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The effects of interpersonal synchrony on experienced self-agency

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Abstract

People usually feel they cause their own actions and subsequent outcomes, and attribute behavior to the proper agent. This is usually referred to as self-agency. Our sense of self-agency helps us to distinguish between self and other. During interpersonal synchrony self- and other-produced movements are highly aligned in both form and time, which may interfere with the ability to discriminate self- versus other-produced action. The current research examines the effects of interpersonal synchrony on experienced self-agency.

Fifty-four undergraduates performed an authorship ascription task in pairs where they consciously intended to produce an action-outcome (explicit processing) or were subtly primed with the action-outcome (implicit processing) before they performed the action and observed the outcome. Simultaneously, the participants were tapping their fingers either synchronous or asynchronous with each other.

In line with previous research, when participants were primed with or had an intention to produce a specific outcome, and this outcome matched their goal, participants experienced higher self-agency then when the outcome did not match their goal. Additionally, findings showed a significant interaction between matching and the degree to which participants felt they did the task together with the other participant. Furthermore, synchrony had no effects.

Implications for future research are discussed.

1. Introduction

I press a button and the music starts playing. I make a funny face and people start laughing. The performance of behavior is often accompanied by a sense of self-agency, that is, the feeling that we cause our own actions and their consequences. Our sense of self-agency helps us to see who is the agent of an action by distinguishing between self and other. When the cause of the outcome is clear, as in the examples above, people usually do not have much difficulty in attributing agency. But what if at the same time that I was making a funny face, someone next to me was making a joke? Authorship processing in social situations involves the presence of other agents, introducing layers of complexity beyond "what caused the music to start playing?" One specific social situation in which authorship processing becomes complicated is during interpersonal synchrony. Synchronous behavior can vary from simple leg movements, finger tapping or clapping to dancing or making music. During interpersonal synchrony self- and other-produced movements are highly aligned in both form and time. At the moment that the perceptions of self and other closely overlap, it may interfere with the ability to discriminate self- versus other-produced action (Hove & Risen, 2009; Georgieff & Jeannerod, 1998). For example, if both of you pressed a button at the same time, who was the one that caused the music to start playing?

To my knowledge, there is no previous research on the link between interpersonal synchrony and experienced self-agency. However, there is research on the effects of imitation on self-agency. This is highly relevant, because it is suggested that interpersonal synchrony relies on the same neural mechanisms as imitation (e.g. Tognoli, Lagarde, DeGuzman, & Kelso, 2007). Thus, synchrony may promote self/other overlap in neural representation. Research showed that by imitating another person or empathizing with the other, the individual might lose track of one's own authorship (Wegner & Sparrow, 2004). When performed and perceived actions are the same, that is, when you see someone else performing the same action as you, it could reduce the feeling of authorship (Dijksterhuis & Bargh, 2001). For example, when someone picked up his or her pen just before you picked up your pen, your experience of authorship may be strongly undermined.

Synchronous actions do not only match in terms of performance and perception, but also in time. (Keller, 2008; Sebanz, Bekkering, & Knoblich, 2006). As a result, the self/other distinction is blurred during synchronous behaviors. The temporal coordination of behavior during interpersonal synchrony could make authorship processing even harder than during imitation (when movements are not necessarily simultaneous). To date, it is still uncertain what the exact effects of the suggested blurred self/other distinction during interpersonal synchrony are on experienced self-agency. The present research is the first to investigate the effects of interpersonal synchrony on experienced self-agency.

The suggested self/other overlap during interpersonal synchrony has important implications for social interactions. One of these implications is that it can result in losing track of one's own authorship. Consequently, this could decrease feelings of responsibility over self-produced actions. Research on the effects of interpersonal synchrony has shown that synchronous behavior can lead to compliance with a request to aggress (Wiltermuth, 2012a), and obedience (Wiltermuth, 2012b). Additionally, earlier research showed that when people obeyed others they experienced an "agentic shift" such that their sense of authorship was reduced. Participants gave electric shocks to people, without feeling fully responsible for this (Milgram, 1974). Fortunately, interpersonal synchrony can have positive effects as well. Performing actions that are similar to, and coordinated with those of an interaction partner elicits feelings of connectedness and interpersonal rapport (Berneiri, 1988; Berneiri, Davis, Rosenthal, & Knee, 1994; Chartrand & Bargh, 1999; Lakin & Chatrand, 2003; Tickle-Degnen & Rosenthal, 1990) and moving in synchrony facilitates human bonding (Bernieri & Rosenthal, 1991; Condon & Sander, 1974; Tickle-Degnen & Rosenthal, 1990). Behaving synchronously also promotes cooperation and helping behavior (Kirschner & Tomasello, 2010; Valdesolo & DeSteno, 2011; Wiltermuth & Heath, 2009). Interpersonal synchrony is a skill that could have been important in our evolutionary history, as getting along with others and creating and maintaining social bonds are critical for both social and physical survival (Lakin & Chartrand, 2003; Rizzolatti & Craighero, 2004). It is possible that people infer closeness when they notice

synchrony, because synchronous behavior is associated with communal relationships. For example, touch, physical proximity, shared resources, and synchronized movements act as cues to a communal sharing relationship (Fiske, 2004; Smith, 2008). It is also suggested that during self-other overlap, positive views of our selves extend to the other (Galinsky, Martorana, & Ku, 2003). Considering the possibly harmful as well as beneficial effects of interpersonal synchrony, it is important to get a clearer picture of the link between interpersonal synchrony and experienced self-agency.

To enhance our understanding of interpersonal synchrony, it is essential to keep in mind the proposed close overlap between perceptions of self and other during interpersonal synchrony. This would interfere with the ability to discriminate self- versus other-produced action. Lakens (2010) has shown that observed synchrony could lead to a higher perceived feeling of entitativity (i.e., unity) between people. Movement rhythms were experimentally manipulated in four studies. Stick figures waving in synchrony were rated higher on entitativity than stick figures waving in different rhythms (Study 1), and this effect was extended to interactional synchrony, where different movements are performed in the same rhythm (Study 2). Objective differences in movement rhythms are linearly related to ratings of perceived entitativity, and this relationship is partially mediated by the subjectively perceived similarity of movement rhythms (Study 3). These results also held for entitativity judgments for videotaped individuals waving rhythmically (Study 4). These results suggest that movement rhythms are an important source of information, which observers use to infer the extent to which individuals are a social unit. Since it is not clear what causes the synchrony between people (i.e. the outcome), people make interpretations to predict the cause (i.e. being a social unit) of their behavior (Lakens, 2010; Brewer, Weber, & Carini, 1995). Additionally, in the study done by Lakens (2010), people remembered fewer individual differences when they observed individuals moving in synchrony. When people are seen as a unity, it is harder to distinguish between people. If perceived synchrony has these effects, it insinuates that experienced interpersonal synchrony causes the individuals in synchrony to infer feelings of

entitativity between them and the person they are moving in synchrony with. This would then cause them to see less individual differences and would make it harder to distinguish between the self and the other (Brewer, Weber, & Carini, 1995). An example of a study where participants experienced interpersonal synchrony is the study on the effects of synchrony on affiliation (Hove & Risen, 2009). They investigated the relationship between interpersonal synchrony and affiliation by having participants match finger movements with a visual moving metronome. In Experiment 1, affiliation ratings were examined based on the extent to which participants tapped in synchrony with the experimenter. In Experiment 2, affiliation ratings were compared for an experimenter who either tapped to a metronome that was synchronous to the participant's metronome, tapped to a metronome that was asynchronous, or did not tap. In both studies, the degree of synchrony predicted affiliation ratings. Experiment 3 found that the affiliative effects were unique to interpersonal synchrony. When participants tapped in or out of synchrony with just an auditory metronome instead of the experimenter, this did not increase feelings of affiliation towards the experimenter sitting next to them. These findings imply that experienced interpersonal synchrony causes people to attribute a feeling of rapport towards each other. Feelings of rapport towards each other can result in a less clear self/other distinction.

To distinguish between self and other we use our sense of self-agency. Self-agency experiences are often explained in terms of the so-called motor prediction model (Frith, Blakemore, & Wolpert, 2000). This model relies on a causal link between the action and the outcome. When performing an action, a copy of the motor command (efference copy) is compared with real sensory signals from the movement itself. Self-agency is experienced when these predictions match the actual sensory signals (Blakemore & Frith, 2003; Wolpert, 1997). For example, you press the '2' button on the elevator and it goes to the second floor. You already picture what is going to happen (i.e. prediction) and in addition, you can feel your finger pressing the button (i.e. sensory signals), which causes the elevator to move. This is referred to as the motor-predictive account of the sense of self-agency. However, research has shown that self-agency experiences often result from

inferences that we draw from our purpose to engage in behavior (Wegner, 2002; Wegner & Wheatley, 1999). When it is not clear what causes the outcome, as in many social situations, you cannot rely on just sensory signals to make predictions. For instance when you press a button and it can cause different outcomes, the action per se cannot reliably predict the outcome causing one to rely on cognitive inferences.

Taking into account the cognitive inferential processes involved in experienced self-agency, recent research suggests two routes that model the inferential nature of authorship processing (e.g. Aarts, Custers, & Wegner, 2005; Wegner, 2002): an explicit and an implicit route. That is, if one had the explicit goal of bringing about a certain outcome and then that outcome actually occurred, one must have caused it. Interestingly, recent research indicates that self-agency experiences also arise in everyday social interactions that are guided by the environment and that occur without much conscious intent and thought. Specifically, observing outcomes that are implicitly pre-activated (or primed) in our minds before action performance also provides the feeling that we caused the behavioral outcome once it actually occurs (e.g., Aarts, Custers, & Wegner, 2005; Sato, 2009; van der Weiden, Aarts, & Ruys, 2010; Wegner & Wheatley, 1999).

The present study investigates the effect of interpersonal synchrony on experienced self-agency. This study aims to replicate findings of earlier research on the inferential nature of authorship processing in a social context where two individuals simultaneously tap in a synchronous or an asynchronous rhythm. It is overall predicted that both intention to cause a specific outcome and priming of the action-outcome will increase experiences of agency over producing the outcome when that outcome actually occurred. When the outcome does not match the intention or prime, participants will experience less self-agency. In this way a distinction is made between self- and other-produced actions, differentiating between self and other. Research on interpersonal synchrony implies that overlapping representations in the brain during self- versus other- produced actions, as well as cognitive inferential processes that increase feelings of for instance affiliation and entitativity, interfere with the ability to discriminate between the self and the

other. In the synchronous condition, the participants are expected to see less individual differences between themselves and the other. Therefore, it is hypothesized that it is less likely that an outcome that matches the primed or intended outcome is primarily ascribed to the self. Specifically, if both you and the other perform the same action at the same time, it is more difficult to determine who was the one that caused the outcome. In turn, an outcome that does not match the primed or intended outcome is less likely to be mostly ascribed to the other. Consequently, the difference in experienced self-agency between an outcome that matches the primed or intended outcome and an outcome that does not match the primed or intended outcome is smaller in the synchronous condition than in the asynchronous condition.

Taking into account the suggested self/other overlap during interpersonal synchrony, another possible outcome is that during synchronous behavior, the overall experienced self-agency is reduced. This would be in line with previous research on the link between imitation and experienced self-agency, where imitation could reduce the overall feeling of authorship. Therefore, the overall experienced self-agency is expected to be lower during synchronous behavior, as opposed to asynchronous behavior.

2. Methods

2.1. Participants and design

Fifty-four undergraduates participated in return for course credit or a small fee. The study was done in pairs as a mixed 2x2x2 design, with Synchrony (synchronous tapping vs. asynchronous tapping) as a between-subject factor and Route (implicit vs. explicit) and Matching (match vs. mismatch) as within-subject factors. Measures of individual tapping indicated that not all participants successfully matched their tapping cues in this task. This affected the amount of synchrony between participants (i.e. some participants in the synchronous condition were actually not synchronous and some participants in the asynchronous condition were actually not asynchronous). Trials where their tapping did not successfully match the tapping cue were excluded from the analysis. When the rhythm of tapping on the response box did not correspond with their condition (i.e. synchronous or asynchronous) in more than half of the trials, participants were excluded from the analysis. This led to the exclusion of sixteen participants from the analysis. Answers to the open questions checking for suspicion confirmed that no participants were aware of the true nature of the study. Of the remaining thirty-eight participants, twenty-five were in the synchronous condition and thirteen were in the asynchronous condition. The analysis included eleven males and twenty-seven females and the mean age was twenty-three years (*SD* = 2.7).

2.2. Experimental task and procedure

In this experiment a finger-tapping task (adapted from the study done by Hove & Risen, 2009) was combined with a self-agency inference task, similar to the self-agency task used by van der Weiden, Aarts and Ruys (2011). Participants were seated behind a computer and worked in pairs.

2.2.1 Self-agency task

Upon arriving in pairs, participants were assigned to either tap in or out of synchrony with each other. Both participants were presented with two versions of the self-agency paradigm, i.e. an explicit and an implicit one. Participants were told that the study was designed to investigate how

people's experiences of action causation come and go and how this is affected by performing other simple actions at the same time. They operated a kind of vending machine that is programmed on a computer. Specifically, they learned how to stop a sequence of letter strings rapidly presented in the middle of the computer screen by pressing a key on the keyboard upon seeing a stopping-cue. Participants were told that pressing the stop-key would cause a word ('RED' or 'BLUE', in Dutch this was 'ROOD' or 'BLAUW') to be selected based on their timing while the words were rapidly alternating. After the key-press, the selected word was shown in the middle of the screen. Each trial began with a small fixation box, proceeding with the alternation of the product words, and eventually a stop-cue.

After practicing, participants were told that they will no longer be the sole author of the presented outcomes, as it now would be randomly determined whether the shown outcome would be their doing, or that of the other participant. In reality, all outcomes were randomly predetermined, such that participants' action would not predict the outcome. After each outcome, participants indicated to what extent they felt that they had caused the shown word to appear. This agency feeling was measured on an 8-point scale ("not at all me" (1) – "absolutely me" (8)). Both words were presented 16 times as outcome per task, where half matched the outcome information and the other half mismatched it. Trials were presented randomly. In the tasks, the participants encountered trials where action outcomes matched previously primed information, or mismatched it. Hence, both task type and matching constituted within-subject factors. The experiment consisted of 8 practice trials and 32 test trials. The task lasted approximately 30 minutes.

In the implicit task, the priming, masking and action phase of each trial were comprised of two different sub-events. In a priming-event of 200ms, five capitalized random letter strings preceded a prime – which would be either 'RED' or 'BLUE'. The prime and each letter string were presented for 33ms, constituting 2 cycles on a 60hz monitor. In a non-priming event, five random letter strings preceded a non-word, derived from each prime. The priming phase consisted of eight consecutive priming-events, after which the masking phase used five non-priming events and the

action phase contained three non-priming events. Hence, the priming phase was presented for 1600ms the masking phase 800ms and the action phase 800ms. In the action phase, a small circle was presented above or below the non-priming events for the duration of the action phase, to which participants reacted with a button-press. As described above, the timing of their button press supposedly determined which letter string would be shown. After the action phase, a 100ms blank screen was presented, after which participants were shown the outcome for 1500ms. Finally, participants indicated their self-agency experience on the 8-point scale. In the explicit task, the priming phase differed from the implicit task. Here, three non-priming events precede the 200ms presentation of the goal. This takes 800ms, which is then repeated to match the priming phase length of the implicit task. In this explicit task, participants are instructed to attempt to cause the briefly shown word – giving them an explicit goal for these trials.

2.2.2 Synchrony

While doing the self-agency task, participants tapped their index finger on a response box when a cue appeared during the priming phase. The cue consisted of a big dark circle in the background in the middle of the screen where the letter strings appeared as well at the same time. Participants sitting on the left tapped with their right index finger while participants on the right tapped with their left index finger. In this way their finger movements were visible to each other. The participants were seated next to each other and their response boxes were approximately 25 cm apart. The taps on the response box produced a light sound. The participants were not able to see each other's computer screen, due to a partition.

In the synchronous condition, the participants' cues appeared every 666ms (i.e. 15 times per trial). In this condition the cues of the participants were tempo-coordinated. In the asynchronous condition participant 1 tapped to cues that were 33% faster than those of participant 2. Thus, the cue of participant 2 appeared every 500 ms (i.e. 20 times per trial). The experimenter made sure (by pressing a key on an external keyboard) that every trial would start again at the same time for both participants, so that they would think that they were doing the task together.

2.2.3 Questionnaires

Before the task started the participants were asked for their demographics and were asked two questions exploring their relationship with and affiliation towards the other participant (see appendix 1). When the self-agency task was finished, thirteen closed questions and six open questions in relation to the other participant (i.e. rapport and entitativity) and the task (e.g. difficulty, suspicion) itself were asked (see appendix 2). Examples of questions that were asked are "To what extent did you feel coordinated with the other participant during the task?", "How friendly do you think the other participant is at this moment?" and "To what extent did you feel you could successfully keep the rhythm?" After this the participants filled in the Interpersonal Reactivity Index - questionnaire, designed by Davis (1980, 1983).

3. Results

3.1 Self-agency experiences

A main effect was found for matching; all statistics are displayed in **Table 1.** Both intention to cause a specific outcome and priming of the action-outcome increased experiences of agency over producing the outcome when that outcome actually occurred, supporting the hypothesis. In addition, the significant route-by-matching interaction indicated a smaller matching effect in the implicit than in the explicit route. There were no significant main effects found for route and synchrony, suggesting that there was no difference in self-agency experiences between the implicit and the explicit route as well as between the synchronous and asynchronous condition respectively. See **Figure 1** for the mean self-agency experiences of each cell in the design.

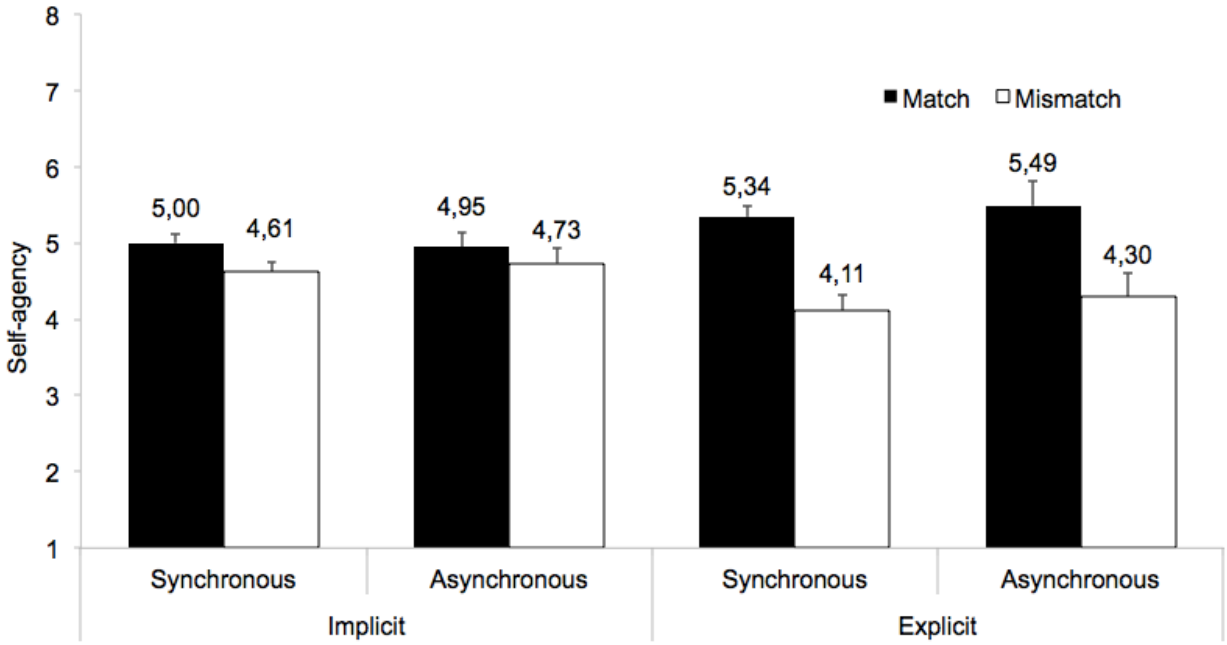

Figure 1. Self-agency experiences as a function of Synchrony, Route and Matching. Error bars represent standard errors of the mean.

To gain insight in the nature of the 3-way interaction I used ANOVAs to test effects of matching and synchrony in the explicit and implicit conditions. In the explicit condition a main effect of matching was found. Matches between the actual outcome and the intended outcome led to stronger experiences of self-agency than mismatches. There was no significant main effect found

for synchrony. Furthermore, the matching-by-synchrony interaction was not significant, indicating that the matching effect on inferences of self-agency resulting from the explicit route did not differ between the two synchrony conditions. In the implicit route, a main effect of matching indicated stronger self-agency experiences when actual outcomes matched with primed outcomes compared to mismatches. Although simple main effects showed that the matching effect was significant in the synchronous group, in the asynchronous group the implicit matching effect did not reach significance. However, there was no significant main effect of synchrony and the matching-by-synchrony interaction was also not significant.

Table 1

Statistical analyses for Self-agency experiences

Main analysis (df = 1, 36)	*F*	*p*	η_p^2
Synchrony	.25	.622	.007
Route	.02	.889	.001
Matching	29.37	< .001*	.449
Route X Synchrony	.48	.494	.013
Matching X Synchrony	.14	.712	.004
Route X Matching	17.94	< .001*	.333
Route X Matching X Synchrony	.08	.775	.002

Follow up analysis (df = 1, 36)	Explicit			Implicit		
	F	*p*	η_p^2	*F*	*p*	η_p^2
Synchrony	.48	.515	.012	.03	.862	.001
Matching	31.78	< .001*	.469	5.67	.023*	.136

Matching X Synchrony	.01	.923	.000	.43	.515	.012

Simple main effects	Synchronous (*df* = 1, 24)			Asynchronous (*df* = 1, 12)		
	F	*Sig.*	η_p^2	*F*	*Sig.*	η_p^2
Explicit Matching	24.37	< .001*	.504	11.34	.006*	.486
Implicit Matching	5.67	.026*	.191	1.81	.203	.131

3.2. Rapport and Entitativity

An independent samples T-test was conducted to compare the answers to the closed questions of participants in the synchronous condition to the participants in the asynchronous condition; for all statistics[1] see **Table 2**. There was a marginal significant difference in the degree to which the participants felt like they did the task together. Participants in the synchronous condition scored higher on this question than participants in the asynchronous condition. The questions concerning the ease of keeping the rhythm, difference in affiliation for the other participant before and after the task, feeling of being a unit, feeling coordinated and feeling the same as the other participant also showed higher means for participants in the synchronous vs. participants in the asynchronous condition; these differences were not significant.

[1] An independent samples T-test was conducted to compare the answers to the IRI-subscales of participants in the synchronous condition to the participants in the asynchronous condition**.** There was a marginal significant difference in the scores on 'Personal Distress'. Participants in the asynchronous (*M* = 1.76, *SD* = .64) condition scored higher on this subscale than participants in the synchronous (*M* = 1.42, *SD* = .38) condition; *t*(1, 36) = -1.75, *p* = .098. The scores on IRI-subscales 'Perspective Taking', 'Emphatic Concern' and 'Fantasy' did not show any significant differences.

Table 2

Closed questions compared for Synchronous vs. Asynchronous condition

Main analysis (df =1, 36)	Synchronous		Asynchronous			
	M	*SD*	*M*	*SD*	*t*	*p*
Attention to tangled information[1]	4.36	2.14	4.77	2.35	- .54	.592
Success in keeping the rhythm[2]	6.56	1.48	6.38	1.19	.37	.714
Attention to circle[3]	6.44	1.92	7.15	1.87	- 1.10	.279
Difference in affiliation[4]	.28	1.80	- .46	1.45	1.29	.206
Feeling of being a unit[5]	4.16	2.12	4.08	1.61	.12	.902
Feeling of togetherness[6]	4.44	1.92	4.46	1.90	- .03	.974
Work together[7]	4.72	1.72	5.00	1.73	- .48	.638
Feeling of being one[8]	3.04	2.21	3.23	1.48	- .28	.781
Aware of other participant[9]	7.16	1.57	7.38	1.39	- .43	.667
Doing the task together[10]	6.40	1.68	5.23	2.01	1.90	.065
Coordinated with other[11]	5.16	2.08	4.85	2.30	.43	.673
Feeling the same[12]	6.08	2.04	5.15	1.57	1.43	.162
Understand each other[13]	5.04	2.25	5.38	1.56	- .49	.625

1-13: For full questions the number corresponds with the number of the question in appendix 2

3.3 The link between the feeling of doing the task together and self-agency experiences

The results from the independent t-test showed a marginal significant difference in the degree to which the participants felt they did the task together: participants in the synchronous condition scored higher on this question than participants in the asynchronous condition. In order to examine this interaction, the effect on self-agency experiences was assessed for participants with a weak feeling of doing the task together (one standard deviation below the mean) and for participants with a strong feeling of doing the task together (one standard deviation above the mean) separately (for more info see Aiken & West, 1991). These analyses showed a significant main effect for matching in the implicit route, $F(1, 34) = 5.36$, $p = .027$, $\eta_p^2 = .136$ and a significant main effect for matching in the explicit route $F(1, 34) = 27.53$, $p = < .001$, $\eta_p^2 = .447$. Furthermore, in the implicit route, there was a significant interaction between matching and a feeling of doing the task together $F(1, 34) = 16.74$, $p = < .001$, $\eta_p^2 = .330$. Participants who had a strong feeling of doing the task together with the other participant showed no significant effect of matching $F(1, 34) = 1.20$, $p = .281$, $\eta_p^2 = .034$ (see **Figure 2** in appendix 3). Participants who had a weak feeling of doing the task together with the other participant did show a significant matching effect $F(1, 34) = 23.83$, $p = < .001$, $\eta_p^2 = .412$ (see **Figure 3** in appendix 3). Additionally, for these participants the matching-by-synchrony interaction was marginally significant $F(1, 34) = 3.89$, $p = .057$, $\eta_p^2 = .103$. Participants that scored one standard deviation above the mean showed a matching effect that was smaller in the synchronous condition than in the asynchronous condition, while participants that scored one standard deviation below the mean showed a matching effect that was bigger in the synchronous condition than in the asynchronous condition. Furthermore, the three-way interaction between matching, synchrony and feeling of doing the task together did not show any significant effects $F < 1$.

4. Discussion

The present study was a first examination of the effects of interpersonal synchrony on experienced self-agency. It explored the explicit and implicit route to inferences of self-agency experiences in a social context. In line with previous research (Aarts, Custers, & Wegner, 2005; van der Weiden, Aarts, & Ruys, 2012; Renes et al., 2013) results showed that both intention to cause a specific outcome and priming of the action-outcome increased experiences of agency over producing the outcome when that outcome actually occurred. Not only does this research replicate findings of earlier research on the inferential nature of authorship processing, it replicates these findings in a social context where two individuals simultaneously tap in a synchronous or asynchronous rhythm. This demonstrates that even in this situation where people have to pay attention to tapping on a response box (i.e. focus on an extra task next to the self-agency task) and where two individuals perform this task together, the sense of self-agency still operates well. This shows how robust the effects of both subtly pre-activated outcome information and an intention to produce a specific outcome are on experienced self-agency. Additionally, being assigned to tap in or out of synchrony with another individual during the experiment did not have the anticipated effects on experienced self-agency.

Predicted was that individuals in synchrony would see less individual differences between them and the other participant, than individuals in the asynchronous condition. In turn, this would make it harder to distinguish between the self and the other (Lakens, 2010; Brewer, Weber, & Carini, 1995). Therefore, it was hypothesized that it would be less likely that an outcome that matched the primed or intended outcome would be primarily ascribed to the self. Specifically, if both you and the other performed the same action at the same time, it would be more difficult to determine who was the one that caused the outcome. In turn, an outcome that did not match the primed or intended outcome would less likely be mostly ascribed to the other. Consequently, the difference in experienced self-agency between an outcome that matched the primed or intended outcome and an outcome that mismatched this would be smaller in the synchronous condition than

in the asynchronous condition. However, results showed that there were no significant differences between both conditions. Several questions on rapport and entitativity did show higher means in the synchronous condition compared to the asynchronous condition. Nevertheless, it cannot be said if this is due to the amount of synchrony between participants, since it is not clear if participants actually felt in synchrony with each other in the synchronous condition. Consequently, if the participants did not feel in synchrony with each other, it would then also not affect the degree to which the participants experienced self-agency. Hence, results showed there was no difference in the matching effect between the synchronous and the asynchronous condition. Furthermore, based upon previous findings of the effects of imitation on authorship processing (e.g. Dijksterhuis & Bargh, 2001; Wegner & Sparrow, 2004; Tognoli, Lagarde, DeGuzman, & Kelso, 2007), it was predicted that participants tapping in synchrony would experience a reduced feeling of self-agency. The findings showed, though, that the participants assigned to the synchronous condition did not report a lower overall sense of self-agency than participants that were assigned to the asynchronous condition.

While the results suggest that interpersonal synchrony does not have any effects on experienced self-agency, the current findings do not provide us with enough information to draw conclusions on the link between synchrony and self-agency. Even though the same amount of participants was assigned to the synchronous condition as to the asynchronous condition, unfortunately not everyone matched their tapping cue correctly. Especially participants in the asynchronous condition eventually ended up tapping more in synchrony with the other participant. This resulted in an underpowered sample size and the comparison of more people in the synchrony condition, than in the asynchrony condition. Although in the similar study done by Hove & Risen (2009), participants correctly matched their target metronome on the screen, the results of the current study are in line with earlier research that showed that people have been found to unconsciously match each other's behavior (Chartrand and Bargh, 1999).

An important difference between my study and the study done by Hove & Risen is that the

participants had to focus their attention on the self-agency task while they were tapping. It could be that the self-agency task itself took too much effort, which distracted the participants from tapping on the response box. The distraction from tapping could have resulted in more difficulty with keeping the tapping rhythm, making the participants' tapping more of an automatic process. It could be that this is one of the reasons why the interpersonal synchrony did not show any effects on experienced self-agency. If the participants were distracted too much by the self-agency task, they did not pay enough attention to the rhythm they tapped on the response box. By not detecting this rhythm, the effects of interpersonal synchrony would also not show. This idea is supported by research, where those focused on another task more during interpersonal synchrony, paid less attention to their synchrony relative to another person, and hence show less differences in related brain activity between synchronous and asynchronous conditions (Chapin and colleagues, 2010)

Another potential reason why interpersonal synchrony did not show the expected effects on experienced self-agency could be that participants felt as if tapping in synchrony with the other participant was not their choice. The possibility that the synchronous behavior is experienced as something that only happens because they are instructed to do so could be used as a source of information regarding shared feelings of rapport. Research on the effects of observed synchrony on perceived rapport and entitativity, showed that movement synchrony activates psychological inferences about the social unity of the observed individuals. However, judgments of unity among groups differed based on whether the movement synchrony simply emerged, or was the result of an explicit instruction to synchronize (Lakens & Stel, 2011). During synchronous behavior, the reason for tapping in synchrony could be attributed to an external source (i.e. the external cue). Additionally, tapping to the cue could make the participants feel as if they were in synchrony with the target metronome instead of in synchrony with the other participant. If participants felt they were tapping in synchrony because they were responding to an external cue during synchronous behavior, this would not affect the ability to discriminate between self and other. Consequently, this would then not increase feelings of rapport and entititativity.

Furthermore, results showed that in both the synchronous and the asynchronous condition, not all the participants felt they did the task together with the other participant. Instead of inferring closeness during synchronous behavior, this could lead to a feeling of competition. A feeling of competition would just create a greater distinction between self and other. Results showed that participants who had strong feeling that they did the task together with the other participant, showed a significantly smaller matching effect than participants who did not really feel they did the task together. Thus, when people felt they were doing the task together, an outcome that matched the primed or intended outcome was less likely to be ascribed primarily to the self, compared to when people did not feel like they were doing the task together. Furthermore, an outcome that did not match the primed or intended outcome was less likely to be ascribed primarily to the other, which resulted in a reduced distinction between self and other produced action. It is possible that because not everyone experienced a feeling of doing the task together, synchrony did not lead to a reduced distinction between self and other produced action.

Whether there is no effect of synchrony, or whether it is due to not paying enough attention to the synchrony, the impression participants have that their behavior only happens because of an external instruction to do so or a feeling of not doing the task together with the other participant, results of this experiment did not show the expected effects of synchrony on experienced self-agency. The manipulation of synchrony in this experiment was not successful enough to demonstrate whether synchrony affects self-agency.

For future research on the link between interpersonal synchrony and self-agency it is crucial that the participants experience synchrony with each other. To make participants feel more like they are doing a task together instead of against each other, it would be interesting to do a self-agency experiment that is cooperative instead of competitive. Past findings on interpersonal synchrony have lent support to the theory that moving together in synchrony serves as a cooperation-enhancing mechanism, binding individuals together into adaptive units of reciprocal exchange (Haidt, Seder, & Kesebir, 2008; McNeill, 1995; Wilson, Van Vugt and O'Gorman, 2008). In

combination with research demonstrating the influence of non-conscious mimicry on liking, affiliation, altruism and interdependence, a growing body of evidence supports the role of coordinated action as a "social glue" (Ashton-James, van Baaren, Chartrand, Decety, & Karremans, 2007; Stel, van Baaren, & Vonk, 2007; Van Baaren, Holland, Kawakami, & van Knippenberg, 2004). Taking into account the idea that synchrony serves as a cooperation-enhancing mechanism; a cooperative instead of a competitive self-agency task could be a sensible next step. When the participants cooperate during the task, it is more likely to lead to the cognitive inferential processes that could increase feelings of rapport and entitativity, making it harder to discriminate between self and other. In turn, synchronous behavior during a cooperative task is more likely to have an effect on experiences of self-agency than synchronous behavior during a competitive task. An idea could be to just tell the participant to tap while he or she is doing the self-agency task, without a visual cue for this on the screen. At that same time, a confederate would be used that would tap together with the participant. The confederate could manipulate the amount of synchrony between them. Since, the participant would either unconsciously match the tapping of the confederate (Chartrand and Bargh, 1999), or the confederate could make sure the rhythm of their tapping will be asynchronous. The amount of synchrony between them could then be checked afterwards instead of manipulated in the experiment, after which this could be analyzed and compared to self-agency experiences. In this way the synchrony that is measured between participants is spontaneous instead of induced.

In conclusion, the current research presented us with interesting findings on experienced self-agency. It showed how robust the effects of both subtly pre-activated outcome information and an intention to produce a specific outcome are on experienced self-agency. This demonstrates that even in a situation where people have to pay attention to tapping on a response box (i.e. focus on an extra task next to the self-agency task) and where two individuals perform this task together, the sense of self-agency still operates well. Moreover, it showed that the link between interpersonal synchrony and self-agency needs further investigation to be able to draw any conclusions about it.

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Appendix 1

Closed questions before the experiment

1. How well do you know the person next to you? (1 “never seen before” to 10 “best friends”)
2. How friendly do you think the other participant is at this moment? (1 “very unfriendly” to 10 “very friendly”)

Appendix 2

Closed and Open questions after the experiment

Closed questions 1-13:

All questions and statements were measured with a 10-point Likert scale.

1. To what extent did you pay attention to the tangle of information during the task?
2. To what extent did you feel you could successfully keep the rhythm?
3. To what extent did you pay attention to the big black circle that indicated the rhythm during the task?
4. How friendly do you think the other participant is at this moment?
5. I feel we are a unit.
6. I experience a feeling of togetherness between us.
7. I feel we can work together.
8. I feel we are as one
9. To what extent were you aware of the other participant during the task?
10. To what extent did you feel you did this task together with the other participant?
11. To what extent did you feel coordinated with the other participant during the task?
12. To what extent did you feel the same as the other participant during the task?
13. To what extent did you and the other participant understand each other?

Open questions 1-6:

1. Did you notice anything significant during the task? If so, what?
2. Do you have any idea what the task was about?
3. Did you notice anything about the rhythm in which you tapped on the response box?
4. Did you notice anything about the rhythm in which the other participant tapped on the response box?
5. To what extent were you aware of the experimenter during the task?
6. In what way do you think the experiment formed part of the task?

Appendix 3

Interaction in the implicit route between matching and a feeling of doing the task together for participants who felt they did the task together (i.e. +1 SD) and participants who did not feel they did the task together (i.e. -1 SD).

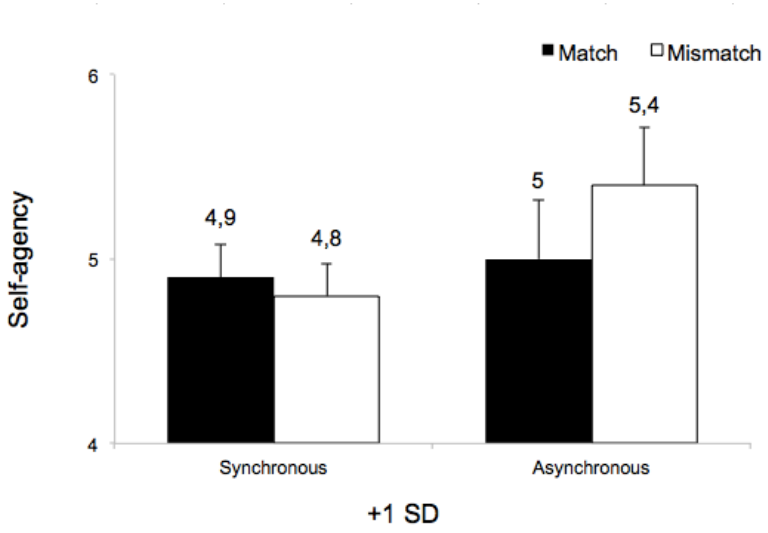

Figure 2. Self-agency experiences of participants that felt they did the task together as a function of Matching. Error bars represent standard errors of the mean.

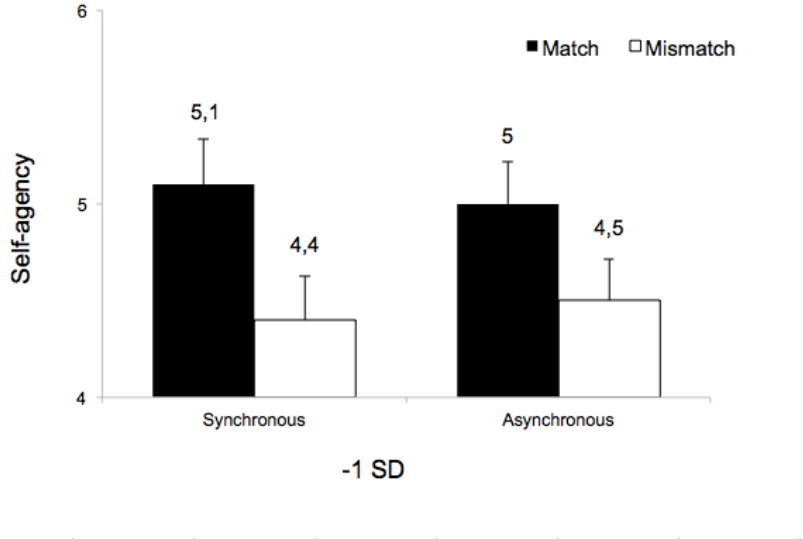

Figure 3. Self-agency experiences of participants that did not feel they did the task together as a function of Matching. Error bars represent standard errors of the mean.