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Mutual coordination strengthens the sense of joint agency in cooperative joint action

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ABSTRACT

Philosophers have proposed that when people coordinate their actions with others they may experience a sense of joint agency, or shared control over actions and their effects. However, little empirical work has investigated the sense of joint agency. In the current study, pairs coordinated their actions to produce tone sequences and then rated their sense of joint agency on a scale ranging from shared to independent control. People felt more shared than independent control overall, confirming that people experience joint agency during joint action. Furthermore, people felt stronger joint agency when they (a) produced sequences that required mutual coordination compared to sequences in which only one partner had to coordinate with the other, (b) held the role of follower compared to leader, and (c) were better coordinated with their partner. Thus, the strength of joint agency is influenced by the degree to which people mutually coordinate with each other's actions.

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1. Introduction

The *sense of agency* refers to the feeling of generating and controlling actions and their effects (Haggard & Tsakiris, 2009). For example, when someone turns on a light, they have a sense of agency over flicking the light switch and causing the light to come on. Previous research has shown that the sense of agency is driven by a combination of predictive processes as well as postdictive cognitive inferences (Moore & Haggard, 2008; Synofzik, Vosgerau, & Voss, 2013). However, most research on the sense of agency has focused on individuals performing tasks alone. Little research has investigated agency during *joint action*, when two or more individuals coordinate their actions to achieve a shared goal (Sebanz, Bekkering, & Knoblich, 2006). Philosophers have proposed that the experience of agency during joint action might be substantially different than during solo action (e.g., Pacherie, 2012). In addition to experiencing a sense of *self*-agency over actions and their effects (e.g., a sense that “I did it”), people may also experience a sense of *joint* agency over actions and effects (e.g., a sense that “we did it”). The current study investigates people's experiences of joint agency when they engage in cooperative joint action.

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1.1. Philosophical accounts of joint agency

Gallotti and Frith (2013) proposed that when people coordinate their actions, they engage in a collective mode of cognition called the *we-mode*. The main idea of the *we-mode* is that co-agents represent their actions as something they are going to pursue together, as a single unit. This way of cognizing is hypothesized to enlarge people's potential for action by giving them access to more information about their partners' behavior than they would have as mere disembodied observers. This information provides new possibilities for action, allowing people to bring about actions and effects they could not accomplish individually and expanding their agency scope (Pacherie, 2012). For example, two people may be able to lift a heavy object that neither person could lift alone.

Cognition in the *we-mode* may lead to feelings of joint agency (Dewey, Pacherie, & Knoblich, 2014). Dokic (2010) defines joint agency as “the perceptual sense that we are acting together” (p. 40). Similarly, Seemann (2009) proposes that joint action will involve “a sense of acting together . . . [which] amounts to a sense of joint control” (p. 504). Pacherie (2012) provides the most specific definition of joint agency, describing it as the sense that one's contribution to a joint goal is equal to the contributions of one's co-agents and that one's coordination relations with co-agents are relatively symmetrical. Pacherie (2012) therefore predicts that the sense of joint agency will be strongest in situations where individual contributions are of similar importance to the joint goal, and where both people coordinate with each other rather than one person coordinating and the other being coordinated. Pacherie also proposes that joint agency may be experienced in two forms: *shared agency*, whereby people experience a sense of joint agency along with an intact sense of self-agency, and *we-agency*, whereby the experience of joint agency is accompanied by a reduction in self-agency. *We-agency* is thought to be experienced when co-agents perform similar actions with similar effects and synchronous timing. For example, soldiers marching in step may experience a loss of self-agency as their actions become one with the group (McNeill, 1995). However, most everyday joint actions are thought to involve shared agency, as they typically require people to produce coordinated yet distinct and complementary actions.

1.2. Empirical investigations of agency in joint action

A handful of studies have examined people's experiences of agency during cooperative joint action. Some studies have focused on people's sense of control over actions and effects that unfold over time, such as the movement of a cursor on the screen (Dewey et al., 2014; van der Wel, 2015; van der Wel, Sebanz, & Knoblich, 2012). These studies have asked participants to continuously coordinate their actions to elicit a joint effect and then rate the extent to which they felt control while they performed the task. For example, van der Wel (2015) had pairs of participants coordinate their joystick movements to move a single dot from the center of the screen to one of two target areas. Similarly, Dewey et al. (2014) had pairs of participants use joysticks to keep a cursor centered on a moving target. van der Wel (2015) showed that ratings of control were equally high for the partner who chose which target to move to and for the partner who followed the other's choice. Dewey et al. (2014) showed that participants' ratings of control were higher when both participants' actions contributed to the movement of the cursor compared to when only one participant's actions contributed to its movement, as long as participants' contributions were distinguishable (e.g., each was responsible for one movement direction). These findings indicate that people's sense of control depends on both partners' combined contributions rather than their own individual contributions, suggesting that people may experience joint agency during these tasks. In other words, people may have evaluated their sense of control at the group level rather than at the individual level (“we are in control”; Dewey et al., 2014).

Empirical investigations of agency during joint action have also examined the influences of perceptual and sensorimotor information on people's experiences of control. van der Wel (2015) showed that participants' ratings of control were positively correlated with the smoothness of both their own movements and their partner's movements. van der Wel et al. (2012) showed that when pairs coordinated their actions to move a pole back and forth between two targets, each individual's ratings of control were positively correlated with pair-level task accuracy but not with the amount of force exerted by each individual. These findings are consistent with predictive accounts of agency (e.g., Blakemore, Frith, & Wolpert, 1999; Wolpert & Flanagan, 2001) in which agency is derived from comparisons between the predicted and actual consequences of actions; the better the match, the stronger the sense of agency. More specifically, these findings suggest that in joint action, agency may be based predominantly on comparisons between expected and actual perceptual information, to which both people have access, rather than sensorimotor information, to which only individuals have access (see also van der Wel & Knoblich, 2013).

Other empirical investigations of agency in joint action have examined people's sense of causal initiation for brief, jointly-produced action effects, such as a single tone (Dewey & Carr, 2013; Obhi & Hall, 2011). These studies have focused on how people's role in the joint action affects their sense of causal initiation. Obhi and Hall (2011) had pairs of participants coordinate their actions to depress a single button, which evoked a tone. Participants either initiated the button press (leaders) or passively moved their finger along with their partner's action (followers). Participants' ratings of responsibility for producing the tone were polarized such that leaders felt entirely responsible whereas followers felt completely not responsible. Dewey and Carr (2013) had pairs of participants produce either the first button press (leaders) or the second button press (followers) in a two-press sequence. A single tone was evoked at a variable delay after the second button press, and participants rated whether they or their partner had produced the tone. In this study, followers felt more self-agency (and were rated as having more other-agency) compared to leaders, likely because the follower's button press occurred closest in time to

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