

What is the sense of agency?

Is it a prospective (premotor) or a retrospective (ideomotor) mechanism?

Abstract:

In the paper I evaluate an ideomotor (comparator model) and a premotor (action selection) model of sense of agency. It is argued that the premotor model is overall more satisfactory in explaining sense of agency but, as I claim, its explanatory power is limited—i.e., there are certain cases where it falls short of it. Accordingly, an alternative model of sense of agency is outlined, which proposes that the awareness of action may be, to a certain extent, an epiphenomenon.

Keywords: *sense of agency, premotor model, ideomotor model, judgement of agency, awareness of intention, epiphenomenal awareness of action*

1. Introduction

In the paper I am going to evaluate and discuss the most recent theoretical models and empirical findings regarding the phenomenon of sense of agency in the light of the discussion between the proponents of the prospective (premotor) and retrospective (ideomotor) models of sense of agency. Sense of agency [SoA] (Gallagher, 2000; Haggard & Tsakiris, 2009), by some scientists called sense of control [SoC] (Chambon & Haggard, 2012; Wenke, Fleming, & Haggard, 2010), by others strongly distinguished from SoA (Pacherie, 2007), is a feeling of controlling one's own movements or thoughts. There is a broad discussion whether our SoA is determined only retrospectively (Pacherie, 2000, 2008)—i.e., we observe the effects of our actions and when they match our intentions we feel that we are the agents acting. In these cases we base on the so called *afferent signals*¹ from our body. On the other hand there are researchers claiming that it is determined also prospectively (Chambon & Haggard, 2012; Nahab et al., 2011; Wenke et al., 2010)—i.e., basing on *efferent signals*, internal and prereflective motor instructions, or selection between alternative possible actions. These efferent and afferent signals are a part of the *comparator model* (Feinberg, 1978; C. D. Frith, 1987; C. Frith & Done, 1988; Miller & Matzel, 1988), briefly described below, which is supposed to theoretically grasp the SoA we experience; it is recently one of the most popular models for explaining SoA development.

¹ These are feedback sensory signals contingent on self-movement. They origin for instance from proprioception or perception of outcomes of actions.

There is some empirical evidence suggesting that SoA depends on the combination of both internal mechanisms (efferent signals) and external cues (afferent signals or retrospective evaluation of action outcomes) (Synofzik, Thier, Leube, Schlotterbeck, & Lindner, 2010). In this paper I am going to analyze these statements but at the same time I will incline towards the idea that perhaps SoA is either epiphenomenal, or that is constructed on the neural level with the stipulation that it can be later ‘overwritten’ by a retrospective perception of action. At the same time, I will agree that SoA may sometimes depend only on prereflective mechanisms (Haggard, Clark, & Kalogeras, 2002; Moore & Obhi, 2012; Synofzik, Vosgerau, & Newen, 2007).

SoA is an aspect of phenomenology of action, understood in the sense of experiencing certain phenomena while performing an action. Thus, let me first briefly describe what phenomenology of action amounts to.

2. Phenomenology of action – a brief introduction

First, we should ponder over *intentional action*. It is a hard task to explicate it fully, since it is still a strongly debated issue. Because of the lack of space I will put it very simplistically—it is an action done by a subject due to some reason he or she has. According to Anscombe, intentional action is a behavior to which one can apply the “why-question” in a specific sense, which provides some specific reason as an answer (Anscombe, 1963). Certainly, not all behavior is intentional—actions are intentional when done for a reason while the agent is aware of a reason (in the sense that she/he can give some reason for a certain action). Anscombe presents three prerequisites for the intentional action to occur:

- a) the person acting has to be aware of acting,
- b) this cannot be a third-person-observer-like awareness,
- c) the person has to feel and be convinced that she controls the action (here we may say that “sense of agency” must occur).

This seems to be an effective theoretical background for further discussion of SoA, yet there are some problematic points e.g., when we inquire into the relations between these prerequisites, one can see that they are strictly interconnected and cannot be separated. Awareness of one’s own action is inseparable from the experience of agency. The latter is well depicted by the awareness of specific features of the action. Moreover, the intentional action is not purely observational; still, it is a controversial issue, as I will argue later.

Even though there are a few seemingly complete theories of agency, the notion of agency is still being discussed in the current philosophical and psychological literature. Davidson (1963), for instance, claims that it would be the phenomenon we ascribe to agents. When we say that someone did something (some action), it is equal to ascribing agency to him by taking into the account the behavioural event, as well as the results and consequences of it in the world.

In the model described above, there is always a reason for an intentional action (*acting for a reason*). A simple answer for the question why I opened the window would be, for example: “Because you asked me to”. However, there are other kinds of movements, and some of them are not considered actions. For instance, reflex movements are not actions, since when a knee is kicked, it is *led* to move. We can distinguish a whole array of movements between the extremes of intentional action and reflex movement. O’Shaughnessy (1980) has coined a term “*subintentional*” in reference to some movements. For instance, a person talking to somebody while rubbing her forehead, or scratching nose. Often, there is no aim in doing the movements, they are neither intentional actions, nor reflex movements, even though they may have a reason ascribed from a third-person perspective (like reducing psychological tension).

There is also another category of movements that can be placed on the borderline between intentional and subintentional movements. In Mark Rowlands’ (2006) terminology these are “*preintentional*” movements; “*prenoetic*” may be a proper term here—these movements happen without our awareness. It is difficult, however, to distinguish preintentional from intentional movements; this is visible in one of Rowlands’ examples. The preintentional movement mentioned by him is saccadic eye movement. It has been suggested that this kind of movements come along with intentional action (for a review of a number of experiments see: Kristjánsson, 2007). Rowlands presents a conception holding that saccades are controlled by the action one is performing at a moment. There are different saccades for different tasks—there has been several scenarios devised for the subjects in experimental conditions; they were asked to view a specific group of individuals and, for example, to judge how old they are, placing them in different contexts, among objects, or remembering their attire etc. Each time the saccades were different. This task was to make the subjects scan the surroundings in different tasks, so these were not reflex movements; still, they are non-

conscious and almost completely automatic. There is no intentionality here, but it is employed to complete the given task—so they are in opposition to subintentional movements.

Not every movement is an action. According to phenomenologists Shaun Gallagher and Dan Zahavi (2008) it must meet two prerequisites—intentionality and goal-directedness. So the movements that lack these two factors—passive, subintentional, preintentional, and reflex movements—cannot be treated as actions; however, they are sometimes misinterpreted in such a way by the observer. This view does not allow for anything like unintentional action; still there are unintentional results or unintentional movements produced by actions. If someone chooses to act for some reason, that is, if one has some aim in mind before an action, then the action can be said to be intentional. Due to the fact, motivation or justification is necessary to gain understanding of action, and not just physical causes of it. The reason for an action can be explained in numerous ways, what is suggested by the already mentioned Davidsonian account.

Agency does not require an excessive and extraordinary conscious knowledge. Indeed, in most instances there is just a prereflective awareness. There are, however, cases when an explicit consciousness of acting for specific purposes occurs. Nevertheless, usually we have an impression that we act for a reason, and at times our acts are preceded by a decision-making process. In situations like this, we have an established sense that we are the ones controlling what is happening; we are the main actors of our actions. There could be a pre-reflective awareness of what we do (during the very act) involved in the SoA, or even a more prominent consciousness full of well-developed goals.

When there is actually an intention (we are thinking about something, of doing something), it is relatively noticeable (by the agent). But purposeful decision-making does not evidently precede every intentional action. The action may take place before the decision is made. In that case, we do not feel that we decide, even though *post factum* we may admit that we did, or that our decision is *in* the action. John Searle (1983) uses the notion “*intention-in-action*” to describe such situations. At any rate, the intention-in-action is inescapable; it appears even in actions that involve an explicit decision. If we decide on doing something, like going out for a walk, we do not have to effortfully decide on each subsequent action like moving our feet, leaving a room etc. The intention is already contained in the action. Any observer would

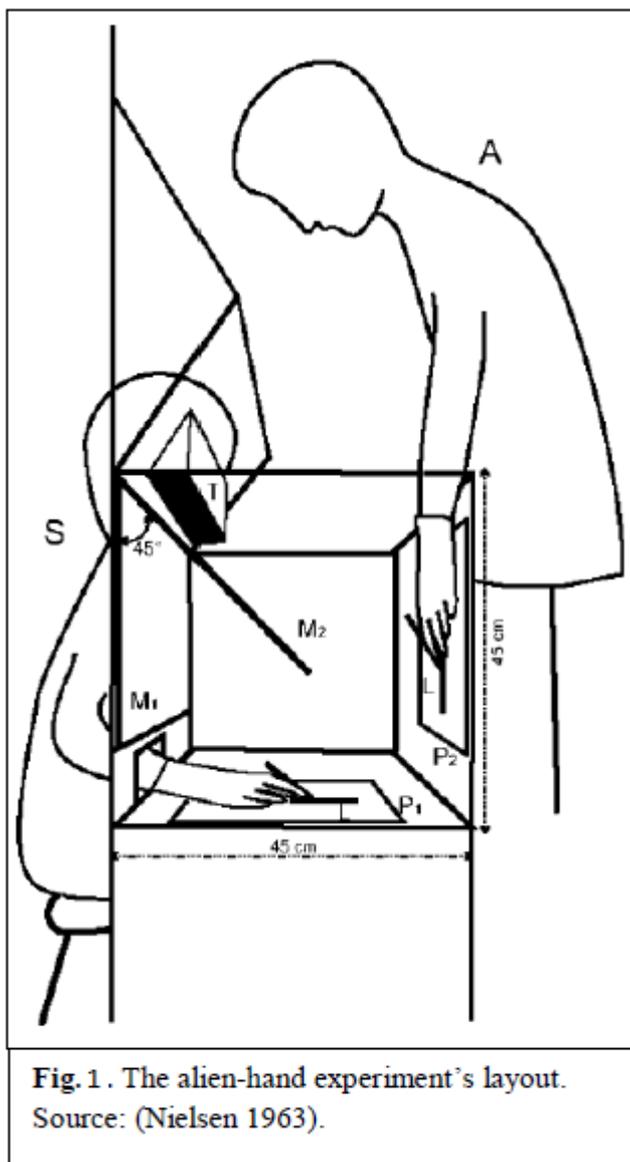
have certainly registered the intention being conveyed by the action. We put no attention to these movements; but there is no doubt that we are conscious of performing them. We move in the pre-reflective sense; our thinking of what should we do next is not distorting it. What does that pre-reflectivity carry with itself in this context? Awareness here is blurred and recessive—and there is no need of an effortful attention. There is a strict connection between all of these elements: the way we analyze our actions, the time when reasons come into play, intentions and awareness while performing an action (at the pre-reflective and the reflective level), when we can say that we act intentionally. We must still differentiate two types of relations between agency and intentional action. One of them is an experiential SoA (it appears with the action at the pre-reflective level, at the first-order level of consciousness). This is a state at which we feel our movement; any detailed awareness of movement is not needed. The other type is the reflective attribution of agency which may take place after an action (like a why-question). If someone asks somebody if she did something she can say ‘yes’ *post factum*. Thus, the action is attributed to her. This can also arise in memory, yet the experience is still necessary. This shows that the attribution of agency may depend on the more elementary experiential SoA (see more on this issue: Gallagher & Zahavi, 2008).

The experiential SoA, to be obtained, should be differentiated from the *state of ownership* of movement. It happens that we have an experience of moving along with the sense of ownership of it (to say it is our movement), but we lack SoA for it (that can occur in involuntary and reflex movement, or in some pathological cases like schizophrenia). For schizophrenics, in their symptoms of delusions of control or thought insertion there is no SoA, yet some sense of ownership remains. People afflicted by this disease say their body is moving, but that they are not the cause of the movement. Similar situation occurs with thoughts—they are not the creators of their own thoughts (yet, they confirm these thoughts are in their minds).

Some scientists and philosophers (Synofzik et al., 2007) distinguish also between *sense* of agency and *judgment* of agency, where the former is identified with lower-level, sensorimotor, pre-reflective processes, while the latter with higher-order, belief-constructs or reflective processes. Thus, judgment of agency would be supposed to allow for identification of the “who” system, who causes the action (and the “who” system can be identified here with the self, the other individual, etc.). Of course, the notion of the pre-reflective SoA

answers our common-sense understanding of agency, since we typically do not reflect on an action during performing it. This thought can be enclosed in a slogan that is phenomenological in its nature: “we do not think, we act”. The idea is also similar to Gallagher’s and Damasio’s conception of a basic form of self-consciousness which would be pre-reflective (A. R. Damasio, 2010; A. Damasio, 1999; Gallagher, 2000). It is supposed that sensorimotor processes that lead to the feeling of agency may be pre- or unconscious but available to awareness, and there is a need for a higher-order belief processing for the appearance of judgment of agency. This mechanism springs up in psychological experiments, where very short, less than 250ms temporal delays in sensory feedback are produced by experimenters, and are not noticed consciously by the subjects, but are observable at the brain imagery records, since neural signatures appear in response to the delays (David, Newen, & Vogeley, 2008). Moreover, even though awareness of action and SoA are usually connected, experimental evidence suggests that occasionally they go apart. Thus, is it enough to have an awareness of action done by us in order to have a sense of that action as being done by us? Dennett (1991) suggests that we should not be treated as the infallible reporters of our own experiences: we may be mistaken or unaware of the phenomenological occurrences in us. After all, we are often not capable of providing a reflective and precise description of our experiences, e.g. due to emotional commitment. In such situations, we can describe our experience and action but we may not be able to tell the different aspects of the agency apart and determine what are the contents of our awareness of the action. Moreover, the spotlight of our attention is limited and many phenomenological events may escape our consciousness. In cases of disturbances in the SoA, like in schizophrenia or some kinds of anarchic hand syndrome (Saccoa & Calabrese, 2010), subjects are aware of the content of the action, they feel the ownership of the action but they lack the SoA, they reject the fact that they are causing the action. It is also possible to produce a disconnection of awareness of action and SoA artificially, in experimental conditions, in non-pathological subjects. This was achieved in the alien-hand syndrome experiment (Brøsted Sørensen, 2005; Nielsen, 1963). It is experimentally proven that it is possible to produce illusions of control (subjects experience a SoA for actions performed by someone else) and illusions of action (where subjects do not feel SoA in situations where they perform an action) in healthy subjects (Balconi, 2010). In the trials where the awareness of action and the SoA are examined, the experimenters usually tinker with the sensory, mostly visual, outcomes of a subject’s actions. For example, the subjects are asked to draw a line on a paper and observe their hand. In some trials the subjects

observe their hand, but in other the alien hand—a hand of another person, which they still recognize as their own, but which deviates from the movements done by the subjects' real hand (fig. 1). In consequence, subjects most often adjust their actual movement in accordance to the false visual information without being aware of the adjustment, so they respond to the so-called visual re-afferences. Yet, SoA is not simply defined with the use of visual re-afferences (external signals of agency) but there is a scarcity of experiments that introduce internal signals (intentions, proprioceptive and motor signals, motor plans, motor programs, efference copies etc.) into the framework of trials, so the influence of them on subjects is not fully examined (some experiments are proposed in: Chambon & Haggard, 2012; Haggard et al., 2002; Moore, Wegner, & Haggard, 2009; Wenke et al., 2010).



The interconnectedness of and differences between the SoA and the awareness of action is therefore still to be investigated. At the same time the SoA is not reducible to the sense of ownership, as I have previously mentioned, even though they are correlated as well. The shortage of experiments examining internal signals of action monitoring may be caused by the difficulty of parameterizing them—they are automatic and consciousness has a limited access to them. However, it is possible to get an access to prior intentions and visual feedback; and it was experimentally scrutinized. On this ground the division between a feeling and a judgment level may be juxtaposed with internal signals correlated with implicit and pre-reflective feeling of agency. According to many philosophers and cognitive scientists, visual re-afferences are not the only defining element of SoA, but still they may influence to some extent the judgments of experimental subjects, so if they are asked to judge the agency attribution they will use both internal and external signals (David et al., 2008).

One last preliminary remark on the nature of SoA is in order. Another aspect of phenomenology of agency closely linked to SoA is the sense of *causality*. It is fueled by the fact that we perceive actions as initiated, inhibited and controlled, and the intentional binding of actions, intentions and sensory feedback furthermore strengthen our feeling of their causal interconnectedness. We need to learn what are the causes of actions and their stages of performance in order to comprehend them fully. It is not enough to know that sense of action is an experience of an act of will distinguishing bodily movements from actions. It is also crucial that the aspect of intention is not a one-time event, at the beginning of an action, but remains continuously present in the intention-in-action, throughout the whole performance of an action. The same holds for the SoA—it is a feeling of a continuous control of action execution. For these reasons

...in anosognosic patients the sense of initiation is disrupted, while de-afferented patients suffer from a deficit of the sense of their own movements. Anosognosic patients do not try to initiate any action and do not send any efference copy that could be compared to sensory feedback and that would inform them that the intended movement has not been performed. (Balconi, 2010, p. 6).

3. Sense of agency – premotor (prospective) or ideomotor (retrospective)?

In my discussion of whether SoA is prospective or retrospective in its nature, I will begin by a short description of both approaches and then evaluate them.

The retrospective or ideomotor approach to SoA stems from the theory of William James (1890/1950). The contemporary inheritor of the approach is the *comparator model* (Blakemore, Frith, & Wolpert, 2001; C. Frith & Done, 1988; C. Frith, 1992), as it is sometimes suggested. Ideomotor model amounts to a psychological representation of actions states that we develop by perceiving their (external) effects—i.e., effects in the world. In the comparator model (which is an expansion of the ideomotor model) there are two versions of internal models—inverse and forward models—of motor learning and motor control in the central motor system, the role of which is to control and adjust motor behavior, but experimenters also assume that they can also be in part responsible for action awareness. The forward model (fig. 2) employs the notion of *efference copy* (a copy of a motor command predicting respective sensory consequences; they are produced by our own movement and not by those of other people). When an efferent copy is created, it is compared with the actual consequences of a movement, and it is compared most often unconsciously. If the two are congruent, then the movement, its originator and the SoA are attributed to ourselves. If they are incongruent we attribute these aspects of agency to the others (for a recent review of the comparator model see: Shin, Proctor, & Capaldi, 2010). As David and colleagues (2008: pp. 524-525) state, there is some empirical evidence that presumably supports the thesis that judgment of agency is determined by the level of congruence. However, as we remember from the alien-hand experiment, sometimes the agent adjusts to the incongruence and still claims that she is the actual mover. Ideomotor theory deals quite satisfactorily with motoric SoA but it has several problems—e.g., it does not sufficiently explain the thought insertion in some cases of schizophrenia, and it has a major problem of lack of proper explanation of the fact that some schizophrenics attribute agency to one's self and some attribute it to the others (Ciechanowski, 2012).

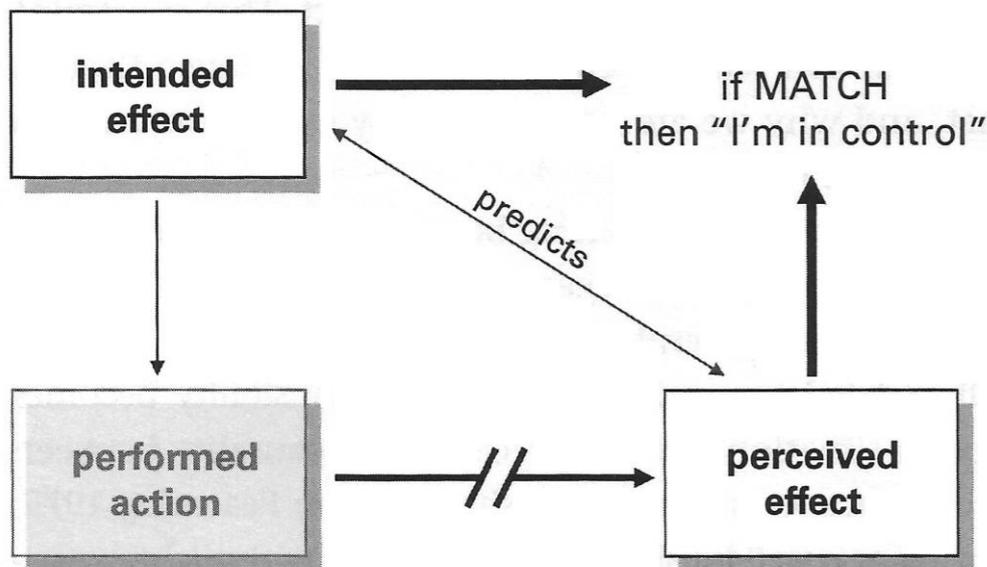


Figure 2

A predictive forward (comparator) model of action experience, presented in (Chambon & Haggard, 2013: p. 369): “Sense of control [a term used here in the sense of SoA] is stronger when a close match exists between the intended and the actual (i.e., observed) effects of the action than in the case of a mismatch (broken line).” It is assumed here that the observed effects of movement are predicted from the intended movement.

The prospective or premotor approach to SoA characterizes a few models, which analyze this phenomenon. Among them we find e.g., the action selection model (Chambon & Haggard, 2012; Wenke et al., 2010), the phenomenal model (Gallagher & Zahavi, 2008) and others.

Chambon and Haggard (2013), two proponents of the action selection model (fig. 3) of SoA developed their theory in response to limitations of the ideomotor model. They present us with an example of a deviant causal chain, an idea originally introduced by Chisholm (1966). They base on a modified thought experiment from Greco (2008) of “success through chance”. There is an archery contest and one of the competitors prepares to make a shot. Everybody knows that the competitor is not a good archer. Due to a sudden and startling sneeze of some man from the audience the archer releases arrow by surprise and hits the bull’s eye. The archer is embarrassed—it was her intention to hit the target, but she is not sure who was responsible for it in this particular circumstances. Chambon and Haggard provide us with the following explanation (2013: pp. 370-1):

The most obvious answer is that the action specification process has been aborted early. We suggested that this process is meant to causally relate the two terms of the intention-action link. Thus the archer does not feel in control, not because of a perceived mismatch between

intention and effects (as the IM [ideomotor] account would predict it) but precisely because her intention has been achieved by an action that was not selected or wanted, that is, by an action that had no causal link with the intention to achieve the corresponding effect. Importantly, the thought experiment of the archer shows that the sense of controlling one's own action is sensitive to the means specification process itself. This following distinction is worth stressing: sense of agency is not only sensitive to whether actions achieve intention (IM account) but also sensitive to particular actions by which an intention is achieved, and thus to processes arising before the initiation of the action (premotor account). Agency... require[s] reference to means.

The authors claim that the ideomotor model of SoA would have problems with the analysis of this example, since the archer does not feel SoA or a full responsibility for her action, yet the ideomotor criteria are met (the intention to hit the target match the perceived effects of the agent's actions).

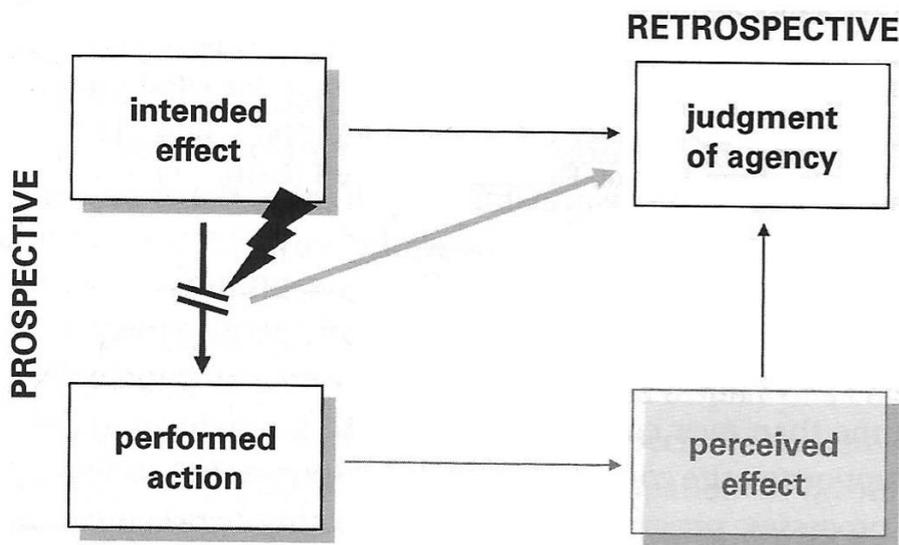


Figure 3

A premotor model of action experience presented in (Chambon & Haggard, 2013: p. 374): “Judgments of control depend on (a) similarity between intended and actual effects inferred retrospectively (thin black arrows), and also on (b) fluency of action selection experienced prospectively (thicker gray arrow). When action selection is perturbed by external influences (broken line), the prospective contribution to the sense of control is reduced.”

4. Critical analysis

Even though premotor models of SoA undoubtedly have many advantages, there is one problem with them—i.e., explanation of cases where people report experiencing SoA (or feel to be in control), and at the same time undergo certain movements which are caused externally. In such cases they most probably confabulate in reporting SoA. In these situations

it seems that neither ideomotor nor premotor models explain satisfactorily the situation. Among such problematic cases we find experiments with electrical brain stimulation [EBS] with local anesthesia (Penfield, 1958; Penfield & Boldrey, 1937).² According to an experiment by Desmurget and colleagues (2009) carried out on patients during awake brain surgery in a similar paradigm—direct electrical stimulation [DES] to the human cortex—it is suggested that conscious intention appears due to certain brain areas activation, which may be completely independent from any action selection, conscious motor intention development etc. In the experiment several patients were exposed to electrical stimulation of their parietal and premotor cortex regions. Right inferior parietal areas, when stimulated, generated a strong intention and desire to move the contralateral limb (hand, arm, or foot). When increased stimulation was applied to these regions, the participants had a strong belief that they performed a movement, even though there were no changes in electromyographic activity (muscle contractions). On the other hand, when the experimenters applied electrical stimulation to the premotor region it caused overt mouth and contralateral limb movements, while participants confidently denied they had performed any movements.

Moreover, there is experimental data suggesting that bodily movement can also be caused by neural stimulation without the occurrence of SoA, which usually should accompany the movement. When Wilder Penfield carried out his experiments with the use of EBS, his patients were undergoing various movements and emitted diverse sounds when their brains were electrically stimulated, and they were aware that it is Penfield who had been the cause of the movements/sounds (W. Penfield, 1975). On the other hand there are cases (Delgado, 1969; Hecaen, Talairach, David, & Dell, 1949) of EBS causing movements of patients' limbs, movements that we would call involuntary; though, in these cases patients reported that they moved their limbs intentionally, but they either were not able to provide any reason for the movement (Hecaen et al., 1949; EBS caused clenching and unclenching of fists), or they were saying that they were moving for a specific reason (Delgado, 1969; EBS caused head turning and certain movements, like turning on the bed, indicating that the patients were looking for something). For instance, patients were saying that they are restless, that they

² A painstaking analysis of the past and present usage of EBS and akin experiments may be found in (Selimbeyoglu & Parvizi, 2010).

heard a noise or that they are looking for something under the bed.³ The experience of SoA was not measured in these experiments, but it may indicate an interesting path for future studies. Even though, we may suppose that the patients' levels of SoA were relatively high, since they have confabulated about having a certain reason for their movements, which in fact were produced externally, independently of their intentions. These examples prove what I have mentioned earlier, namely that there is a distinction between *judgment* of agency and *sense* of agency, which is a recent suggestion (Synofzik et al., 2007). The addition of this distinction in the domain of agency may in turn suggest that the above-mentioned patients did not experience any SoA, they might have only reported judgments of agency.⁴ In the described experiments, neither the premotor nor the ideomotor theory provide us with a proper model of SoA, since the patients did not develop any intention concerning the action effect and thus the action intention could not be properly compared with the actual action effect in order to ascribe the action's agency to the patient (since most probably there were no action intention) (fig. 4). However, there is a possibility to construct another model. Namely, we need to assume that the intention predicting the effect of an action is capable of being produced already on a very basic, prereflective, neural level; and that the phenomenon of intention comes down to a series of neural activations in the brain.

³ Similar confabulations are characteristic of some anosognosic (a denial of being sick) patients who e.g., claim that they performed movements if asked to, with their paralyzed limbs (Ramachandran & Rogers-Ramachandran, 1996).

⁴ By the same token we may wonder whether the patients really carried out intentional actions, since one of its prerequisites (that I describe in the section 2.) is that the awareness of action cannot be a third-person-observer-like. However, it is disputable what kind of awareness is experienced by the patients in these cases. Even more problematic would be an attempt to parameterize this awareness experimentally.

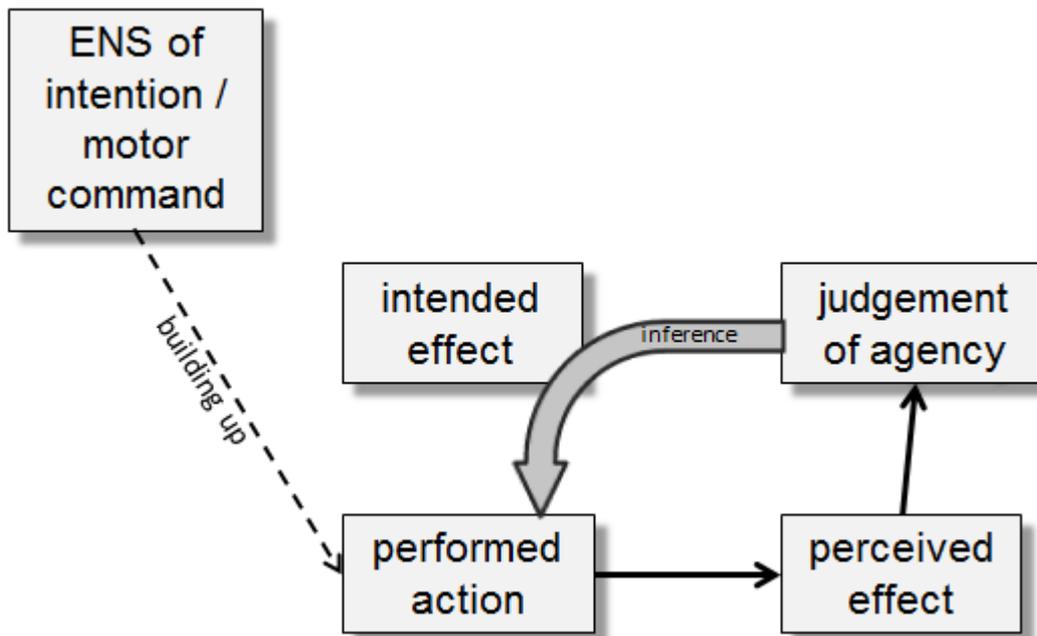


Figure 4

My proposition for a model of SoA explaining the cases, in which patients are stimulated with EBS and yet feel that they are the authors of resulting actions. The *early neural signals* [ENS] of intention or motor command—it depends upon assumed terminology—are building up (or are produced by electrical stimulation) and after reaching a critical point of activation they result in action, which is perceived and assessed regarding the agency attribution. Finally, the agent makes an inference that since there was some action performed, she must had had an intention for the action.

SoA of the participants in the abovementioned experiments was not measured, but still these results may strongly suggest that SoA is (at least sometimes) independent of action selection. It would seem strange to claim that the patients selected their actions, since they most probably based only on retrospective judgement of agency. Additionally, this conclusion is supported by the alien-hand experiments described above—they base on a similar effect that brain DES experiments do, but obviously the abovementioned brain DES experiments are an extreme example of an illusion of SoA, since the patients do not have an intended effect or any goal-directed intentions before they perceive the action. This is similar to the recent studies of choice blindness and introspection illusion phenomena. The former is a failure to notice an incongruity between intention and outcome in a decision process.⁵ It has been

⁵ So that when subjects picked a certain decision or object that they preferred and then were presented with its alternative (some subjects did not notice the deceitful swap made by experimenters) and asked to provide a reason for their choice they were basing their accounts on the alternative and not on the decision/object that they have initially picked. So they confabulated the reasons.

proven for simple decision tasks (Johansson, Hall, Sikström, & Olsson, 2005; Steinfeldt-Kristensen & Thornton, 2013) but also, shockingly, for moral decisions (Hall, Johansson, & Strandberg, 2012). The introspection illusion comes down (among others) to false explanations of one's own behavior and being confident of a proper insight into one's own mental states considering one's behavior (for summary of a few experiments on introspection illusion see: Pronin, Berger, & Molouki, 2007).

All these findings may therefore suggest that there are two ways of SoA by which they enter our awareness. First of all, the basic experience of SoA may be produced on a subpersonal, unconscious, neural level, and enters our awareness after specific brain regions reach a certain level of activation. Second, the experience of SoA may be produced (sometimes) solely as an outcome of a retrospective report or a judgment of agency (this point is denied by the proponents of premotor or prospective models of SoA).

Considering the first suggestion, a question may appear at this point: what qualitative patterns of functional organization across the cortical and subcortical areas are likely to trigger conscious and unconscious SoA (in experiments where subjects were convinced that they performed movements while they did not) or intention to act (in experiments where subjects' brain were stimulated producing movements, but they were convinced that they move for a reason)? To put it simply: which brain regions, when activated, produce awareness of SoA or intention to act? In an attempt to answer this question we may employ the "global workspace" model of functional organization of conscious states.⁶ Global Workspace Theory

⁶ I am using this model being inspired by Winkielman and colleagues' (2011) idea of employing the Global Workspace Theory in order to prove and explain the existence of unconscious emotions. Even though Winkielman's idea is controversial—there is a reasonable criticism possible, which I develop in another paper (Ciechanowski, 2013)—I believe it is beneficial to use Baars' model in respect to the analysis of unconscious premotor sense of agency. Obviously, most probably all our conscious processes have unconscious fundamentals, as we could infer from Baars' theory (in the case of cognition or perception), or from the analysis of the lateralized readiness potential (in the case of movement), which is believed to be an increase of electrical activity at the surface of the brain in preparation of motor activity. But none of these models claim that the output of unconscious processes reaching awareness is unconscious, thus there are no unconscious emotions, there are only unconscious processes leading to conscious phenomena, like emotions. And the fact that the cortical and subcortical activation is very similar in cases of conscious and unconscious processing of the same information seems to be a weak argument for the existence of unconscious emotions, and analogically the readiness potential does not amount to conscious movement but it is an increasing cortical activation in the preparation of movement. Hence, my thesis is not as strong as Winkielman's—I just believe

was developed by Bernard Baars (Baars & Franklin, 2007; Baars, 1988) in order to account qualitatively for a large set of matched pairs of conscious and unconscious processes.

In Baars' theory cognition is understood as a network of specialized processors (neuronal nets) carrying out nonconscious computations. Consciousness appears only when a subset of processors produces an output that 'overflows' the whole system and is transferred to an entire network of processors. This global exchange of information allows for coping with new and complex information by the system. None of the processors is able to deal alone with compound information; each of them is specialized to process simple data and to communicate with one another. Indeed, it has been experimentally suggested that there are certain unconscious processes that employ the same dedicated cortical areas that are devoted to conscious processing of similar information. As Winkielman and colleagues write (Winkielman, Berridge, & Sher, 2011: p. 203):

...numerous studies have found evidence for semantic priming from visually masked words, even when subjects are unable to report the identity of the words. In neuroimaging experiments, unconsciously masked words produce sustained activity (albeit at reduced levels) in the same specialized cortical region of the left temporal lobe that is strongly and specifically activated by consciously visible words. However, when subjects are not conscious of the word stimuli, sustained activity is *not* seen across a slew of word non-specific areas strongly activated by conscious word stimuli.

Now, connecting this model with unconscious processing of SoA and intention to act, we may try to look for examples of prereflective, unconscious processing of them that leads to their awareness. Does the unconscious and conscious processing of SoA and intention arise in the same brain areas or are they completely different in their neural origin? Actually, there are some studies concerning the neural correlates of SoA (for a review, see David et al., 2008; Miele, Wager, Mitchell, & Metcalfe, 2011; Sperduti, Delaveau, Fossati, & Nadel, 2011; see also Kühn, Brass, & Haggard, 2013; Vogeley & Fink, 2003) but unfortunately, there were no studies of SoA showing what are the neural correlates of SoA in cases where this phenomenon is produced by observing movements produced involuntarily, through a cortical stimulation like EBS or DES. In such cases, as I have already mentioned, there are effects of action present but probably there is no intention of the action, no efferent copies

that the increasing cortical activation produces a sort of a 'weak/preparatory SA' or an 'intention potential', which later is consciously felt respectively as a sense of agency or an intention to act.

etc. The SoA is most probably present in these cases but presumably it was either entirely inferred retrospectively or the intention to act was produced on the neural level. Further studies are required to solve this issue. The issue with intention to act is even more problematic, since intention is a more complex phenomenon than SoA both theoretically and practically. It is studied experimentally at least since the famous Libet research (Libet, Gleason, Wright, & Pearl, 1983), which is an attempt to prove that the brain preparation to move is much earlier than the conscious intention to move, and it is as passionately criticized. Some attempts to find its neural correlates were undertaken (Desmurget & Sirigu, 2012; Haggard, 2008; Matsushashi & Hallett, 2008; Soon, Brass, Heinze, & Haynes, 2008).

Now, considering the second point, which is the statement that SoA can be produced solely as an outcome of a retrospective report or a judgement of agency. If we assume this statement to be true, then one of the possible outcomes of it is that SoA is epiphenomenal. Actually, the distinction on sense of agency and judgment of agency combined with the experiments involving EBS and DES paradigms may suggest that SoA is, on the conscious level, only an epiphenomenon.⁷ On this interpretation SoA would be a physiologically redundant phenomenon, advantageous only because of its usefulness in self-awareness and social interactions, thus on high levels of consciousness.

5. Conclusion

The conclusion that SoA is epiphenomenal is somewhat hasty and demands further investigation. There is a critique of this thesis, stemming from the evidence that SoA and any phenomenon of conscious states is evolution-wise necessary (Pockett, Banks, & Gallagher, 2006).⁸ Nevertheless, there are already similar suggestions about the possibility of the

⁷ A similar conclusion is proposed by some cognitivists in reference to emotions (e.g., Bowlby, 1968; Kagan, 1978). They claim that the phenomenal part of emotions—i.e., the *feeling* of happiness, sadness, anger etc.—has no causal powers but is a by-product of neural and physiological, unconscious processes. Feelings are supposed to be mere outcomes of certain bodily changes and they play no further explanatory role in action descriptions.

⁸ Cf. for instance a point by Hirstein (2005: p. 175):

One thing the majority of current theorists of consciousness agree on is that conscious states involve large areas of the cortex and activity among subcortical organs, such as the thalamus and the amygdala. Why would an organ subject to evolutionary forces in the way that the brain has been devote such a huge amount of representational space and computational power to producing a deception for itself? The brain uses a large percentage of the calories we consume. Calories are expensive and often hard to obtain. Why the waste?

illusory character of SoA. For instance, Michela Balconi claims, following Wegner's model explaining the interconnections between conscious and unconscious processes producing voluntary movement (Balconi, 2010: p. 13):

The link between conscious thoughts and action represents a causal path that does not occur in reality but may be erroneously inferred, in the same way as any external causal relationship is inferred. Retrospective reconstruction assumes a predictive mechanism of the phenomenal experience of intention. According to Wolpert and Ghahramani, a forward model makes predictions about the behavior of the motor system and its sensory consequences. These predictions are used to compare the actual outcome of a motor command with the desired outcome, enabling rapid error correction before sensory feedback is available. In line with that model, sensory attenuation has been shown to result from these kinds of predictive mechanisms. Similar processes are implicated when subjects are led to believe that they consciously intended actions or consequences of actions they did not produce themselves, and are based on the mechanism of back referral of an intention. Recent empirical studies demonstrated that subjects always indicate that they intentionally initiated an action while reaction time data strongly suggest that they in fact failed to stop the action or they misattributed their awareness of intention as a function of intentional involvement during action planning.

Wegner in his book (2002), and a series of papers (e.g., Aarts, Wegner, & Dijksterhuis, 2006; Ebert & Wegner, 2010; D M Wegner & Wheatley, 1999; Daniel M Wegner, 2004), proposes a view that conscious will plays no causal role in action performance, it is used only for action interpretation. Additionally, it is claimed that conscious experience of will is not produced by the same brain systems that cause behavior—hence, they are supposed to be independent processes. However, as we might suppose, Wegner's proposal prompted an extensive critique (e.g., Bayne, 2006; Nahmias, 2002).

An interesting model, much akin to my proposition, is presented by Aarts, Custers, and Marien (2009). They claim that the mechanism that facilitates maintenance of nonconscious goals actually produces experiences of self-agency; four experiments are presented to support their claims. Aarts, Custers, and Marien write (2009: p. 967-8):

...we argue that, on the basis of the idea that goals contain a representation of the desired outcome as well as an affective component that signals potential reward, priming an outcome representation just before the outcome is produced should promote experiences of self-agency, even when the outcome is actually caused by an external source. Moreover, we propose here that when the outcome that is primed by the environment is accompanied by a positive affective (reward) signal and hence that outcome represents a goal one is motivated to attain,

the mechanisms that drive nonconscious goal pursuit will sustain the activation of the outcome representation. The agency feelings may therefore not be the direct result of one's wanting but rather a by-product of the mechanism that keeps the representation of outcomes active over time, even when the outcome is activated relatively long before the actual outcome is produced.

Similar points were made (besides Wegner) by Prinz, Yarrow and Libet (Prinz, 2003; Yarrow & Libet, 2005). However, there are passionate discussions concerning the problem of the status of various conscious, phenomenal experiences, like emotions/feelings, phenomenal aspects of perception, qualia, experience of free will, sense of agency and sense of ownership. And though the discussants seem to be quite convinced as for their claims, the matter is far from being settled once and for all.

The already mentioned Desmurget and colleagues (2009) present an interesting but tentative suggestion also very supportive of my argument. Namely, they claim that conscious intention and motor awareness may arise from an increasing parietal activity before movement execution. The recent suggestion of Desmurget (2013: p. 830), concerning a possible model of intention development, is rather promising:

...the early neural signals [activating in preparation to make voluntary movements]... [reflect] a buildup in neural activity that ultimately leads to the emergence of a conscious intention to move. According to this view, the conscious experience of wanting to move is not the consequence but the cause of movement initiation.

The initial mechanism is similar, but Desmurget has a different conclusion. In my model the conscious experience is a *consequence* of movement initiation.

This conjecture is similar to the one upheld by some philosophers and neuroscientists, inspired by the experiments of Libet (Libet, Gleason, et al., 1983; Libet, Wright, & Gleason, 1983), who state that we do not have free will, since the decision concerning movement is an epiphenomenal experience that comes *after* the actual decision to move, and which is presumably caused by the increasing neural activation in the motor cortex and supplementary motor area (Libet called the measure of this activity a *pre-motor potential* or *readiness potential* [RP]). However, these experiments are questionable in respect of their methodology, and thus they are extensively criticised both from the side of philosophy and neuroscience (see e.g., Bennett & Hacker, 2003; Klemm, 2010). Moreover, my hypothesis is

not as bold—I claim only that the phenomenal experience of agency and intention to act is *sometimes* epiphenomenal.

Still, although we have a few promising theories, there is a lot of unanswered and critical questions: what is the relation between the prospective and retrospective accounts of SoA, how do they influence each other and interact (and in which circumstances), why the electrical stimulus to the brain motivates the subjects to report at some times an external cause of their movements (W. Penfield, 1975) and on other times they think their illusory intention had been a causal factor (Desmurget et al., 2009).

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