Authors’ Reply

Age Versus Time Since Baseline as the Time Scale in the Analysis of Change

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We appreciate the comments by Mendes de Leon (2007) regarding the challenges involved in using multilevel models to analyze aging effects in samples of older adults that combine multiple birth cohorts. The core argument in the latter portion of his commentary focuses on the advantages of using continuous, rather than categorical, outcome variables when analyzing aging-related change. We are in complete agreement with Mendes de Leon on this point.

In Part 1 of his commentary, Mendes de Leon expresses concern over our approach of modeling change by age at the time of each interview as opposed to time since baseline (see Shaw, Krause, Liang, & Bennett, 2007). His major concern is that our age-based approach fails to fully distinguish between cross-sectional age differences and longitudinal changes in a variable of interest. He indicates that failing to distinguish between these two effects could result in estimates of aging effects that are biased, due either to birth cohort effects or the “healthy participation effect.”

We wish to convey our view that using a time-based approach is not the only means for addressing this concern. First, cross-sectional age differences can be controlled for in age-based models just as they are in time-based models. As we noted in our article, we did this by including dummy variables for 10-year birth cohorts (corresponding to baseline ages of 85 and older, 75–84, and 65–74) into our between-persons (Level 2) models.

We should note that including measures of birth cohorts in our models should have controlled for both the cohort effect and the healthy participation effect referred to by Mendes de Leon. That is, in addition to accounting for differences in social relations between cohorts observed at the same point in time (i.e., a cohort effect), including measures of birth cohorts should also have accounted for differences in social relations between individuals who were the same age at different points in time (e.g., individuals who were 75 years old at baseline vs individuals who were 65 years old at baseline and 75 years old at follow-up) as is proposed by the healthy participation effect.

Nevertheless, some may raise concerns about the coarseness of our cohort definitions relative to a continuous age variable. For example, Mendes de Leon suggests that our measures of birth cohorts might be inadequate controls for the healthy participation effect because “a healthy participation effect may not manifest itself in discrete 10-year age intervals” (p. S199).

Although this may be true, it is not an issue of age-based versus time-based models. In fact, in a set of supplementary (unpublished) analyses we estimated our age-based models using a continuous measure of baseline age rather than the cohort dummy variables. The results regarding aging effects were quite similar.

With controls for baseline age (measured either as dummy cohort variables or as a continuous variable) in place, we feel that the choice of time versus age as the time scale should not have major substantive implications. Time and age are perfectly colinear, with equal increments. The main difference is that time effects from time-based models estimate change over a common period of time for each individual (e.g., from Year 0 to Year 10), whereas age effects from age-based models estimate change over the entire course of later adulthood (e.g., from age 65 to age 100). We acknowledge that spreading the aging effects across the entire age range resulted in trajectories that probably did not fully distinguish between aging and cohort effects, even after we included measures of birth cohorts in our models. However, because our major objective was to examine changes in social relations across this entire age range and not just over a certain 10-year period, we feel that this is a limitation we can live with. This is especially true given that our data showed only modest differences in the results when we compared age-based and time-based approaches. We have done our best to describe these differences for readers as clearly as possible and have also noted the potential limitations of our age-based approach.

At this time, we should also note that, to the best of our knowledge, the extent of any healthy participation effect in longitudinal data is not well established. Although we believe that it is reasonable to assume that the average 75-year-old who enters a study at baseline is relatively healthy (otherwise this individual would not have participated in the first place), it is also reasonable to assume that the average person who turns 75 years old during follow-up is relatively healthy as well (otherwise this individual would have dropped out). Thus, it is not clear how influential the healthy participant effect really is. We surmise that the extent to which aging effects are influenced by healthy participation effects probably has more to do with the outcome studied and the length of follow-up than the particular indicator of the passage of time used.
Moreover, given our uncertainties regarding the healthy participation effect, we feel that a more significant source of potential bias in studying change over time is likely to arise from differences between those who dropped out of the study and those who have complete data across all waves. Estimates of aging effects are likely to mask these differences, and therefore we have attempted to account for this possibility explicitly in the Analysis of Attrition section of our article.

In closing, we would like to make clear our opinion that neither the age-based nor the time-based approach is perfect, but both are suitable options. Although both fail to fully untangle age, period, and cohort effects, and although neither approach reveals the extent of any healthy participation effect, both approaches can control for these effects to some degree. With this in mind, we agree with Mendes de Leon that readers could benefit from guidance regarding which approach is most appropriate in a given situation. Mendes de Leon’s suggestion of modeling baseline age and time separately within the same model, assessing the level of similarity between these effects, and then deciding whether to retain the time-based approach or use the age-based approach is a useful starting point. However, as Mendes de Leon himself acknowledges, at this point the guidelines offered for defining an acceptable level of similarity are largely heuristic rather than statistically based.

Therefore, for the time being we favor a decision-making process that is based on what these two options mean from a theoretical point of view, and how these different approaches affect the substantive findings. If one is interested in estimating aging effects across a wide age range, then an age-based approach probably provides more easily interpretable results. If one is more interested in change over a particular period of time, then the time-based approach is probably better. Moreover, by running both the age-based and the time-based approaches and noting the extent to which substantive findings differed, as we have done, investigators can gain a clear sense of the impact of any additional bias in the age-based models compared to the time-based models. If differences in the substantive findings between age-based and time-based models are minor and are fully disclosed, and if readers are made aware of the limitations and the assumptions required for both approaches, we feel that any limitations of the age-based approach are outweighed by its advantages in illustrating the course of aging-related changes throughout late life.

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**References**


*Received January 30, 2007*

*Accepted January 21, 2007*

*Decision Editor: Kenneth F. Ferraro, PhD*