TECHNICAL APPENDIX

SD_{noise} affects SD_{obs} in the following way:

$$SD_{obs}^2 = SD_{signal}^2 + SD_{noise}^2$$

where SD_{signal} is the underlying true but unmeasurable SD, as if based on measurements free of noise. Because the terms are squared, SD_{noise} needs to approach SD_{signal} in size before it has any important effect on SD_{obs}. Rearranging the formula as:

$$SD_{signal}^2 = SD_{obs}^2 – SD_{noise}^2$$

provides an estimate of SD_{signal}. An extra-noisy version of SD_{obs} is obtained by doubling SD_{noise} to give:

$$SD_{obs+noise}^2 = SD_{signal}^2 + (2\times SD_{noise})^2.$$

For Figure 2 the increment data were grouped by measure and time interval, and their mean and SD were modelled as P-spline curves in √age with 6 degrees of freedom using the NO family in GAMLSS (1). The choices of degrees of freedom and age transformation were guided by the BIC. Table 2 is based on Figure 2, with columns 2-4 corresponding to the ages where the Mean curve crosses each of the SD curves, while columns 5-7 are the % velocity centile corresponding to the z-score z = -Mean/SD at 12 months.

For Figure 3 the increment data were again grouped by measure and time interval, and expected age-specific increments corresponding to the 9th velocity centile were calculated as $Mean_{obs}$ - 4/3 SD_{obs} using the smoothed values in Figure 2. Then each increment was converted to a velocity z-score z = (increment – $Mean_{obs}$) / SD_x where SD_x was respectively SD_{signal} and $SD_{obs+noise}$, and the corresponding velocity centile curves were plotted against age.

1. Rigby, R. A. and D. M. Stasinopoulos (2005). "Generalized additive models for location, scale and shape (with discussion)." Applied Statistics 54(3): 507-544.