

Hedonic value of intentional action provides reinforcement for voluntary generation but not voluntary inhibition of action



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ABSTRACT

Intentional inhibition refers to stopping oneself from performing an action at the last moment, a vital component of self-control. It has been suggested that intentional inhibition is associated with negative hedonic value, perhaps due to the frustration of cancelling an intended action. Here we investigate hedonic implications of the free choice to act or inhibit. Participants gave aesthetic ratings of arbitrary visual stimuli that immediately followed voluntary decisions to act or to inhibit action. We found that participants for whom decisions to act produced a strong positive hedonic value for the immediately following visual stimulus made more choices to act than those with weaker hedonic value for action. This finding is consistent with reinforcement learning of action decisions. However, participants who experienced inhibition as generating more positive hedonic value did not choose to inhibit more than other participants. Thus, voluntary inhibition of action did not act as reinforcement for future inhibitory behaviour. Our finding that inhibition of action lacks motivational capacity may explain why self-control is both difficult and limited.

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1. Introduction

The feeling of deciding and controlling one's own behaviour – of intentional action – is a fundamental aspect of human mental life. However, defining the unique features of actions that make them specifically intentional – as opposed to reactive or “absent-mindedly” reflexive – has proven problematic. A common idea suggests that actions are intentional if the agent ‘could have done otherwise’. One psychological interpretation of this idea invokes healthy adults’ capacity to withhold or ‘veto’ actions that they are about to make. Many people recognise the experience of becoming very angry with a friend to the point of saying something they would regret later... and then feeling relieved if they did indeed stop themselves from saying those cross words at the very last minute. We use the term intentional inhibition to refer to this capacity to voluntarily refrain from an impending action just before execution.

Thus, just as intentional action can be defined in terms of behaviour that is selected and executed based upon endogenous (internally generated) processes (Passingham, Bengtsson, & Lau, 2010), so intentional inhibition can be defined as an endogenously-generated last-moment “brake” on an action that is about to be executed. While inhibition of action triggered by external stimuli has been extensively studied (Logan, Cowan, & Davis, 1984; Verbruggen & Logan, 2008), intentional inhibition of action has been neglected until relatively recently, despite growing awareness of the need to accommodate volition within theories of cognitive control (Aron, 2011).

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Brass and Haggard (2008) included intentional inhibition in a general cognitive model of intentional action, by postulating three distinct decision processes: what action to perform, when to perform it, and whether to actually go ahead with it. Neuroimaging evidence for the whether decision came from a modified version of the Libet task (Brass & Haggard, 2007). Participants were instructed to make volitional key-press actions, and report the timing of their intention to do so as in Libet's experiment (see Libet, Gleason, Wright, & Pearl, 1983), but were also instructed to sometimes cancel the key-press action at the last possible moment. An area in the dorsal fronto-median cortex (dFMC) was active when participants intentionally inhibited their action, compared to when they intentionally acted. This area might therefore house a “brake mechanism” for overriding and inhibiting areas that participate in voluntary action, such as the presupplementary motor area (pSMA; Kühn, Haggard, & Brass, 2009).

Interestingly, Brass and Haggard (2007) also found activations of anterior insula cortex (AIC) on intentional inhibition trials. They speculated that this could reflect a negative hedonic feeling due to the “frustration” of inhibiting an action that had already been prepared. The AIC has previously been associated with the processing of inhibitory failure (Ramautar, Slagter, Kok, & Ridderinkhof, 2006) and disappointment (Chua, Gonzalez, Taylor, Welsh, & Liberzon, 2009). Further, a positive or negative hedonic response to inhibition could provide a valuable reinforcement signal biasing selection of action or inhibition on subsequent occasions. In this way, the “will” might be affectively trained by appropriately reinforcing some courses of action, while reinforcing inhibition from other courses of action.

Importantly, action and inhibition may have hedonic value for two quite distinct reasons. First, action and inhibition processes might have different intrinsic hedonic values: for example, inhibiting an action might be intrinsically less satisfying than executing it, as Brass and Haggard (2007) suggested. Second, action and inhibition may each be associated with specific external rewards (Guitart-Masip et al., 2011). These extrinsic relations between action and value are widely studied under the labels of goal-directed action, and decision-making. However, the intrinsic hedonic values of action and inhibition have not been widely studied, and it remains unclear how such intrinsic value guides voluntary action choices. Here we have studied the intrinsic hedonic value of action and inhibition by instrumentally associating free choices to act or inhibit action with arbitrary visual effects, and asking participants to make hedonic judgements of those visual images. Thus, we have studied value of action/inhibition through association with their outcomes, taking advantage of the transmission of value between associated events in the same way as studies of goal-directed decision-making. However, our approach differs in one crucial respect. In goal-directed decision-making studies, the value is transferred from outcome to action or to inhibition. However, in our approach, the outcomes are themselves valueless, and value is transferred in the other direction, from action or from inhibition to outcome. The hedonic value of outcomes thus becomes a useful experimental probe for the intrinsic hedonic value of action and of inhibition (see Fig. 1).

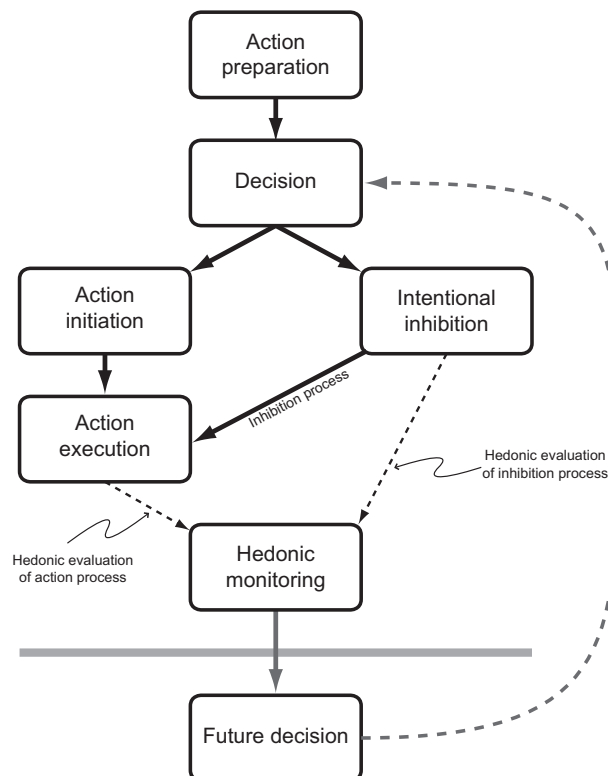


Fig. 1. A schematic of hedonic processes involved in volitional action and intentional inhibition. Adapted from Brass and Haggard (2010).

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