Moving ahead through time?

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Abstract

Miles, Nind and Macrae (2010) reported findings to suggest that our ability to mentally represent the past and future might be represented in the sensorimotor systems that govern human motor control. They ran an experiment showed participants to lean forward when thinking of the future and lean backward when thinking of the past. We aimed to explore this phenomenon further; firstly by exploring whether the knee would move in the opposite direction to the head when participants were standing (i.e. an automatic counterbalancing movement to avoid instability). We also applied the same methodology as reported by Miles et al. (2010) in an attempt to replicate their results. Findings demonstrated that found that the head does indeed move in the opposite direction to the knee, but more interestingly, our second experiment actually failed replicate Miles et al's (2010) original findings. Our data strongly suggest that the sensorimotor system prioritises the maintaining of postural control postural maintenance even when a standing individual is engaged in abstract thought processes. This strategy seems the most conducive to survival, given that this approach reduces the likelihood of falls.

Summary

Miles, Nind and Macrae (2010) suggested that mental time travel (a.k.a 'Chronesthesia' - the ability to mentally represent ones past and future) might be represented in the sensorimotor systems that govern human motor control. Miles et al. (2010) reported found that 20 standing participants leaned forward when thinking about the future, and contrastingly leaned backwards when thinking about the past – as indexed by a progressive linear shift in knee position. This is a most notable finding because it suggests that postural stability can be placed at risk through abstract thought processes. More interestingly, the findings reported by Miles et al. (2001) seem especially strange given that forward movement of the knee appears to automatically involve a counterbalancing backward movement of the head, and vice versa (NB. probably as a fall avoidance mechanism) as can be readily established by the interested reader.

In order to explore the phenomena reported in the original Miles et al. (2010) study, we ran two experiments. In the first experiment we explored the relationship between knee and head movement and found that the head does indeed move in the opposite direction to the knee. This raises the intriguing question of why participants in Miles et al's (2010) study moved their head in the opposite direction of their thoughts (i.e. it seems reasonable to suppose that the head might be considered the seat of 'mental time travel'). In a second experiment we therefore repeated exactly the methods used by Miles et al. (2010), yet nevertheless failed to replicate their findings.

Methods

Experiment 1

Ten participants (age range = 22 to 45 years; 6 females) were recruited from an opportunistic sample. Participants had an Infrared Diode (IRED) attached to their knee (lateral femoral epicondyle) and to the temple of the head. The experimental task required participants to stand in three different postures: (i) normal upright standing position; (ii) with their knees pushed forward; (iii) with their knees pushed backwards. The relative position of the head and knee IREDs were captured using a motion analysis system (NB. Optotrak was used for this analysis) for five seconds at a rate of 100Hz.

Experiment 2

Twenty participants (age range = 21 to 30 years; 13 females) were recruited (from an opportunistic sample) to take part in a direct copy of the experiment ran by Miles et al. (2010). Methodology for this study was identical to the set-up employed by Miles et al. (2010), except that we used an "Xsens 3D Orientation Inertial Sensor" rather than the "Polhemus Motion Tracker". The sensor for experiment 2 was attached just above the knee (as per Miles et al., 2010) with its major axis aligned with the major axis of the tibia. We

decided the inertial sensor was preferable to the Polhemus as it directly measured the leg orientation with respect to gravity (i.e. angular resolution of 0.05 degrees). This provides a direct measure of postural orientation that is normalised for individuals of different height. In contrast, changes in positional data (as reported by Miles et al., 2010) cannot be unambiguously interpreted as shifts in postural orientation and are a function of participant height.

The University of Leeds ethics and research committee approved this experiment and all participants gave written, informed consent in accordance with the Declaration of Helsinki.

Results

Experiment 1

Forward movement of the knee (mean knee movement = 17.9cm) resulted in a mean relative head movement of 15.58cm in the opposite direction. Conversely, backward knee movement (mean = 7.0cm) resulted in a mean of 14.51cm movement of the head in a forward direction. This was statistically significant as indicated by an independent t-test ($t(9) = 4.157$, $p=0.002$), and this pattern was the case for all of the ten participants.

Experiment 2

Analyses revealed a slight (but non-significant) degree of sway, but no systematic shift of postural orientation in the Chronesthesia conditions (mean sway = 0.40 degrees across participants over the 15sec, with no differences in sway between the retrospective and prospective thought conditions; $t(19) = 0.632$, $p=0.535$). We fit linear regressions to each individual's data (as per Miles et al., 2010) and compared the retrospective and prospective thought conditions. This revealed no significant difference between conditions ($t(19) = 0.524$, $p=0.606$).

Discussion

Miles et al. (2010) suggested, interestingly, that prospective and retrospective thinking can influence standing posture as indexed by knee position. Our data would therefore suggest that the head moved in the opposite direction to the supposed "mental time travel" – which would be most remarkable. Nevertheless, we were actually unable to replicate the findings of Miles et al. (2010) in our second experiment. It is not clear why we did not find the same results but one possibility is that their results are an artefact of inappropriate analysis and/or

measurement. Instead of examining each individual's posture, Miles et al. (2010) took the average knee position across all their participants at fifteen different time points. They then averaged the group positional data at these fifteen different points and used linear regression to fit their data. Postural sway is a natural phenomenon (and we observed such non-systematic movement in our experiment), hence some random change in position is expected over time at an individual level. This observation suggests that group averaging might paint a misleading picture of an individual's stance.

The notion that abstract mental time travel is revealed in standing posture has an appealing simplicity. The intuition that temporal thought processes are reflected in 'body language' might yet receive support from studies of seated individuals - people might systematically lean backwards in their chair whilst retelling some yarn of old but tilt forward as they state their prospective plans. Future work can test such conjectures. But our data strongly suggest that the sensorimotor system prioritises postural maintenance in a standing individual even when engaged in abstract thought processes – which seems sensible as the priority for the system must be the avoidance of falls.

References

Miles, L. K., Nind, L. K. and Macrae, C. N. (2010). Moving Through Time. *Psychological Science*, 21, 222–223.