves between age groups and latent classes

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ABSTRACT

In studies on the development of cognitive processes, children are often grouped based on their ages before analyzing the data. After the analysis, the differences between age groups are interpreted as developmental differences. We argue that this approach is problematic because the variance in cognitive performance within an age group is considered to be measurement error. However, if a part of this variance is systematic, it can provide very useful information about the cognitive processes used by some children of a certain age but not others. In the current study, we presented 210 children aged 5 to 12 years with serial order short-term memory tasks. First we analyze our data according to the approach using age groups, and then we apply latent class analysis to form latent classes of children based on their performance instead of their ages. We display the results of the age groups and the latent classes in terms of serial position curves, and we discuss the differences in results. Our findings show that there are considerable differences in performance between the age groups and the latent classes. We interpret our findings as indicating that the latent class analysis yielded a much more meaningful way of grouping children in terms of cognitive processes than the a priori grouping of children based on their ages.

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Introduction

In cognitive psychological research, the aim of developmental studies is to investigate the cognitive processes related to developmental differences between children. The most commonly applied approach to study developmental differences between children is to form age groups, present the children in the age groups with particular tasks, and interpret the mean differences in performance between the age groups as developmental differences in cognitive processes. Although this is a widely accepted approach, we argue that there are some major issues making it difficult to expose the real differences in development (see Wohlwill, 1973, for a similar point of view).

Most important, there is the strong implicit assumption that age is a close proxy for development. Consequently, the variation in cognitive performance within an age group is considered to be measurement error, even though a part of this variation is prone to be systematic rather than random. Therefore, some of the within-group variation provides useful information about the cognitive processes used by some children within a group but not others. These individual differences should be taken into account by grouping children a posteriori based on the variance in their responses. In contrast, when children are grouped a priori based on their ages, the performance of all the individuals in that group is averaged and the individual differences in cognitive processes cannot be detected (Bouwmeester, Vermunt, & Sijtsma, 2012). In the current study, we demonstrate the differences in results and subsequent conclusions when grouping children a priori according to a manifest grouping variable, compared with grouping children a posteriori, accounting for individual differences and assuming a latent grouping variable. This demonstration applies to cognitive development in general, but here we focused specifically on the development of verbal and visual short-term memory (STM) processes because these processes are subtle in their emergence in responses and, therefore, form a strong case for the use of individual differences to investigate children's cognitive performance.

There have already been demonstrations of the usefulness of examining the systematic variance (i.e., individual differences) in cognitive performance within a manifest (quasi-) experimentally formed group. Adult memory studies show that within manifest groups there are considerable individual differences with respect to verbal and visual STM performance when participants can choose any preferred type of memory (Daneman & Carpenter, 1980; Logie, Della Sala, Laiacona, Chalmers, & Wynn, 1996; Saito, Logie, Morita, & Law, 2008; Unsworth & Engle, 2007). Developmental studies on memory have also found individual differences between children in the way they memorize simple stimuli when they have a choice in how to memorize the stimuli (e.g., Henry, Messer, Luger-Klein, & Crane, 2012; Palmer, 2000). In a study on more consciously chosen solutions, Chen and Klahr (1999) showed that children may respond differently with respect to strategy use, revealing interesting information about the possible paths they go through before successfully acquiring a specific strategy or not. Moreover, the usefulness of forming groups a posteriori based on systematic variance was made very clear in a classic study of Siegler (1987) showing that analyses in which data are averaged over strategies yield less accurate results compared with analyses in which the data are divided into subgroups adopting a certain strategy.

Based on the results above, it may be expected that children of the same age will form different subgroups showing individual differences in verbal and visual STM processes as long as they can choose a preferred type of processing and the subgroups are formed a posteriori based on the variance in responses. A very suitable way of investigating such expectations is to apply latent class models. Latent class models have been previously applied in research areas such as alcohol research (Muthén & Muthén, 2000), studies on strategy use (Jansen & van der Maas, 2002), reasoning (Bouwmeester, Sijtsma, & Vermunt, 2004), and in longitudinal studies on developmental trajectories with large datasets (see Laursen & Hoff, 2006, for an overview). Unfortunately, such models have not been applied much in studies aimed at inferring the type of (unconsciously) preferred STM processes based on specific response patterns of children, thereby revealing individual differences in memory performance. By far the most developmental memory studies investigate the performance of age groups and consider individual differences within those age groups to be nuisance. In the current study, these individual differences were used to form subgroups of children who showed similar response patterns on specific memory tasks.