



On the inference of personal authorship: Enhancing experienced agency by priming effect information[☆]

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Abstract

Three experiments examined whether the mere priming of potential action effects enhances people's feeling of causing these effects when they occur. In a computer task, participants and the computer independently moved a rapidly moving square on a display. Participants had to press a key, thereby stopping the movement. However, the participant or the computer could have caused the square to stop on the observed position, and accordingly, the stopped position of the square could be conceived of as the potential effect resulting from participants' action of pressing the stop key. The location of this position was primed or not just before participants had to stop the movement. Results showed that (subliminal as well as supraliminal) priming of the position enhanced experienced authorship of stopping the square. Additional experimentation demonstrated that this priming of agency was not mediated by the goal or intention to produce the effect.

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1. Introduction

While belief in the causality of the self is only an illusion. . . , [one phenomenon] which explain[s] such a belief. . . is our ability to foresee the result before it actually takes place.
(Michotte, 1963, p. 10)

Each of us has the frequent experience of causing events in the world. We push a button and cause a coke to come out of a machine, or we say something silly and cause someone to smile. This assessment of authorship seems a straightforward affair, but sometimes it can go wrong. Perhaps the soft drink would have come out all by itself, or perhaps the person who smiled was amused by something other than us. Still, we may be likely to feel that we are the author of these events—whether we truly caused them or not—if we happen to have thought about the events just prior to their occurrence, and then perceive that the events do occur. In more conceptual terms, one may experience enhanced personal causation of the observed action effect (where action effect refers to any possible outcome that may arise from concrete actions) because the representation of the effect is primed before one performs the given action. The present research focused on the basic processes that may underlie biases in social agency assessment by examining whether priming action effects indeed enhances the experience of causing those effects. Specifically, we aimed to demonstrate that the process of authorship ascription does not require intentional or goal-directed thinking in order to occur, thus showing that the feeling of agency can merely follow from a belief-like mental state and may be illusory.

2. The role of effect information in the experience of authorship

There are a variety of potential sources of information about authorship of an action. The processing of authorship (Wegner & Sparrow, 2004; Wegner, Sparrow, & Winerman, 2004) draws on a variety of *authorship indicators*, including body and environment orientation cues (e.g., Vallacher & Wegner, 1985), direct bodily feedback (e.g., Gandevia & Burke, 1992; Georgieff & Jeannerod, 1998), direct bodily feedforward (e.g., Blakemore & Frith, 2003; Blakemore, Wolpert, & Frith, 2002), visual and other indirect sensory feedback (e.g., Daprati et al., 1997; Nielson, 1963), social cues (e.g., Kelley, 1972; Milgram, 1974), agent goal information (e.g., Jones & Davis, 1965; Langer & Roth, 1975), and own behavior-relevant thought (e.g., Wegner, 2002, 2003; Wegner & Wheatley, 1999). This last indicator is the topic of the current research. Knowledge of the effects of our actions before we perform them is one of the main sources of information we have about our own contribution to the world, and, as discerned by Michotte (1963), such information serves as a key input to establishing a sense of our own agency.

Normally, the thoughts people have prior to action are experienced as intentions, and are felt to cause the behavioral event. Such feelings of causation thus emerge when the perception of an effect corresponds with the effect that is expected or desired to result from performing a (motor) action. However, because one cannot directly observe causal connections between one's own actions and resulting effects, such conscious causation is always an inference and never something directly observable (Hume, 1888). As such, the mind is a system that produces appearances for its owner, which may lead to *apparent mental causation*: the experience we have of causing events

that arises whenever our thoughts are inferred to cause these events (Wegner & Wheatley, 1999). Accordingly, observing effects that are presaged in our minds during action performance provides the feeling that we caused the behavioral effects. And this feeling of personal authorship can sometimes be illusory.

There is some evidence to suggest that information about behavioral effects plays a basic role in grasping a sense of authorship. One line of support comes from studies that systematically investigate discrepancies between expected and observed action effects during the production of manual movements to establish feelings of agency. People in one study, for instance, were asked to detect a mismatch between their intended manual gestures and corresponding (visual) effects of a virtual hand presented on a computer-controlled video screen (Franck et al., 2001). By manipulating the temporal discrepancies between hand movements and the visual feedback, the researchers showed that participants experienced less agency when the representation of the displayed hand movement (observed action effect) and the representation guiding the actual tactile movement (expected action effect) were discrepant by 150 ms (see also, Blakemore, Frith, & Wolpert, 1999). In another study conducted by Fournier and Jeannerod (1998), participants were given the goal to draw a straight line on a computer screen. Participants could not see their hand, and received false (motor) feedback that forced them to make deviations to reach their goal. Verbal reports showed that participants were unaware of making deviant manual movements in response to the false feedback—in fact, they claimed to have made straight movements. This result points to the idea that people have limited direct conscious access to the actual operations of their actions (see also, Bargh, 2005). Hence, behavioral effect information is important to check whether the action is completed as intended and to arrive at judgments of agency.

A series of experiments by Haggard, Clark, and Kalogeras (2002) further demonstrate how the perception of actions and their effects bind together to produce a feeling of authorship of the effects. Participants were asked to press a key, which on some trials was followed 250 ms later by an auditory tone. Their task was to judge the timing of their key-press and the tone by reporting the corresponding position of a moving clock hand. Remarkably, when the tone was causally linked to the key-press, participants judged the key-press to occur 15 ms later and the tone to occur 46 ms earlier than if the two events occurred alone. However, this temporal binding effect diminished when an unintended movement (caused by transcranial magnetic stimulation) was followed by a tone, or when the gap between action and tone increased in time (from 250 to 650 ms). These results suggest that when a person performs an action to attain a desired effect, the perceived times of these two events shift towards each other. This temporal attraction between intentional, goal-directed actions, and their observable effects may enhance our feeling of agency.

Studies in neuroscience suggest that the brain is tuned differently toward the recognition and production of behavior than toward the understanding and experience of agency. For instance, it has been shown that observing an ordinary behavior performed by someone else elicits the same brain activity in the motor system as executing the behavior oneself when instructed to do so (e.g., Avikainen, Forss, & Hari, 2002; Grafton, Arbib, Fadiga, & Rizzolatti, 1996; Grezes & Decety, 2001; Jeannerod, 1997). Thus the recognition and execution of behavior seem to share the same neural system. More recent research, however, suggests that specific brain regions in the parietal cortex are activated when one has to deal with the attribution of action effects to the proper agent

(Chaminade & Decety, 2002; Farrer & Frith, 2002; Ruby & Decety, 2001). In addition, lesions in these regions render judgments of authorship more difficult (Kinsbourne, 2002; Sierra, Lopera, Lambert, Phillips, & David, 2002; Spence, 2002). These findings indicate that different brain areas are recruited to recognize and generate behaviors (which involves the categorization of actions, but not categorization as self's action or other's action) rather than to infer the causes of the actions on the basis of their effects (involving categorization of actions in terms of self or other).

The fact that the recognition and production of behaviors and the assessment of authorship are handled by anatomically separate, distinct parts of the brain enables us to distinguish our own behavior from those of others. On the other hand, the cortical dissociation between “doing” and the “feeling of doing” raises the possibility that we sometimes can feel personal authorship quite independent of any actual causal connection between our thoughts, actions, and effects. That is, people may think they have caused events when, in actuality, these events are produced by an external source.

3. The priming of effect information and biases in authorship

The theory of apparent mental causation (Wegner, 2002; Wegner & Wheatley, 1999) provides a context within which these ideas can be understood. Based on the principles underlying causal perception for physical events (e.g., Gilbert, 1998; Kelley, 1972; Michotte, 1963), the theory proposes that for the experience of personal causation, three preconditions have to be met—the priority, consistency, and exclusivity of the thought we have about our own behavior. That is, if the thought of the effect occurs appropriately prior to the action, is consistent with the observed effect, and is not accompanied by other potential causes, then we experience the effect as willfully caused by our selves. Thus, illusions of personal causation are more likely to ensue if the thought of the action effect occurs before, and is consistent with the observed effect—even if other sources cause the effect. In that case, people interpret their own accessible thought as the cause of the behavioral event, thereby arriving at the deceptive belief that they produced it.

In one test of this theory, Wegner and Wheatley (1999) designed an experiment to learn whether prior and consistent thoughts of action effects influence experience of personal causation in a situation in which the exclusivity of the cause of effects is ambiguous. Participants were asked to move a small square board in circles together with a confederate while music was played through their headphones. The square board was mounted atop a computer mouse, thereby moving a cursor on a screen on which several small objects were displayed (e.g., car, dog). Participants were instructed to stop the cursor every 30 s or so. On some trials they were exposed to a word over the headphone that served to prime thoughts about an item on the screen (e.g., car). Thus, representations of possible effects of stopping the movement with the mouse were made accessible at different points in time (e.g., 30 or 1 s before the stop). On these trials, however, the confederate received instructions over the headphone to move the cursor to the primed item. After each stop (when the cursor had landed on the primed item) participants indicated the extent to which they felt to cause the stop. In line with the general decay function of covert priming effects in perception and cognition (e.g., McKone, 1995), results showed that experienced control was lower when the prime appeared 30 s before the stop, and increased when it was presented 5 or 1 s before the

stop. On trials when stopping on an item was not forced, however, it was found that prior primes did not incline participants toward stopping on the primed item. These data indicate that priming of effects biases experiences of personally causing the effects, even when those effects are not personally caused.

To summarize, the foregoing findings are suggestive of, and consistent with the notion that accessible effect information encountered prior to action readily serves as a source for assessments of authorship. Experiences of personal authorship thus may arise as a result of merely priming effects just before a person executes an action while the actual effects are caused by another source.

4. The present research

We report three experiments that further scrutinize Wegner's (2002) work on the theory of apparent mental causation. As an important extension of this work, the aim of the present research was to sort out the role of intentions or goals to produce effects in the process of authorship ascription. A central feature of Wegner and Wheatley's (1999) experimental procedure was that participants were consciously aware of the primes, and hence could (and indeed they did; see p. 489) intentionally search for the items on the screen that they had heard over the headphones while the confederate moved the cursor to these items. Their results are therefore not clear as to whether the goal to produce the primed effect (in their case, stopping the cursor on the primed item) is a necessary prerequisite for biasing experienced agency. However, the framework proposed by Wegner (2002) suggests that the mere priming of an effect suffices to attribute the observed corresponding effect to one's own action. Thus, it is important to assess whether priming of effect information heightens feelings of agency without installing the goal to produce the effects. For this purpose, we designed an experimental setup that enables us to prime the representation of the effect before participants generate the action—but in which the intention or goal to produce the primed effect is not instigated.

In an adaptation of the wheel of fortune game, in our task participants had to move a gray square rapidly traversing a rectangular path consisting of eight white tiles on a computer-screen by holding a key. At the same time, however, the computer independently moved another gray square with the same speed but in opposite direction. At a certain point in time, participants had to rapidly press another key to stop all movement (see Fig. 1). Once they had pressed this stop key, a black square was presented on one of the white tiles. They were told that this square indicated either the position of their own square at the time of the stop, or that of the computer's. Thus, whether the presented position was an effect of their action of pressing the stop-key was unclear, as they were not the exclusive source that could have caused the effect (cf. Wegner & Wheatley, 1999). Note that, other than in a wheel of fortune game (in which people can decide themselves when to swing or to stop the wheel), in our task participants were forced to start and stop the moving of the squares by an external signal, thereby rendering the task more reactive. Of importance, although the pushing of the stop-key is externally triggered and controlled, the question here is how participants experience authorship over the observed stops as potential effects of their action of pressing the stop-key.

As a measure of feeling of authorship, participants were asked to indicate whether it was they themselves or the computer that caused the square to land on the respective position.



Fig. 1. Illustration of the experimental task showing how the squares move in opposite direction.

On some trials, the location of the black square (that is, the possible effect of participants' action of pressing the stop key) was primed just before participants pressed the stop key. The time participants took to push the stop key was also recorded for two purposes. First, we wanted to know whether priming of effect information (either subliminal or by means of a goal) modifies the timing of producing the stops. Second, we wanted to assess whether participants' reaction times in the prime condition would have produced results that were closer to the presented effect than in the baseline condition, causing them to experience more control over the observed stops. We therefore calculated a measure of potential control by examining the absolute difference between participants' response time and the actual time required to land right on the presented stop.

By employing this experimental setup, then, we systematically tested the effects of priming on authorship ascription. Experiment 1 examined effects of subliminal priming of effect information and compared them with conditions in which participants had the conscious goal to produce the effects. Experiment 2 tested the role of conscious perception of the primes by comparing subliminal versus supraliminal priming effects. Finally, Experiment 3 aimed to assess whether subliminal priming of effect information indeed enhances the experience of authorship without propelling the goal to cause the effects—that is, we further tried to rule out the possibility that the prime causes participants to intentionally stop the square on the primed position by specific timing of their key pressing. The general expectation was that priming of the location of the black square before the action would enhance the participants' feeling that this position was the result of their action, or in other words, that they were the cause of the presented effect.

5. Experiment 1

In this experiment, we compared the effects of conscious goals to produce effects (that is, intentionally stopping the square on a specific tile by pressing the stop key) with subliminal priming of the representation of these effects (a specific tile) on experienced authorship. Subliminal priming was used as a way of enhancing the accessibility of thoughts about a specific location just before the action of pressing the stop key, while simultaneously preventing conscious awareness of these thoughts (for a review, see Dijksterhuis, Aarts, & Smith, 2005). Participants performed the previously described computer task. In the subliminal priming condition, the location of the black square indicating the stop position that was presented after participants pressed the stop key was primed for 34 ms just before they had to press the key. In the conscious goal condition, participants were given the goal to stop the square on this location by their key press. We predicted that both kinds of prior events would enhance experienced authorship as compared to a baseline task in which no location was indicated by subliminal priming or conscious goal.

5.1. Method

5.1.1. Participants and design

Fifty-three undergraduate students participated in the experiment receiving 2 Euros in return. They were randomly assigned to one of two conditions varying type of priming: subliminal vs. conscious goal.

5.1.2. Experimental task and procedure

Participants worked in separate cubicles on the experimental computer task. They learned that the study was designed to examine people's feelings of personal causation and how these feelings come and go. For this purpose, participants had to move a gray square rapidly traversing a rectangular path in a counterclockwise direction by pressing and holding a start key. This path consisted of eight white tiles. The computer independently moved another gray square along the path at the same speed, but in the opposite direction (clockwise). At a certain point in time, participants had to press a stop key. Furthermore, they were told that after they had pressed the stop key one of the eight white tiles would turn black, representing the location of either their square or the computer's at the time they pressed stop. Thus, the black square either did or did not represent the effect of their action. After each presented stop, they indicated their feeling of authorship. The task consisted of two consecutive blocks: a base-line (non-prime) condition block and a block in which the stops were either subliminally primed or given as a conscious goal to produce. An illustration of the task is depicted in Fig. 1.

As can be seen in Fig. 1, when "start" appeared on the computer-screen participants had to press the "S" key, thereby initiating the moving of the squares. The "S" key had to be held until the message "stop" was shown. When "stop" appeared on the screen they had to press the "Enter" key immediately, thereby stopping the movement. They were told that the message "stop" would appear on the screen at a random moment in time. Between the "stop" message and the key press the squares were not visible, so participants could not directly perceive the position of their square at the time they pressed the "Enter" key. After the "Enter" key was pressed, the black square was presented and the experience of authorship was assessed. Participants were

asked to indicate whether they had caused the square to land on that position or the computer had caused it. Their authorship judgment was measured on a 10-point answer scale with endpoints *not at all me* (1) and *absolutely me* (10). Participants practiced the task once to ensure that they had understood it correctly, and then moved on to the actual task.

The experimental task consisted of 16 trials that were divided in 2 blocks of 8 trials. In each block, the black square was presented on each of the eight tiles of the path. The first block served as a baseline (no prior event) condition, whereas the second block served to manipulate the type of prior event (subliminal prime of position vs. conscious goal to reach a position). There was a short break (30 sec.) between the blocks. In this break, participants in the conscious goal condition learned about the goal to produce the stops, while participants in the subliminal priming condition were told that they should adhere to the task instructions. The trials were randomly presented within a block.

5.1.3. *Type of prior event*

In the second block the type of prior event was experimentally varied between participants. In the *subliminal priming condition* the black square that would be displayed on a specific position after participants pressed the Enter key was briefly flashed on that position just before the message “stop” appeared. Thus, the primed location always corresponded with the presented location of the black square. The prime (e.g., lower corner right) occurred 40 ms after the last presentation of the participant’s square (e.g., upper corner left). Primes were presented for 34 ms, and were 46 ms later followed by the message “stop” (the total time for the priming event thus is 120 ms). In the *conscious goal condition* participants were told that, till now, they had stopped the squares without a purpose. However, for the next trials they were explicitly given the goal to stop the square on a designated position. As in the subliminal priming condition, it was further stressed that they should adhere to the task of pushing the ENTER key immediately upon the message “stop.” In each trial, the goal was given by presenting the path of eight white tiles and the respective stop position (in black) for 2 s before the message “start” appeared on the screen. The time events before the message “stop” were identical to the subliminal priming condition trials, except that the position of the black square was not flashed (the position was simply presented in white for 34 ms, just like in the base-line trials). The prior event was employed for every possible location, resulting in eight replications of the prior event condition (block 2) and the base-line condition (block 1). That is, eight times the position of the black square was either subliminally primed or given as a conscious goal to produce (block 2), and eight times it was not (block 1).

5.1.4. *Events in a trial*

Each trial started with a warning signal (“attention”) for 3 s. Next, the empty path was presented on the screen, showing the message “start” in the middle of the screen until participants pressed the “S” key. One second after participants pressed (and held) the “S” key, the participant’s and computer’s square started to move along the path in alternating motion (that is, the squares were displayed one after the other). Squares were displayed for 60 ms on each position. Thus, the speed of one lap was 960 ms [$60 \text{ ms} \times 8 \text{ positions} \times 2$ (participant’s and computer’s square)]. The number of laps in a trial that were completed before the message “stop” appeared could vary between 8 and 10, and was randomly determined by the computer. From the moment that the message “stop” was presented, only the eight empty white tiles were visible until the par-

participant pressed “Enter.” On that response, a black square was presented after 100 ms, for one second. The position of this square was always four positions farther than the last position of the participants’ square before the message “stop” had appeared. So, for example, the black square was presented in the right lower corner position after the participant’s last square was presented in the left upper corner position; the black square was presented in the right middle position after the participant’s last square was presented in the left middle position, etc. Thus, participants did not have actual control, as the position of the black square did not depend on their reaction. After the presentation of the black square, experienced authorship was measured.

5.1.5. *Measurement of response time*

The computer also measured participants’ time (in ms) to push the Enter key in response to the message “stop.” Because the location of the black square was always four positions farther than the last presentation of the participant’s square, the time from the onset of the last position of the participants’ square to the onset of the stop position was $960 \text{ ms} / 2 = 480 \text{ ms}$. Accordingly, the time between the message “stop” and the onset of the presented stop was 300 ms (480 ms minus the 60 ms from the last presentation of the participant’s square, and minus 120 ms for the priming event). Furthermore, the primary response time required for the participants square to land exactly on the position indicated by the black square at half of its presentation time was 330 ms (300 + 30 ms).

5.1.6. *Debriefing*

After the computer task, participants were debriefed by using a funnel debriefing procedure similar to that suggested by Bargh and Chartrand (2000). As a check on awareness of the primes, participants were asked to report whether they had noticed anything special during the task. A couple of participants in the conscious goal condition reported that their goal to stop the square was always four positions further than the last position of their own square before the message “stop.” Importantly, however, none of the participants in the subliminal priming condition indicated any awareness of the priming of the stops. Furthermore, we also asked all participants how they had handled the task. Most of them said that it was somewhat difficult to determine whether they caused the stops or not and hence, as suggested by the instructions, they relied on their feelings to arrive at a personal authorship assessment.

5.2. *Results*

5.2.1. *Effects on experienced authorship*

The main dependent measure of interest was the average ratings of experienced authorship across the 8 baseline (no prior event) trials and 8 prior event trials. These ratings were subjected to a 2 (Prior event: baseline vs. prior event) within-participants \times 2 (Type of prior event: subliminal prime vs. conscious goal) between-participants ANOVA. The main effect of prior event was highly reliable, $F(1, 51) = 9.80$, $p = .003$, $\eta^2 = .16$; experienced authorship was substantially higher in the prior event condition ($M = 4.44$; $SD = 1.93$) than in the baseline (no prior event) condition ($M = 3.51$; $SD = 1.83$). These priming effects were independent of the type of prior event, as indicated by a non-significant interaction effect, $F = 1.03$. Furthermore, the main effect of type of prior event was also not reliable, $F < 1$.

5.2.2. *Timing to produce effects*

To check whether participants timed their responses differently in the base-line and the priming conditions, the average response times across the 8 base-line trials and 8 prime trials were subjected to a 2 (Prior event: baseline vs. prior event) within-participants \times 2 (Type of prior event: subliminal priming vs. conscious goal) between-participants ANOVA. The analysis yielded a significant main effects of prior event, $F(1, 51) = 4.00$, $p = .05$, $\eta^2 = .07$, revealing that participants were somewhat slower in the prior event trials ($M = 461$; $SD = 195$) than in the base-line trials ($M = 402$; $SD = 173$). The main effect of type of prior event, as well as the interaction effect, were not significant, $F_s < 2.00$, *ns*. These effects suggest that participants became slower in producing an immediate response upon the message stop when moving from block 1 to block 2.

5.2.3. *Potential control*

On most trials, participants pressed the Enter key within the first lap, that is, before the participant's square started to make a new lap after the presentation of their last square. For these trials we calculated the absolute difference between the response time after the message to stop and the initial time required to land exactly on the position of the black square at half of its presentation time (i.e., 330 ms). For the other trials we first corrected the response time by subtracting the time of the completed laps (960 ms for each lap) from the total response time, and then calculated the absolute difference between this corrected response time and the time required to land on the position of the black square at half of its presentation time (330 ms). This way, for each trial we have an estimate how close participants had landed to the presented position. The smaller the absolute difference, the more likely they actually could have caused the square to land on the position.

The average absolute difference scores across the 8 baseline trials and 8 prior event trials were subjected to a 2 (Prior event: baseline vs. prior event) within-participants \times 2 (Type of prior event: subliminal prime vs. conscious goal) between-participants ANOVA. The analysis yielded a significant effect of prior event, $F(1, 51) = 7.40$, $p = .01$, $\eta^2 = .13$; participants' potential control over producing the stops was lower in the prior event trials ($M = 101$; $SD = 52$) in comparison to the baseline trials ($M = 82$; $SD = 47$). No other effects were reliable, $F_s < 1.66$. The decrease in potential control is largely due the fact that participants' responses were slower in the prior event trials (in block 2). As a result, the absolute difference increases because the time required to land on the stop position is constant (330 ms).

5.3. *Discussion*

Results showed that our experimental setup is capable of tapping into the process of authorship ascription by priming effect information. First, the conscious goal to produce a specified stop caused participants to experience more authorship over these stops, even though actual control was absent—in fact, analyses of response times showed that the potential control decreased in the conscious goal trials. These findings concur with research on the perception of control in non-contingent action–outcome situations, showing that if an actor wants an outcome to follow from his or her action and this outcome occurs, the outcome is more likely seen as connected to the action, thus enhancing experienced authorship (e.g., Alloy & Abramson, 1979; Tennen & Sharp, 1983). Second, subliminal priming of the stops increased feelings of authorship to the same extent as providing goals to produce these stops. Again, these effects were established even though

actual control over the stops was absent. These findings show that feelings of authorship can emerge from subliminally primed prior thoughts of an action's observed effect.

6. Experiment 2

The primary goal of this experiment was to provide a replication of our initial finding that priming of effect information enhances experienced authorship. We made two modifications to our experimental paradigm. First, whereas Experiment 1 used a comparison between a baseline (non-prime) block and a prior event (prime) block, in this study we intermixed the non-prime and prime trials in one task. A plausible reason for the slower responses and the resulting decrease in potential control in the prior event condition of Experiment 1 may be that participants simply became more tired during the task, thereby impairing the speed of responding on later trials. Accordingly, because participants took the 8 prime trials after they had performed the 8 non-prime trials, the slowing-down and decrease in potential control is caused by the time of testing. This time-effect can be circumvented when all trials are combined and randomly presented in one single task.

In the previous study we found that conscious goals and subliminal priming of effect information both increased experienced authorship. It is important to note, however, that in the [Wegner and Wheatley \(1999\)](#) study the priming of effect information was supraliminal. In other words, their participants encountered the common situation in which information about possible action effects may access consciousness before it becomes reality. Yet, they seemed to experience authorship over such effects even though they did not exhibit control over producing them (for a more general discussion of this topic, see [Wegner, 2002](#)). Given that the results of Experiment 1 suggest parallel effects for subliminally primed effect information, it is worthwhile examining whether consciousness of the primed effects has an influence in the present study. Under certain conditions, after all, subliminal and supraliminal primes (that is, when participants are consciously aware of the primes) can have differing influences (see e.g., [Dijksterhuis et al., in 2005](#); [Klauer & Musch, 2003](#); [Lombardi, Higgins, & Bargh, 1987](#)). Accordingly, as a second modification, in this study we examined whether enhanced feelings of authorship can result from subliminal as well as supraliminal priming of effect information in our experimental setup. Also, the inclusion of a supraliminal priming condition allows us to check whether our debriefing question is capable of picking up conscious perceptions of the primes.

6.1. Method

6.1.1. Participants and design

Fifty undergraduate students participated in the experiment receiving 2 Euros in return. They were randomly assigned to cells of a 2 (Type of priming: subliminal vs. supraliminal) between-participants \times 2 (Priming: no vs. yes) within-participants design.

6.1.2. Experimental task and procedure

In this experiment we used the 8 non-prime trials of block 1 and the 8 prime trials of block 2 employed in Experiment 1. However, instead of presenting them in blocks we incorporated the 16

trials in one task, and presented them randomly. Instructions, procedure and dependent variables were identical to those used in the subliminal prime condition. Thus, participants again had to press the Enter key immediately after the presentation of the message “stop.” However, in this experiment the primes were either presented for 34 ms (subliminal priming condition) or 68 ms (supraliminal priming condition).¹ As in Experiment 1, in the subliminal priming condition the prime (e.g., lower corner right) occurred 40 ms after the last presentation of participants’ square (e.g., upper corner left). Primes were presented for 34 ms, and were 46 ms later followed by the message “stop” (the total time for the priming event thus is 120 ms). In the supraliminal priming condition the prime also occurred 40 ms after the last presentation of participants’ square. However, because the presentation time of the prime was 68 ms, the message “stop” occurred 12 ms later (thus keeping the total time for the priming event equal to the subliminal priming condition, i.e., 120 ms).

6.1.3. Debriefing

Immediately after participants completed the computer task they were thoroughly debriefed. In response to the question whether they noticed anything special during the task, none of the participants in the subliminal condition said that they had seen squares highlighted in black. As in the previous experiment, then, participants in the subliminal priming condition were not aware of the priming events. However, in the supraliminal priming condition, 43.5% (10 out of 23) of the participants had the impression that a black square was sometimes highlighted on a certain position or that their attention was drawn to a specific location just before the message “stop,” indicating that these participants’ thoughts about the possible effects were accessible to consciousness. Given this relatively high percentage of conscious perception of the primes, it is likely that more participants in the supraliminal priming condition were aware of the primes (Bargh & Chartrand, 2000). Moreover, these findings suggest that the debriefing question is capable of tapping conscious perception of the primes, as this conscious perception only emerges when a longer presentation time of the primes was used. The debriefing further indicated that almost all participants relied on their feelings to indicate whether they caused the stops or not. Thus, it seems that none of the participants realized the true nature of the study.

6.2. Results and discussion

6.2.1. Effects on experienced authorship

The average ratings of experienced authorship across the 8 non-prime trials and 8 prime trials were subjected to a 2 (Type of priming: subliminal vs. supraliminal) between-participants \times 2 (Priming of position: no vs. yes) within-participants ANOVA. The analysis showed that the effect of priming of position was significant, $F(1, 48) = 10.68$, $p = .002$, $\eta^2 = .18$, revealing that participants’ experienced authorship was substantially higher after priming ($M = 5.56$; $SD = 1.75$) than after no priming ($M = 4.19$; $SD = 1.83$). These effects were independent of the type of priming, as

¹ Because of situational and dispositional factors it is difficult to determine when subliminal stimuli become supraliminal, i.e., enter conscious attention (Dijksterhuis et al., 2005). Given the timing parameters for subliminal presentation described by Bargh and Chartrand (2000), we deemed it appropriate to multiply the presentation time of the stops by two (for the consequences of this procedure, see Section 6.1.3).

was indicated by the non-significant interaction effect, $F < 1$. Furthermore, the main effect of the type of priming was not reliable, $F < 1$.

6.2.2. *Timing to produce effects*

To check whether participants timed their responses differently in the two priming conditions, the response times across the 8 prime trials and 8 non-prime trials were subjected to a 2 (Type of priming: subliminal vs. supraliminal) between-participants \times 2 (Priming of position: no vs. yes) within participants ANOVA. The analysis yielded no significant interaction effects or main effects, $F_s < 1.17$. The mean response time was 352 ms ($SD = 90$). The observation that the timing to produce effects did not vary between the (combined and randomly presented) non-prime and prime trials suggests that the time of testing slowed down participants' responses in the prime condition of the previous experiment.

6.2.3. *Potential control*

On most trials participants pressed the Enter key within the first lap, that is, before the participant's square started to make a new lap after the presentation of their last square. As in the previous experiment, for these trials we calculated the absolute difference between the response time after the message stop and the primary time required to land on the stopped position at half of its presentation time. For the other trials we first corrected the response time by subtracting the time of the completed laps (960 ms for each lap) from the total response time, and then calculated the absolute difference between this corrected response time and the primary time required to land on the stopped position. The averaged absolute difference scores across the 8 non-prime trials and 8 prime trials were subjected to a 2 (Type of priming: subliminal vs. supraliminal) between-participants \times 2 (Priming of position: no vs. yes) within participants ANOVA. The analysis yielded no significant main effects or interaction effect between priming and position of priming, $F_s < 2.06$, *ns.* (overall $M = 71$; $SD = 35$).

In short, then, the results indicate that participants' feelings of authorship was enhanced by the priming of effect information, irrespective of whether this information reached the threshold of conscious perception or not. These findings establish that people rely on effect information to establish a sense of personal authorship even though they are aware of the fact that the information is pre-activated in their mind.

7. Experiment 3

So far, the results of two experiments show that (subliminal as well as supraliminal) priming of effect information enhances feelings of authorship. Furthermore, analyses of response times indicate that participants did not change the timing of their decision to press the key to try to maximize the probability of stopping on a primed position. Our findings, then, suggest that the mere thought about effect information enhances authorship ascription to oneself without activating the goal to produce the effects or influencing behavior to produce the effects.

However, recent research on automatic processes in goal pursuit and action control suggests that goals or desired outcomes and subsequent actions to reach the desired effect can be (subliminally) primed by environmental cues to then operate outside of conscious awareness (for an over-

view, see e.g., Fitts & Bargh, 2004; Moskowitz, Li, & Kirk, 2004). In other words, people are capable of pursuing a goal by acting on the representation of a desired effect without being aware of it. Accordingly, it could still be the case that priming of effects did activate the goal to produce those effects, but that the timing parameter in our task was not sensitive enough to pick up behavioral changes (pressing the stop-key) resulting from this goal (wanting to stop the square on the primed position). That is, the mean response time in the non-prime condition was not far from the ideal response time that would land the participants' square right on the primed position (330 ms), leaving relatively little room for improved performance in the prime condition. To be more able to detect behavioral changes as a function of subliminal priming, we devised Experiment 3. In this experiment, we varied the position of the primed location relative to the last position of the participants' square. If subliminal priming of the stop would install a goal to produce that effect, one would expect reaction times as to pressing the stop key to change along with changes in the primed position.

7.1. Method

7.1.1. Participants and design

Forty-four undergraduate students participated in the experiment receiving 2 Euros in return. They were randomly assigned to cells of a 2 (Distance to position: fixed vs. variable) between-participants \times 2 (Priming of position: no vs. yes) within-participants design.

7.1.2. Experimental task and procedure

Instructions, procedure, and dependent variables were identical to those used in the subliminal prime condition of Experiment 2. However, in this experiment the distance between the last presentation of participants' square and the position on which one of the two squares was landed was either fixed (as in Experiments 1 and 2) or variable.

7.1.3. Distance to position

In the *fixed distance to position condition* the location of the black square was always four positions farther (e.g., lower corner right) than the last position of the participants' square (e.g., upper corner left) before the message "stop" (as in Experiments 1 and 2). Therefore, as in those experiments the response time required to land on the stop position at half of its presentation time was 330 ms. In the *variable distance to position condition* the last presentation of the participants' square before the message "stop" was always the upper corner left position. However, across the 8 non-prime and prime trials the location of the black square could either be one, two, three, four, five, six, seven or eight (i.e., the same location as the last position of the participants' square) positions farther. Because the distance between the last position of the participants' square and the stops varied from the first to the eighth position, the primary response time required to cause the square to land on the stopped position at half of its presentation time varied from 930 ms (1 position further), 90 ms (2 positions further), 210 ms (3 positions further), 330 ms (4 positions further), 450 ms (5 positions further), 570 ms (6 positions further), 690 ms (7 positions further) to 810 ms (8 positions further). Thus, if participants aim to stop their square on the primed position, then they have to time their key presses in accord with the variations of the distance.

After participants completed the computer task they were thoroughly debriefed. The debriefing indicated that participants did not realize the true nature of the study. As in the subliminal prime conditions of the previous experiments, participants were not aware of the priming events.

7.2. Results and discussion

7.2.1. Effects on experienced authorship

The average ratings of experienced authorship across the 8 non-prime trials and 8 prime trials were subjected to a 2 (Distance to position: fixed vs. variable) between-participants \times 2 (Priming of position: no vs. yes) within-participants ANOVA. The analysis showed that the effect of priming was significant, $F(1, 42) = 11.25$, $p = .002$, $\eta^2 = .21$, revealing that participants' experienced authorship was substantially higher after priming ($M = 5.27$; $SD = 1.87$) than after no priming ($M = 3.95$; $SD = 1.80$). These effects were independent of the distance to position, as was indicated by the non-significant interaction effect, $F < 1$. Furthermore, the main effect of the distance to position was not reliable, $F < 1$.

7.2.2. Timing to produce effects

If priming of stops activated participants' goal to bring about these stops before pressing the Enter key, then different timings of producing them would only materialize between a prime trial and the corresponding non-prime trial in the variable distance to position condition. Thus, this should emerge in a three-way interaction effect, as different response time effects of priming for different stopped positions are expected between the two distance conditions. To check this, the response times across the 8 prime trials and 8 non-prime trials were subjected to a 2 (Distance to position: fixed vs. variable) between-participants \times 8 (Position of stopped square: 1–8) \times 2 (Priming of position: no vs. yes) within participants ANOVA. The analysis yielded no significant interaction effects or main effects, $F_s < 1.71$. The non-significant 3-way effect ($F < 1.28$) on response time indicates that in the prime condition participants did not time their Enter key presses differently than in the non-prime condition to maximize the probability of stopping on the primed position.

7.2.3. Potential control

On most trials participants pressed the Enter key within the first lap, that is, before the participant's square started to make a new lap after the presentation of their last square. As in the previous experiment, for these trials we calculated the absolute difference between the response time after the message stop and the primary time required to land on the stopped position at half of its presentation time. For the other trials we first corrected the response time by subtracting the time of the completed laps (960 ms for each lap) from the total response time, and then calculated the absolute difference between this corrected response time and the primary time required to land on the stopped position. For the *fixed distance to position condition* the primary required time is $(300 + 30 \text{ ms}) = 330 \text{ ms}$ for each stop position. For the *variable distance to position condition* the primary required times are 930, 90, 210, 330, 450, 570, 690, and 810 ms (for the first to the eighth stopped position, respectively). The averaged absolute difference scores across the 8 non-prime trials and 8 prime trials were subjected to a 2 (Distance to position: fixed vs. variable) between-participants \times 2 (Priming of position: no vs. yes) within participants ANOVA. The analysis

yielded only a significant effect of distance to position, $F(1,42) = 535.03$, $p = .000$, $\eta^2 = .93$. Inspections of the means showed that the difference measure was substantially larger in the variable distance condition ($M = 277$; $SD = 22$) than in the fixed distance condition ($M = 75$; $SD = 33$). Of course, this effect is due to the fact that participants' response times in the variable distance condition are equal to the fixed distance condition. As a consequence, the absolute differences increase because the time required to land on the stop position varies.

In sum, the results of Experiment 3 replicated and extended the results of Experiments 1 and 2. Priming of effect information enhanced and biased experienced authorship. Furthermore, our results show that these effects occur without directing participants' attempts to time their stops, as was revealed by equal response times across different positions as a function of varying the distance to these positions. These findings suggest that priming of effects did affect experienced authorship without activating the goal to produce the effects.²

8. General discussion

Results of three experiments strongly supported the idea that priming of effect information enhances the feeling of behaviorally causing the effect. Subliminal and supraliminal priming were capable of heightening experienced authorship to the same degree as conscious goals to produce these effects. Thus, the observation of behavioral effects can provide the feeling that we caused them when these effects are presaged in our minds. Of importance, variations in the distance to the effects indicated that priming of effect information did affect neither participants' attempts to produce the effects nor their potential control over causing the effects. The present findings extend Wegner's (2002; Wegner and Wheatley, 1999) inquiry into the emergence of mental apparent causation by ruling out the idea that the process of authorship ascription requires intentional or goal-directed thinking in order to occur. Specifically, we provided new and important evidence that the influence of effect information priming on the experience of personal authorship is not mediated by the person's goal to produce the effects. Taken together, then, our results indicate that we may experience authorship because the mere thought of the possible effect informs us that the subsequent execution of a motor program may produce the corresponding effect—whether we truly caused it or not.

It is important to realize that the nature of our subliminal priming procedure did not allow participants to become aware of the effect representation operating at hand. This suggests that the influence of effect priming on attributing the cause of effects to one's own actions did occur outside of participants' conscious awareness (this idea is also corroborated by the findings of Experiment

² Although the data of Experiment 3 reveal that subliminal priming of effect information enhances the feelings of authorship (whether the distance to the position was fixed or variable), it may be valuable to analyze the effects of subliminal priming in Experiments 1 and 2 separately to ensure that the reported main effects of priming did not merely result from the conscious goal or supraliminal priming conditions, respectively. Separate t tests showed that the effect of subliminal priming (that is, the difference between the no prime and subliminal prime conditions) on the experienced authorship measure was significant in both experiments; Experiment 1, M -non-prime = 3.44 vs. M -prime = 4.65, $t(27) = 2.70$, $p = .01$, and Experiment 2, M -non-prime = 4.41 vs. M -prime = 5.44, $t(26) = 2.03$, $p = .05$. Overall, these findings strongly support the idea that subliminal priming of effect information increases the feeling of authorship. We thank one of the reviewers for suggesting these analyses to us.

2, in which supraliminal primes still enhanced experienced authorship). Gilbert (1998) recently noted that the processes involved in attributions are not necessarily conscious: “Because people can do wondrous attributional tricks, they must know *how* to do wondrous attributional tricks, but this knowledge is often tacit” (p. 95). Although this argument mainly pertains to the evidence showing that attributions of causes to other people behaviors occur automatically and spontaneously (e.g., Aarts, Gollwitzer, & Hassin, 2004; Gilbert, 1989; Hassin, Aarts, & Ferguson, 2004; Uleman, 1999), these attributional tricks may even be more regularly used and well-known to deal with causes and effects of our own behavior. Therefore, on a fundamental level there is no compelling reason why non-conscious processes should not extend to attributing effects to one’s own actions in order to establish a sense of personal authorship.

The present data shed light on the basic processes that may underlie biases in social agency assessment by demonstrating that people are more prone to attribute the cause of effects to their own action rather than to someone else when the effect is merely primed just before the action is performed. An important question emanating from these findings is how priming of effects biases judgments of personal authorship. Why does activating a mental representation of the potential action effect lead to a sense of agency? A key to answering this intriguing question may lie in the old idea that events that are close together in space and time are more likely than spatiotemporally distant events to be perceived as causally related (Hume, 1748; Michotte, 1963; see also Wegner, 2002). In the case of intentional action, people explicitly look forward to producing the goal-directed effect by performing the proper action. Hence, performance of an action, when properly executed and immediately followed by conscious perception of the effect, is expected to be causally related to the effect. As Haggard et al. (2002) show, under such goal-directed circumstances the perception of the action and effect bind together to create a sense of personal authorship. However, generating actions without having such clear goals, as was the case in the priming conditions of the present studies, should not yield this result. What sort of mechanism, then, causes a person to infer personal authorship when non-conscious perception of the effect (by subliminal priming) precede the unintended production of the action effect and directly follows conscious perception of the effect?

Perhaps this mechanism is based on a match between the primed effect representation and the observed effect that signals the person that she may have been behaviorally involved in, and caused the event. Such signal function of matching sources of information is also known to underlie (unconscious) fluency of processing effects on other subjective assessments, such as feelings of familiarity, liking, and confidence (e.g., Jacoby & Dallas, 1981; Kelley & Lindsay, 1993; Reber, Winkielman, & Schwarz, 1998; Whittlesea & Williams, 2000). Because individuals have limited or no direct conscious access to the operating procedures guiding their actual behavior (Fournieret & Jeannerod, 1998; Bargh, 2005; see also Nisbett & Wilson, 1977), the matching signal of primed and observed effect information could be a key source for grasping a sense of agency (Frith, Blakemore, & Wolpert, 2000). This may especially be the case when the two events are close together in space and time and thus more likely to be perceived as causally related (see also Eagleman & Holcombe, 2002). Hence, feelings of personal authorship can arise whether the action actually caused the effect or not. An interesting avenue for further research would therefore be to analyze how these processes operate in the mind, and to study possible conditions that either cause people to experience personal authorship on the basis of these processes or not.

9. Conclusions

We observed that experienced authorship is enhanced through the mere priming of possible effects of one's own actions. Such influence is likely to occur as our mental system heavily relies on behavioral effect information to establish a sense of personal authorship. Whether the development and working of this mental system serve an adaptive utility or more basic human need in is an essential problem in its own right, and remains a topic of intriguing theorizing and empirical scrutiny (e.g., Dennett, 1996; Neisser, 1993; Pinker, 1997; Wegner, 2002). Importantly, then, our analysis, as well as the results of three experiments, cultivates the idea that our mind may play tricks by producing the impression that we are the authors of events we perceive merely because we have been primed with knowledge of these events in advance of our action (Wegner, 2003, 2005).

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