Consciousness and Cognition 37 (2015) 1–7

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Discrepancy between explicit judgement of agency and implicit feeling of agency: Implications for sense of agency and its disorders

Naho Saito [a], Keisuke Takahata [b], Toshiya Murai [a], Hidehiko Takahashi [a,*]

[a] Department of Psychiatry, Graduate School of Medicine, Kyoto University, 54 Shogoin-Kawahara-cho, Sakyo-ku, Kyoto 606-8507, Japan
[b] Molecular Imaging Center, National Institute of Radiological Sciences, 4-9-1 Anagawa, Inage-ku, Chiba 263-8555, Japan

ARTICLE INFO

Article history:
Received 16 April 2015
Revised 21 July 2015
Accepted 22 July 2015
Available online 5 August 2015

Keywords:
Sense of agency
Voluntary action
Feeling of agency
Judgement of agency
Central monitoring
Intentional binding

ABSTRACT

The sense of agency refers to the feeling of authorship that "I am the one who is controlling external events through my own action". A distinction between explicit judgement of agency and implicit feeling of agency has been proposed theoretically. However, there has not been sufficient experimental evidence to support this distinction. We have assessed separate explicit and implicit agency measures in the same population and investigated their relationships. Intentional binding task was employed as an implicit measure and self-other attribution task as an explicit measure, which are known to reflect clinical symptoms of disorders in the sense of agency. The results of the implicit measure and explicit measure were not correlated, suggesting dissociation of the explicit judgement of agency and the implicit feeling of agency.

1. Introduction

The sense of agency refers to the feeling of authorship that "I am the one who is controlling external events through my own action". This sense is a central component of self-awareness (Gallagher, 2000), and its underlying neural mechanisms have been reported (David, Newen, & Vogeley, 2008). Symptoms of psychiatric and neurological diseases can be explained as a disruption of the sense of agency; examples of such are schizophrenia, conversion disorder, anarchic hand syndrome, and anosognosia for one's own hemiparesis (Kranick et al., 2013; Synofzik, Vosgerau, & Newen, 2008b). For example, delusion of control in schizophrenia is a passivity experience that "My action is being controlled by others", which is an alteration in the sense of agency. These symptoms teach us that the sense of agency, a fallible process (Blakemore, Wolpert, & Frith, 2002), requires reliable and objective clinical indicators. Measures of agency have been invented and assessed to give a fundamental understanding of self-awareness (Haggard, Clark, & Kalogeras, 2002; Nielsen, 1963). At the same time, these measures have served as objective indicators to assess the subjective symptoms of the diseases (Daprati et al., 1997; Franck et al., 2001; Haggard, Martin, Taylor-Clarke, Jeannerod, & Franck, 2003; Kranick et al., 2013; Maeda et al., 2013; Wolpe et al., 2014).

There have been two distinct ways in measuring the sense of agency – explicit and implicit. Explicit measures address the sense of agency by obtaining a direct report of how they attribute the effect of their action. In a pioneering experiment, participants were asked to draw a line on a piece of paper, and at the same time the experimenter gave manual visual feedback that was in concordance with or in discordance with their actual movements (Nielsen, 1963). This paradigm has been modified in

* Corresponding author.
E-mail address: hidehiko@kuhp.kyoto-u.ac.jp (H. Takahashi).

http://dx.doi.org/10.1016/j.concog.2015.07.011
1053-8100/

various works to test the participant's ability to distinguish the actions they have performed and the actions performed by others (Daprati et al., 1997; Farrer et al., 2008; Franck et al., 2001; Maeda et al., 2012). In the study by Franck and colleagues (Franck et al., 2001), participants were given visual feedback of a voluntary action as a virtual hand, which moved in concordance with or in discordance with their movements. They were asked later on if the feedback corresponded with their actual movement or not. Patients with delusion of control in schizophrenia gave more "yes" answers to this question than normal participants did, indicating a correlation of clinical passivity experiences with the experimental attribution of actions.

However, it has been pointed out that explicit measures of agency can be subject to response bias (Wegner, 2003), and the need for indirect markers of agency has been discussed. The "intentional binding" effect focusing on temporal attraction between the perceived time of actions and their effects is a widely used quantitative method (Ebert & Wegner, 2010). Participants perform a volitional button press at the timing of their own choosing. They judge the timing of their volitional button press on the basis of Libet's clock method (Libet, Gleason, Wright, & Pearl, 1983). The button press will be followed by an auditory tone 250 ms later. This is considered the effect of the action. They also judge the timing of the tone. A compression of timing judgments in action and its effect (the "intentional binding" effect) is known in the case of volitional actions but not in the case of non-volitional actions, and thus this method has been regarded as an implicit way to measure the sense of agency (Ebert & Wegner, 2010). The intentional binding effect has also been observed to change in accordance with the passivity experiences in diseases (Haggard et al., 2003; Kranick et al., 2013; Wolpe et al., 2014), which can serve as a quantitative indicator.

So far, a two-step distinction in the formation of implicit and explicit sense agency has been proposed (Synofzik, Vosgerau, & Newen, 2008a; Synofzik, Vosgerau, & Voss, 2013), complementary to the central monitoring theory (i.e. "comparator model") (Frith, Blakemore, & Wolpert, 2000). In the central monitoring theory, the sensory consequence of our action is predicted based on internal signals such as efference copy of the motor command. Comparison of the prediction with sensory afference will enable us to distinguish self-produced sensory information from externally caused events. Congruency of the predicted with sensory afference will lead to an interpretation that the action has been caused by our self, while incongruency will lead to an interpretation that the action has been caused externally. The sense of agency is explained in the final stage of action execution by a single mechanism in this framework. Recent studies pointed out that the sense of agency is not only based on internal signals but also modulated by various context cues (Moore & Haggard, 2008; Moore, Wegner, & Haggard, 2009; Takahata et al., 2012; Voss et al., 2010; Wegner, 2003). These observations have led to arguments that the sense of agency holds a more complex structure, with multiple levels involving different processes (Fletcher & Frith, 2009; Frith, 2012; Moore & Fletcher, 2012; Synofzik et al., 2008a, 2013). The presence of problematic cases of the central monitoring theory in explaining the sense of agency both in healthy subjects and in patients with passivity experiences has also been pointed out (Synofzik et al., 2008a). Accordingly, a two-step distinction is proposed between the level of the "feeling of agency" and the "judgement of agency" (Synofzik et al., 2008a). The first-level feeling of agency is the non-conceptual, low-level feeling of being an agent. It refers to the implicit aspect of agency, which is closely related to action regulation or perceptual processing. The second-level judgement of agency is the conceptual, interpretative judgement of being an agent of an action. It refers to the explicit judgement of self-other attribution, which is closely related to background beliefs or context cues (Synofzik et al., 2008a). However, few experimental studies have approached the relationship between these two aspects of the sense of agency (Barlas & Obhi, 2014; Dewey & Knoblich, 2014; Ebert & Wegner, 2010; Moore, Middleton, Haggard, & Fletcher, 2012).

Recently, some efforts have been made to investigate both explicit and implicit measures of agency in a single task (Ebert & Wegner, 2010). However, the majority of previous experimental studies of psychiatric and neurological diseases assessed either explicit or implicit measures of agency (David et al., 2008), and they reported mixed results (e.g. exaggerated or decreased sense of agency in schizophrenia) (Maeda et al., 2013; Voss et al., 2010). Comparison of the traditional tasks that have frequently been used for clinical cases will facilitate the interpretation of the results of clinical studies from the perspective of the structures of the tasks. Thus, we separately assessed both explicit and implicit agency measures in the same population and investigated their relationships.

2. Materials and methods

2.1. Participants

Twenty-five subjects (thirteen female, mean age = 64.9 years, SD = 2.9 years) participated in the study. Participants with known neurological or psychiatric history were excluded from the study. All the participants were right-handed according to the Edinburg Inventory (Oldfield, 1971). Participants underwent two experiments. The implicit task was conducted first and the explicit task next, in order to keep the participants naïve to the study purpose. Written informed consent was obtained from each participant. Participants were paid for their participation. This study was approved by the ethics committee of Kyoto University Graduate School and Faculty of Medicine.

2.2. Procedures and analysis

2.2.1. Experiment 1 – Implicit task

2.2.1.1. Procedures. The sequence of events from a previous study (Haggard et al., 2002), known as intentional binding task, was employed. The task consisted of four conditions: (1) agency action, (2) agency tone, (3) baseline action and (4) baseline