



Uncovering effects of self-control and stimulus-driven action selection on the sense of agency



Yuru Wang, Tom G.E. Damen, Henk Aarts*

Department of Psychology, Utrecht University, The Netherlands

ARTICLE INFO

Keywords:

Sense of agency
Simon task
Intentional binding
Self-control
Automatic process

ABSTRACT

The sense of agency refers to feelings of causing one's own action and resulting effect. Previous research indicates that voluntary action selection is an important factor in shaping the sense of agency. Whereas the volitional nature of the sense of agency is well documented, the present study examined whether agency is modulated when action selection shifts from self-control to a more automatic stimulus-driven process. Seventy-two participants performed an auditory Simon task including congruent and incongruent trials to generate automatic stimulus-driven vs. more self-control driven action, respectively. Responses in the Simon task produced a tone and agency was assessed with the intentional binding task – an implicit measure of agency. Results showed a Simon effect and temporal binding effect. However, temporal binding was independent of congruency. These findings suggest that temporal binding, a window to the sense of agency, emerges for both automatic stimulus-driven actions and self-controlled actions.

1. Introduction

The sense of agency – the feeling that one causes one's own actions and their subsequent outcomes – is a pervasive and socially well-shared experience that is fundamental to human self-perception and social functioning (Frith, 2014; Wegner, 2002). The sense of agency has been mainly conceptualized and studied as a product of volitional action (Haggard, 2017). Specifically, goal-directed action simultaneously triggers a predictive signal of sensory action-outcomes and a sense of agency emerges when the prediction is consistent with the actual sensory feedback (Haggard, 2008; Haggard & Clark, 2003). The voluntary nature of agency has been nicely demonstrated in the temporal binding task. This implicit measure of the sense of agency hinges on pre-reflective, sensorimotor processes (Haggard, Clark, & Kalogeras, 2002; Stenzel, Schneider, & Engel, 2011), and reveals that intentional action selection produces a temporal contraction in perception between action and outcome compared to when the same action is externally generated. Accordingly, the sense of agency is suggested to originate in self-controlled action selection, and hence represents the voluntary nature of human behavior.

Whereas the voluntary nature of the sense of agency has received much theoretical and empirical attention in research on the temporal binding between action and effect (see Hughes, Desantis, & Waszak, 2012), research on the role of externally controlled action selection in temporal binding has been relatively limited. Building on the notion that behavior is a function of the will and habit (Ach, 1910/2006; James, 1890), the present study aimed to investigate the differential effects of self-control driven versus automatic stimulus driven actions on the sense of agency. Specifically, we examined whether the temporal binding of action and effect is modulated when action selection shifts from processes that rely on volition towards more externally driven processes. Understanding this shift is important, as it provides insight into the question of whether the sense of agency decreases when

* Corresponding author at: Utrecht University, Department of Psychology, Heidelberglaan 1, 3584 CS Utrecht, The Netherlands.
E-mail address: h.aarts@uu.nl (H. Aarts).

individuals move from willful to habitual behavior, and hence volition has a special status for human social functioning (Bayne & Pacherie, 2015).

1.1. *Intentional binding – a window to the sense of agency*

The sense of agency over actions is primarily rooted in motor-prediction processes described in models of goal-directed motor control (Crapse & Sommer, 2008; Frith, Blakemore, & Wolpert, 2000; Pynn & DeSouza, 2013; Wolpert & Flanagan, 2001). The voluntary selection of a goal-directed action is accompanied by the prediction of sensory action-outcomes based on internal copies of movement-predicting signals (i.e., efference copies) generated by the sensorimotor system. This prediction is supposed to be absent in cases where action selection is involuntary or externally controlled and behavior is fully automatic and unintentional. The efference copy pertains to signals sent out from brain areas involved in motor control to the sensory (e.g., auditory) cortex and allow for a comparison with the actual sensory feedback of action (e.g., when pushing a key predicts the occurrence of a high frequency tone). These internal motor predictions are generally considered to be short-lived but very reliable, and sensory outcomes are readily perceived as self-produced unless the prediction does neither correspond with the actual outcomes nor occur in the first place.

The notion that self-produced effects are perceived differently from externally caused effects allows for a systematic measurement of self-causation. According to a pre-activation account of the sense of agency, predicting a sensory outcome increases the baseline activation of the representation of the outcome in the sensory cortex. When the predicted outcome actually occurs, the increased activation causes the outcome to be perceived sooner, as the increased baseline gives the perception of the outcome a head start in reaching the threshold of consciousness (Waszak, Cardoso-Leite, & Hughes, 2012). Thus, a match between the predicted and actual outcome causes one to implicitly perceive (see, hear, or feel) the sensory outcome-information that comes in from the environment earlier and faster, compared to situations in which the baseline activation is not increased or the predicted and actual sensory outcome do not match.

An important implicit way to measure this shift in time perception as a window to the sense of agency is the intentional binding task (Haggard et al., 2002). In an adaption of the Libet, Gleason, Wright, and Pearl (1983), participants perform an action (e.g., a key press) directly followed (e.g., 250 ms) by an outcome (e.g., the occurrence of a tone), and judge the timing of their own action and the outcome with the help of a concurrently rotating clock hand on a computer screen. When selecting actions voluntarily, participants commonly perceive the occurrence of the action and effects as closer in time, hence, the term intentional binding. Crucially, when the action is induced involuntarily by means of transcranial magnetic stimulation (TMS) over the primary motor cortex, and thus does not issue an efference copy to predict the outcome, the binding effect vanishes or even reverses. This latter finding has been taken as evidence that binding of action and effect in terms of perceived time is indeed a result of volition, and hence, represents an implicit measure of the sense of agency.

Building on this work, several studies have examined qualifiers of the motor-prediction process in yielding the sense of agency, such as manipulating the predictability of the action-effect, the time delay between action and effect, externally induced action movement, and motivational boosting of action-effect anticipation by reward signals (e.g., Aarts et al., 2012; Dogge, Schaap, Custers, Wegner, & Aarts, 2012; Haggard et al., 2002). In short, this research indicates that intentional binding occurs when action follows from a voluntary generated movement, and the prediction signal accompanying the preparation of action is strong and reliable enough to render a comparison with the actual sensory feedback of the action possible.

1.2. *Stimulus-driven processes versus self-controlled processes*

So far, research suggests that the intentional binding effect is closely associated with the sense of agency, especially when agency emerges from self-control processes that involve voluntary action selection and the prediction of resulting sensory effects (Brass & Haggard, 2007; Renes & Aarts, in press). Taking away voluntary action selection decreases intentional binding, as involuntary or externally triggered actions do not (or to a lesser extent) produce a prediction signal of the sensory outcomes. The specificity of the temporal binding effect to voluntary movement implies the involvement of sensorimotor control mechanisms that may play a key role in generating the sense of agency.

The difference between voluntary vs. involuntary action selection addressed above speaks to the degree to which human behavior is directed by the will or habit (Ach, 1910; James, 1890), that is, how much of the behavior is under the control of volition or external stimuli (Aarts & Custers, 2009; Aarts, Verplanken, & Knippenberg, 1998; Berberian, Sarrazin, Le Blaye, & Haggard, 2012; Waszak et al., 2005). Habits are proposed to represent stimulus-driven actions in which goal-relevant cues can initiate actions automatically, thus rendering volitional control more or less redundant in selecting that very same action. However, apart from this functionality aspect, stimulus-driven actions can also be dysfunctional, such as when the stimulus-driven response opposes the selection of an instructed action to produce an effect, and volitional control is required to overcome the pre-potent response. In other words, goal-directed actions (that is, selecting an action to cause a subsequent effect) can follow from a high or low degree of volition, depending on whether action selection relies on self-control or a more automatized process. Assuming that volition, rather than automatism, is the key to the sense of agency, proper selection of an action that competes with a stimulus-driven response may be associated with a stronger sense of agency than an automatic stimulus-driven response, because selecting the action to cause an effect is more effortful and the result of an act of self-control (Danner, Aarts, & Vries, 2008; Demanet, Muhle-Karbe, Lynn, Blotenberg, & Brass, 2013; Wegner, 2002).

Most research on the role of external control in agency has relied on methods (such as TMS or a finger pull device) that fully remove action selection processes (Haggard & Clark, 2003; Haggard et al., 2002; Kühn, Brass, & Haggard, 2013; Moore, Teufel,

Download English Version:

<https://daneshyari.com/en/article/5041754>

Download Persian Version:

<https://daneshyari.com/article/5041754>

[Daneshyari.com](https://daneshyari.com)