Is movement variability a consistent personal trait? Kinematic evidence from long-cycle assembly work.

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Background: Recent studies have shown evidence of consistent individual levels of kinematic cycle-to-cycle variability across days during simple, short-cycle repetitive tasks and in more complex, longer cycle assembly work. However, it is unknown whether movement variability is a consistent personal trait across tasks.

Objectives: The aim of the study was to determine if individuals were consistent in movement variability traits across four types of assembly work.

Methods: Upper arm elevation angles (UAEAs) were collected from 15 women performing 36 cycles of simulated occupational assembly work under 4 temporal organisation and work pace conditions, namely: self-paced, assembly line style at 110 MTM pace, batch work at 110 MTM pace, and assembly line style at 120 MTM pace with forced breaks after every 6 assemblies. Mean UAEAs were calculated for each cycle (*mean UAEA)*, and the standard deviation (SD) of the mean angles across cycles was determined for each task (*SD of mean UAEA*). A more detailed comparison was achieved by time-normalising all work cycles, and computing the SD across work cycles of UAEAs for each individual and task at each time point. For each individual and task, the SDs were pooled using a root-mean square procedure to obtain an overall estimate of the standard deviation in UAE trajectory (*SD of UAE trajectory*). For each of the three variables, the total variance was partitioned to between-subjects, within-subject between-tasks, and residual (i.e. within-subject between-days) variance components using a random effects ANOVA III model with subject and condition as nested factors.

Results: For the *SD of UAE trajectory* metric, a true variance *between-subjects* for was found, and it accounted for over half of the total variance – Table 1. These data indicate that individuals differed significantly in the amount of movement variability they demonstrated during repetitive assembly work. Unique *within-subject* components of variance were found for this metric for *task* and *day*, however, the amount of variance attributable to *task* and *day* was markedly smaller than that attributable to subject. For the *SD of mean UAEA* metric, the greatest proportion of variance was attributable to differences *between-days.* Further, the 95% CI for the variance *between-subjects* contained 0, indicating uncertainty in that estimate. Thus, the metric based on a single mean value per cycle did not capture the relevant aspect(s) of movement variability on which subjects differed.

Conclusion: These data demonstrate that consistent individual movement variability strategies were present across four types of long-cycle assembly work which could be identified using the *SD of UAE trajectory* metric. These data offer support for the repeater-replacer hypothesis.

Table 1 – Variance components and 95% CIs calculated for two metrics assessing movement variability in upper arm elevation angle data.

		Variance	95% CI
SD of UAEAs			
Between-subjects		0.04	0.00 - 0.15
Within-subject	Between-tasks	0.03	0.00 - 0.11
Within-subject	Between-days	0.07	0.05 - 0.13
SD of UAE trajectory			
Between-subjects		1.28	0.35 - 3.73
Within-subject	Between-tasks	0.62	0.09 - 1.36
Within-subject	Between-days	0.43	0.27 - 0.76