



## Brief article

# Having control over the external world increases the implicit sense of agency



Brianna Beck, Steven Di Costa, Patrick Haggard\*

*Institute of Cognitive Neuroscience, University College London, Alexandra House, 17 Queen Square, WC1N 3AZ London, United Kingdom*

## ARTICLE INFO

## Article history:

Received 16 June 2016

Revised 1 February 2017

Accepted 5 February 2017

Available online 14 February 2017

## Keywords:

Action selection

Intentional binding

Pain

Sense of agency

Sensory attenuation

## ABSTRACT

The sense of agency refers to the feeling of control over one's actions, and, through them, over external events. One proposed marker of implicit sense of agency is 'intentional binding'—the tendency to perceive voluntary actions and their outcomes as close in time. Another is attenuation of the sensory consequences of a voluntary action. Here we show that the ability to choose an outcome through action selection contributes to implicit sense of agency. We measured intentional binding and stimulus intensity ratings using painful and non-painful somatosensory outcomes. In one condition, participants chose between two actions with different probabilities of producing high or low intensity outcomes, so action choices were meaningful. In another condition, action selection was meaningless with respect to the outcome. Having control over the outcome increased binding, especially when outcomes were painful. Greater sensory attenuation also tended to be associated with stronger binding of the outcome towards the action that produced it. Previous studies have emphasised the link between sense of agency and *initiation* of voluntary motor actions. Our study shows that the ability to control outcomes by discriminative action selection is another key element of implicit sense of agency. It also investigates, for the first time, the relation between binding and sensory attenuation for the same events.

© 2017 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

The sense of agency refers to the feeling of controlling one's own actions and, through them, events in the outside world. It is a ubiquitous and familiar experience, but has proved difficult to study experimentally, in part because of a 'self-serving bias' that associates more positive outcomes to one's own agency (Bradley, 1978; Greenberg, Pyszczynski, Burling, & Tibbs, 1992). Implicit measures of sense of agency may address these issues. The 'intentional binding' measure involves a compression of the perceived interval between voluntary actions and their outcomes, relative to passive movements and their outcomes (Haggard & Clark, 2003; Haggard, Clark, & Kalogeras, 2002). Attenuation of the sensory consequences of a voluntary action has also been proposed as a measure of implicit sense of agency (Blakemore, Frith, & Wolpert, 1999). However, it remains unclear whether both measures reflect a single underlying cognitive construct, or distinct cognitive processes. Dewey and Knoblich (2014) found no association between them across participants, but the two measures were obtained from separate tasks. The relation between

sensory attenuation and intentional binding might become clearer if both measures are obtained for the same action–outcome events.

Another key aspect of the concept of agency, besides motoric action control, is the ability to influence events in the world. However, it is not yet known whether the *implicit* sense of agency is sensitive to the degree of control one has over the outcomes of one's actions. Intentional binding studies generally pair one or more possible actions with a *single* outcome. One showed stronger binding when an action was more likely to produce an outcome (Moore & Haggard, 2008). Another found that intentional binding increased with the number of alternative actions producing the same outcome (Barlas & Obhi, 2013). In everyday life, however, people choose between alternative actions based on their anticipated consequences. Accordingly, Desantis, Hughes, and Waszak (2012) asked participants to press one of two keys, producing either a high or a low tone. They found no difference in binding between a condition where the key predicted the pitch of the tone, and a condition where the pitch was unpredictable. This suggests that intentional binding is insensitive to control over *which* outcome is produced. Yet, no study has investigated intentional binding in the everyday situation of choosing between alternative actions based on the *value* of their likely outcomes. Here we investigated whether implicit sense of agency reflects the degree

\* Corresponding author.

E-mail address: [p.haggard@ucl.ac.uk](mailto:p.haggard@ucl.ac.uk) (P. Haggard).

of voluntary control over outcomes that are meaningful to the agent.

One such meaningful outcome is pain. Some have reported a reduction in intentional binding with negative action outcomes (Christensen, Yoshie, Di Costa, & Haggard, 2016; Takahata et al., 2012; Yoshie & Haggard, 2013). On the other hand, pain is a powerful learning signal, guiding future action to avoid injury and further pain. The importance of associating one’s actions with harmful consequences might suggest an *increased* sense of agency for actions with painful outcomes, as long as one can minimise pain level through action selection. Thus, control over pain level should increase binding. Such a finding would demonstrate that the implicit sense of agency reflects three components of volition: the capacity to choose between alternative actions, sensitivity to their consequences, and the motivational value of those consequences.

In this study, we used intentional binding and stimulus intensity ratings to investigate implicit sense of agency for painful outcomes. Participants selected between two alternative actions. For half the participants, the outcome of their action was either a high intensity or a low intensity heat-pain stimulus. For the other half, the outcome was either a high intensity or a low intensity electrocutaneous stimulus, which was never perceived as painful. In both groups, we compared blocks where participants could control outcome intensity through their action selection with blocks where they could not. Participants reported either the time of their action or the time of the outcome (Fig. 1). We predicted greater

intentional binding (i.e. stronger implicit sense of agency) when participants could learn to minimise pain by selecting the appropriate action. We also asked our participants to rate outcome stimulus intensity after each trial. Since both sensory attenuation and intentional binding have been proposed as implicit measures of sense of agency, we investigated whether lower intensity ratings (i.e. sensory attenuation) would be associated with greater intentional binding across trials.

**2. Materials and methods**

*2.1. Participants*

Fifty healthy adults participated. Half had painful heat stimuli as outcomes (17 female, 18–35 years old,  $M_{age} = 25.28$  years,  $SD_{age} = \pm 4.86$  years). The other half had non-painful electrocutaneous stimuli as outcomes (16 female, 19–39 years old,  $M_{age} = 26.56$  years,  $SD_{age} = \pm 4.93$  years). All gave written informed consent, and were paid £7.50/hr. The experiment was approved by the UCL Research Ethics Committee, and carried out in accordance with the Declaration of Helsinki.

*2.2. Apparatus and materials*

A computer running Labview 2012 (National Instruments, Austin, TX, USA) displayed the clock, triggered the stimuli, and

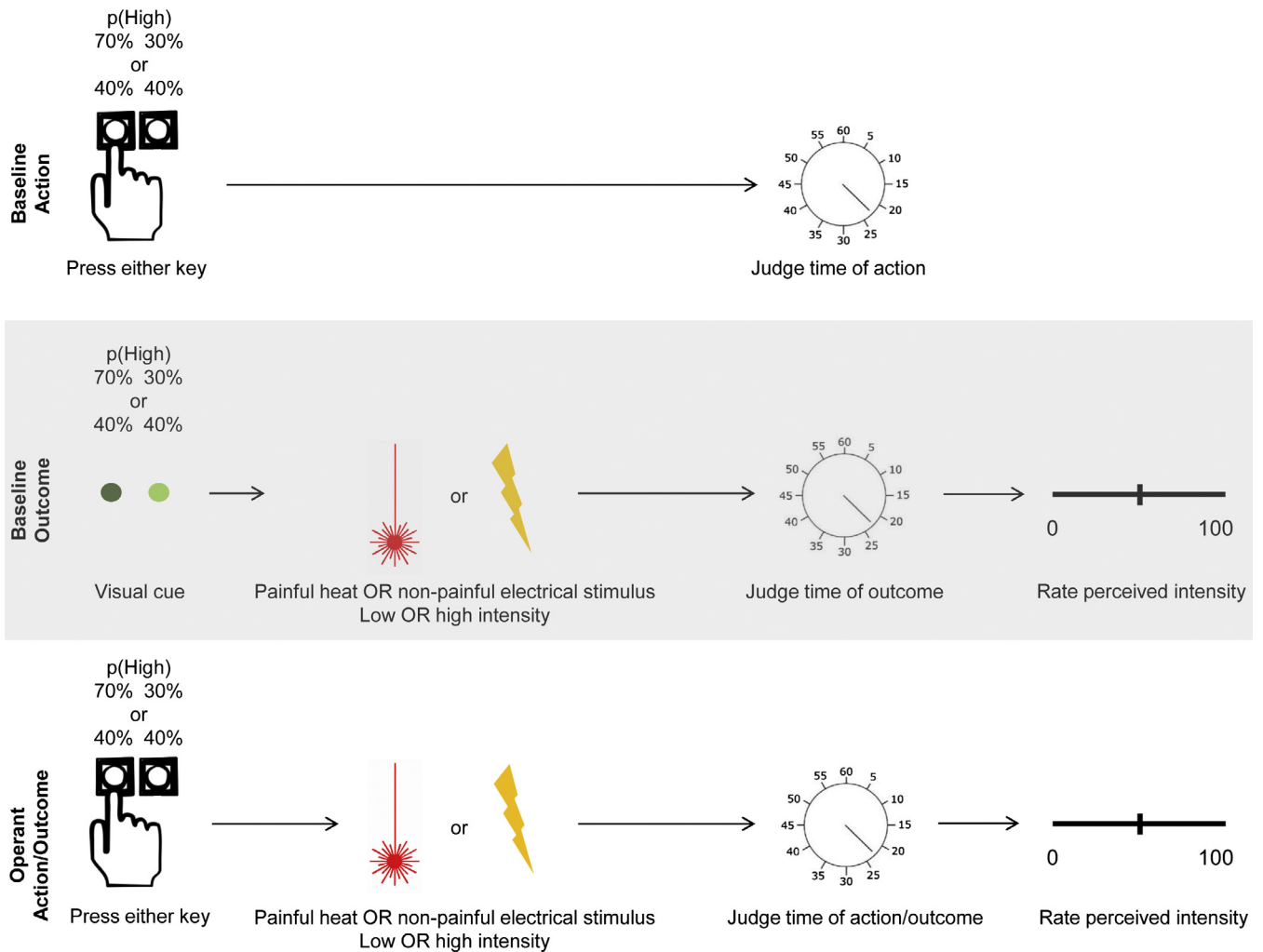


Fig. 1. Trial timelines for baseline action judgement blocks, baseline outcome judgement blocks, and operant action/outcome judgement blocks.

Download English Version:

<https://daneshyari.com/en/article/5041668>

Download Persian Version:

<https://daneshyari.com/article/5041668>

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