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Being (un)moved by mental time travel

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ABSTRACT

Mental imagery of events in the past or future, and of unpleasant or pleasant events, has been found to lead to spontaneous backward/forward bodily motions. Both time and emotion are represented along a spatial continuum, and activation of these representations seems to be simulated in spontaneous changes in body posture. We performed a conceptual replication and extension of an earlier study by Miles, Nind, and Macrae (2010) who reported clear postural effects when thinking of the past and the future. We additionally tested whether changes in posture appear when thinking of an emotional event. Volunteers engaged in mental imagery, involving combinations of time intervals and emotions. We simultaneously recorded center-of-pressure (COP) changes. Results revealed neither an effect of imagery of time nor of emotion on body posture. We conclude that embodied effects of imagery of abstract items on body posture may be less robust than suggested by previous literature.

1. Introduction

Humans have the capacity to imagine the subjective experience of objects, events or scenes, in the absence of an immediate physical referent. This is referred to as mental imagery. In mental imagery, various sensory and affective impressions can be generated (intentionally or unintentionally) that resemble the experience when confronted with the real physical counterpart. There is growing recognition that mental imagery is accompanied by changes in bodily states, such as heart rate and respiration (e.g., Decety, Jeannerod, Durozard, & Baverel, 1993; Oishi & Maeshima, 2004), the direction of eye movements (Hartmann, Martarelli, Mast, & Stocker, 2014), subliminal muscle activity (e.g., Guillot et al., 2007) and postural sway (e.g., Boulton & Mitra, 2013). According to some (e.g., Grangeon, Guillot, & Collet, 2011), such bodily manifestations of cognitive activity may be indicative of 'embodiment' effects, meaning that the mental (imagined) content automatically triggers associated bodily responses. In keeping with this view, thought and action are tightly coupled, so that cognitive activity may lead the body to 'resonate' in like fashion (cf. Barsalou, 2008).

Various studies (outlines below) have found evidence for effects of mental imagery on the control of upright standing. An obvious starting point to investigate such effects is by asking subjects to mentally simulate one of several motor activities (e.g., running, grasping), and to record accompanying changes in postural dynamics. More precisely, changes in the center-of-pressure (COP) displacements may reveal whether, and to what extent, postural behavior is affected by mental states. Several studies reported evidence of postural changes that were specific to the imagined motor acts (Boulton & Mitra, 2013;

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Grangeon et al., 2011; Rodrigues et al., 2010; Stins, Schneider, Koole, & Beek, 2015). For example, Grangeon et al. (2011) found that kinesthetic motor imagery of jumping led to greater postural variability than imagery of finger movements. A likely explanation for these effects is that the to-be-imagined motor activity was not completely blocked from the motor periphery, so that participants made unintentional and subliminal postural adjustments that reflected the imagined motor patterns.

Even though such findings are consistent with an embodiment account, they merely indicate an aspecific increase in postural variability as a function of imagery of various motor acts. However, the embodiment account would gain stronger support if body posture were to shift in a specific direction as a function of thought. As a case in point, two intriguing studies found that generating abstract thoughts indeed led to shifts in body posture along the anterior-posterior axis or —more informally—, forward or backward 'leaning'. Miles, Nind, and Macrae (2010) found that thinking about the past vs. thinking about the future (dubbed 'mental time travel', or '*chronesthesia*') had discernible effects on body position during upright standing. More specifically, thinking about the past led subjects to adopt a slightly backward (posterior) body posture, whereas thinking about the future led subjects to adopt a slightly forward (anterior) body posture. These findings suggest that abstract representations, such as the direction of time, are in fact represented along a spatial dimension, and that the activation of such representations leads to directional changes in body posture. This, in turn, is consistent with the notion that symbolic concepts, such as metaphors (e.g., the 'arrow of time'; Miles et al., 2010, p. 222), are embodied in the sensory-motor system (Gallese & Lakoff, 2005). There is evidence from other paradigms for the notion that time is mentally represented along a spatial continuum. Ulrich et al. (2012) examined the differential ease with which forward/backward arm movements could be executed, when participants were presented with sentences describing events that took place in the past or in the future. It was found that forward movements in response to sentences describing future events and backward movements in response to past events led to faster reaction times compared to the alternate (incongruent) mapping. In another intriguing experiment by Hartmann and Mast (2012), seated participants were passively moved either in a forward or backward direction. It was found that categorization of verbal material related to the future was faster when being moved forward compared to being moved backward. However, the expected converse effect with stimuli involving the past was not significant. In sum, there is evidence from reaction time studies that the representation of time is anchored in space. In that regard, innovative behavioral measures such as changes in body posture, may lead to new insights as to how cognition is grounded in sensory-motor modalities, and to what extent the upright body posture provides a physical substrate for cognitive activity (Frazier & Mitra, 2008).

Miles, Christian, Masilamani, Volpi, and Macrae (2014) performed a follow-up study involving mental imagery of social encounters, and they again tested the emergence of differential postural effects. Similar to the representation of time, the representation of social encounters could also prime (whole body) forward/backward responses. Miles et al. (2014), using the same setup as in their 2010 study, indeed found that imagined positive social encounters (imagining meeting a friend) resulted in forward motion of body posture, whereas imagined negative social encounters (seeing a stranger) resulted in backward bodily motion. Interestingly, the effect only showed up from a first-person (egocentric) perspective, and not from a third-person (allocentric) perspective. The authors argued that mental simulation of the social encounters led to sensorimotor reenactments of the events (i.e., approach and avoidance tendencies), which in turn resulted in anterior and posterior displacements of the body, respectively. This latter effect is consistent with posturographic studies that showed that valence of visual stimuli can lead to whole-body approach-avoidance effects, as regards the control of quiet standing (e.g., Hillman, Rosengren, & Smith, 2004) and the control of forward step initiation (e.g., Bouman, Stins, & Beek, 2015; Stins & Beek, 2011). The latter three studies found evidence for the notion that postural changes in the anterior direction couple to positively valenced visual stimuli. Evidence for the converse effect (backward/unpleasant) has also been found but tends to be weaker. Theoretically, the effects have often been taken as support for the notion that emotions activate motivational (behavioral) tendencies, which in turn shows up in whole body postural adjustments, often with a clear directional (forward/backward) component.

The above two studies by the Miles group were original, and seem to have led to clear-cut postural effects, providing compelling evidence for the notion that abstract thought is embodied in body posture. However, several empirical and methodological issues remain to be answered.

First, Miles et al. (2010) asked subjects to picture themselves four years in the past, or (in another group of subjects) to picture themselves four years in the future. In their Discussion, Miles et al. (2010) suggested that future research should look at whether the effect would be modulated by 'temporal distance' (p. 223), so that less distant events would perhaps lead to smaller postural effects compared to more distant events. Hence, the first aim of our study was to test this hypothesis by directly comparing mental imagery involving four years in the past and the future, and mental imagery involving four days in the past and the future.

Second, the interpretation by Miles et al. (2014) regarding postural directional effects of imagining social encounters may not be conclusive, as alternative explanations are possible. For instance, it may be asked whether the effects of emotion were due to the valence (i.e., pleasantness), or the motivational properties of the imagery events. That is, thinking of a good friend not only elicits feelings of warmth and positive affect, but also the tendency to approach that person and shake his hand. Therefore, in the current study, we asked participants to think of pleasant and unpleasant events in their life (potentially involving social interaction), instead of direct (imagined) face-to-face social encounters, as in Miles et al. (2014). Posturographic studies (e.g., Hillman et al., 2004; Stins & Beek, 2011) found that visual stimuli with affective content can have a