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REPLY

Reply to Commentary by Collins: Distinguishing Proximal and Distal Levels of Explanation

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In this reply to Collins' (1994) commentary, I suggest that the differences between our two positions are more apparent than real. The principal difference seems to be that I (Salthouse, 1994) was emphasizing a proximal level of analysis, whereas Collins (1994) emphasized a distal level of analysis. I argue that both levels of analysis are useful and necessary in developmental research. © 1994 Academic Press, Inc.

The goal of the Salthouse (1994) article was to describe two analytical methods that might be used to determine the number of distinct factors contributing to age-related differences in cognitive functioning. In her commentary, Collins (1994) cautioned against the use of the term cause in the context of cross-sectional data and questioned the meaning of age as a predictive variable in developmental research. In addition, she expressed concern about only considering linear age-related effects in the analyses. However, because procedures exist for examining nonlinear effects, and because several reports have revealed that they are generally small compared to linear effects (McArdle & Prescott, 1992; Salthouse, 1993, in press), this latter issue appears to be of lesser importance and will not be addressed in this reply.

I will begin by noting that there are many points on which Collins and I are in agreement. For example, we both agree that if relevant information is available at the time of assessment, then longitudinal designs are much superior to cross-sectional designs for the identification of factors responsible for changes in cognitive abilities. We also agree that age is confounded with many other variables in cross-sectional (and I would add, also in longitudinal) research, and that age-related influences need to be unpacked or disaggregated in order to be meaningful. I also suspect that neither of us would dispute the assertion that age is merely a dimension along which relevant factors operate and is not a cause in and of itself.

The disparities in our positions primarily seem to reflect differences in level of analysis. The Salthouse (1994) article was largely focused at a proximal level, whereas Collins (1994) appears to emphasize a distal fo-

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cus. My major point in this reply is that both levels of analysis are useful and necessary for progress in developmental research.

The distal level of analysis attempts to identify factors from earlier periods in one's life that are responsible for the current level of performance. In contrast, a proximal level of analysis is concerned with characteristics at the time of assessment that are associated with (i.e., necessary and sufficient for) the current level of performance. (See Salthouse, 1991, for further discussion of this distinction in the context of adult developmental research.)

The distal level of analysis is valuable for unpacking what happens over time and for identifying what may have contributed to the observed age-related differences. The relevant factors could be related to nutrition, cumulative exposure to environmental toxins, cultural or educational experiences, etc. A very broad constellation of exogeneous time-related factors have the potential to influence behavior, and only some of those are typically subsumed within the concept of a cohort. The distal level of analysis is therefore essential to achieve an accurate specification of the true independent variable in developmental research.

However, distal influences do not operate directly, but instead are mediated through proximal factors. That is, distal factors alter something that in turn is responsible for performance at the time of assessment. The proximal mediators could be neurophysiological, such as a change in the quantity of particular transmitters or in the functioning of specific anatomical structures, behavioral, such as an alteration in the efficiency or capacity of a processing component or structure, or sociological, such as a shift in the roles and responsibilities allocated to people of different ages. In all of these cases, it is meaningful to refer to the concurrent factors as potential causes because they could be both necessary and sufficient for the observed level of performance.

Consider the phenomenon of slow running performance in a particular individual. Detailed analyses might reveal that the only physiological difference between this individual and faster individuals is in the strength of his leg muscles. In this specific situation, therefore, leg muscle strength might be viewed as a proximal (i.e., simultaneous) cause of the observed level of running performance, particularly if interventions to alter muscle strength were found to result in faster running speed. Although muscle strength could be viewed merely as a dimension of the running speed phenomenon, it is important to note that muscle strength is assessed independently of running speed. Furthermore, localization of the source of the phenomenon in this manner serves to facilitate research concerned with distal interpretations by allowing researchers to focus on determinants of what is likely to be the critical proximal cause rather than on irrelevant proximal features such as foot size and arm length.

This example reveals that an important goal of a proximal level of analysis is to unpack the dependent variable and to provide the most parsimonious description of what needs to be explained. That is, an analytical approach is adopted in order to characterize as precisely as possible what there is about the current level of functioning that is responsible for the observed level of performance.

As noted above, if the proximal focus is successful at reducing the number of to-be-explained phenomena, then the existence of a clearer description of what ultimately needs to be explained should facilitate the identification of relevant distal factors. For example, if research reveals that only three or four factors are sufficient to account for a large percentage of age-related variance in 100 or more distinct cognitive variables, then the task for other levels of explanation should be considerably easier.

The Salthouse (1994) article was oriented toward this proximal level of analysis in that it was concerned with the question of how many distinct proximal causes (i.e., characteristics of processing at the time of assessment) are involved in the age-related differences in cognitive functioning. It is quite true that from a certain perspective the outcome of proximal analyses can be considered to yield mere description, or a specification of concurrent correlates, of the phenomenon (see Salthouse, 1991). It is also true that proximal causes should eventually function as endogeneous (dependent) variables with distal causes serving as exogeneous (independent) variables. Nevertheless, analyses at the proximal level serve a valuable role in developmental research by providing an accurate and parsimonious specification of the dependent variable. Neither proximal nor distal levels of analysis should therefore be neglected in developmental research.

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