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Consciousness and Control

Not Identical Twins

Abstract: *Human cognition and action are intentional and goal-directed, and explaining how they are controlled is one of the most important tasks of the cognitive sciences. After half a century of benign neglect this task is enjoying increased attention. Unfortunately, however, current theorizing about control in general, and the role of consciousness for/in control in particular, suffers from major conceptual flaws that lead to confusion regarding the following distinctions: (i) automatic and unintentional processes, (ii) exogenous control and disturbance (in a control-theoretical sense) of endogenous control, (iii) conscious control and conscious access to control, and (iv) personal and systems levels of analysis and explanation. Only if these flaws are overcome will a comprehensive understanding of the relationship between consciousness and control emerge.*

The topic of control is hot in the cognitive sciences, as witnessed by a dramatic increase of hits for the keywords 'executive functions', 'executive control', and 'cognitive control' in the Web of Science® database from zero in 1945–1954 to 3672 for 1995–2004. The feeling is that researchers were occupied for a long time with analysing the cognitive machinery but now the time is ripe to find out the way this machinery is used by intelligent agents to realize their intentions (Monsell, 1996). In other words, human will is back on stage. Given that control processes are often considered to be inevitably conscious (e.g., Atkinson & Shiffrin, 1968; Norman & Shallice, 1986; Umiltà,

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1988), there is also a strong connection to another hot topic, which makes the study of control even more interesting.

In the following, I will briefly sketch the transition from will to executive control and present two examples of how the concept of executive control is used in contemporary research. Next, I will discuss the relationship between control and consciousness and point out major flaws in the theorizing about this relationship in the cognitive sciences. Only if these flaws are overcome, so I will conclude, can a less simplistic, systematic theory regarding the function of consciousness in the control of cognition and action emerge.

From Will to Executive Control

The transition from 'will', the philosophical grandfather of control terms, to 'executive' was not smooth and continuous. In the beginnings of experimental psychology a chapter on the will was a must in every textbook and many authors presented their own views on this issue. Lotze (1852), for instance, was struck by the fact that we know so little about how we do the things we do — just think of how little you know about how you manage to tie your shoes. Lotze suggested that we monitor and store the contingencies between our body movements and the events in the external world or inside our body by which these movements are triggered, so that we can later mimic (i.e., imagine, simulate) the stimulus events and thereby trigger the associated body movement. In other words, the will need not impose anything on the body. Rather, it simply exploited the laws according to which the body works anyway. Later authors like Harless (1961) and James (1890) gave this approach a more intentional twist by assuming that agents also acquire contingencies between movements and their sensory consequences. Representations of movements and consequences were assumed to be associated bidirectionally, so that agents could imagine or simulate a consequence and thereby trigger the associated movement. This provided the theoretical basis for what we now know as *ideomotor theory* (see Hommel *et al.*, 2001; Stock & Stock, 2004).

The next step was to address the dynamical aspects of will and choice. The Würzburg school was much less afraid of considering unconscious contributions to the control of cognition and action than the introspectionists Lotze or James were. The ex-Würzburger Ach (1910; 1935) developed the first large-scale experimental research project on human will, which anticipated the architecture of later dual-process theories (e.g., Atkinson & Shiffrin, 1968; Posner & Snyder, 1975) in assuming that will can be measured most purely if it is put into competition with opposing, practice-induced tendencies (habits). Very similar to recent approaches of task switching performance (De Jong, 2000), Ach took the amount of (practice-induced) competition that an individual can overcome as a measure of will power.

Despite these early and rather substantial contributions, the impression one gets from contemporary textbooks of cognitive psychology is that the scientific treatment of executive control in general, and the interplay between so-called intentional and automatic processes in particular, set in no earlier than with the paper of Atkinson and Shiffrin (1968). These authors re-introduced the distinction between automatic processes, which are believed to be independent of attention and intention, and processes that are 'under the control of the subject'. Automatic processes are claimed to result from practice and to operate through relatively permanent sets of associative connections in long-term memory, which makes them 'difficult to suppress, to modify, or to ignore' (Schneider & Shiffrin, 1977, p. 2), whereas control(led) processes, such as retrieval, rehearsal, or coding, reflect a person's current attentional set, intentions, and the task requirements. Accordingly, cognitive operations emerge from a competition between automatic and control(led) processes, exactly as Ach (1910) suggested earlier. Since Atkinson and Shiffrin's article, the distinction between automatic and controlled (or willed, intentional, voluntary, conditional…) processes has enjoyed great popularity and been built into numerous processing models of all sorts of cognitive phenomena (Hommel, 2000; Neumann, 1984). The following two sections will focus on two, relatively representative and broadly discussed families of models addressing the control of visual attention and of response selection.

Attention: The control of stimulus selection

Following Atkinson and Shiffrin's lead, attentional research distinguishes between *endogenous* or *top-down* control and stimulus-induced *exogenous* or *bottom-up* control of attention (e.g., Posner, 1978). One widely used paradigm to investigate endogenous control and its interplay with exogenous factors is the singleton or popout task (e.g., Theeuwes, 1992). In this task, subjects detect or identify a visual target that appears randomly in one of several objects. Interestingly, performance is substantially better if the object in which the target appears has a unique feature (e.g., a single green square among red squares or among green circles), that is, if it is a singleton. This suggests that visual attention is attracted 'automatically' to singletons (Theeuwes, 1992) and sometimes the attraction is so strong, even the eyes cannot be prevented from moving to the location of the singleton (Theeuwes, Kramer, Hahn & Irwin, 1998). Singletons, so these authors argue, can capture attention and take over its control — an apparently clear case of exogenous control.

There is an extended discussion going on concerning how strongly such demonstrations of attentional capture depend on the task, the context, and the strategy of the subjects. As some authors have argued, it may be that asking subjects to respond to singletons or rewarding them for attending to singletons induces an endogenous bias towards singletons, with the side effect that any singleton now attracts attention — even the 'wrong ones' (e.g., Folk *et al*., 1992). More important for present purposes, however, is the question of how the control concept is used in this context.

First, consider the *agent* of control. Who does the controlling? As it is common in experimental psychology, the theorizing on attentional capture is based on the implicitly shared assumption that instructing a voluntary subject in some way induces a goal state in this subject, which in some way biases attention towards the instructed target stimuli — for example by making the perceptual system more sensitive to the target-defining features (Müller *et al.*, 2003). The true controlling is thus done by the experimenter, which is remarkable inasmuch as researchers consider the impact of instructed task goals as particularly good examples of endogenous control (e.g., Monsell, 1996). But the idea is that instructions are somehow 'taken over' by subjects, who then make them goals of their own.

Second, consider the *target* of control, that is, the state, event, or parameter that is assumed to be controlled. Theeuwes and Godijn (2001, p. 121) open their recent review of attentional and oculomotor capture by claiming that 'in order to behave in a goal-directed manner, it is important that we select only the relevant information from the environment and ignore information that is irrelevant, particularly when this information disrupts our actions'. Selecting an object means prioritizing it in the competition for action control, so that a failure to exclude an irrelevant object from selection implies a *loss of endogenous control*. (As I will explain below, this characterization is based on a misconception of how control processes work.)

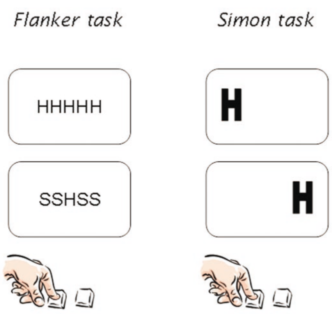

Figure 1. An overview of two popular conflict tasks. The upper row of the schematic stimulus displays shows examples of congruent or compatible conditions and the lower row shows examples of in congruent or incompatible conditions (which produce comparatively worse performance). In the flanker task, subjects respond to a stimulus in a particular location, such as the central letter of a string (here: left keypress for H and right keypress for S), and ignore the flankers. In the Simon task, subjects respond to a nonspatial stimulus feature (here: left keypress for H and right keypress for S, not shown), while stimulus location varies randomly.

Intention: The control of response selection

In addition to inspiring theories of attention, the idea of a dynamic interplay between will and habit or, in more modern terms, between control and automatic processes has inspired theories of response selection. Particularly good examples for experimental tasks that capture the essence of this more dynamic view of response selection are so-called conflict or interference tasks, such as the flanker-compatibility task and the Simon task (see Figure 1). The observation that people show worse performance with response-incongruent flankers has been taken to imply that task-irrelevant stimuli can activate the response they are assigned to in this task. Indeed, flanker stimuli have been found to activate a lateralized readiness potential (LRP) corresponding to the response they signal (Coles *et al*., 1985) and even incorrect subthreshold responses (Eriksen *et al*., 1985). Theoretical accounts of the flanker-congruency effect have made ample use of Ach's and Atkinson and Shiffrin's controlled-automatic dichotomy. The idea is that the target is translated into the correct response in a controlled manner but automatic processes somehow make use of the implemented stimulus-response translation rules and translate the flankers into an activation of the corresponding responses (e.g., Eriksen & Schultz, 1979; Gratton *et al*., 1992).

Very similar observations have been made with the Simon task, where responses to nonspatial stimuli are faster and more accurate if the stimulus happens to spatially correspond with the response. Again, this leads one to suspect that stimulus location can somehow activate a spatially corresponding response, and this is indeed supported by the finding of location-induced LRPs (Sommer *et al*., 1993) and subliminal response tendencies (Zachay, 1991). Almost all models of the Simon effect have made use of the controlled-automatic logic by assuming that the nonspatial target feature is translated into the response in a controlled manner, whereas an automatic process translates stimulus location into a response location (e.g., De Jong *et al*., 1994; Kornblum *et al*., 1990).

As with attention, the *agent* of intention(al) control is again Atkinson and Shiffrin's 'subject' and the task set he or she implements in response to the instructions. The issue of the *target* of control is also treated similarly but one can find a more explicit and clear-cut distinction between *on-line control* and *off-line control*. A comprehensive approach to off-line control is Logan and Gordon's (2001) ECTVA model. It holds that preparing efficiently for a task entails the translation of task instructions into four parameters, three configuring the perceptual system in such a way that the task-relevant stimulus information can be extracted and one controlling the speed and accuracy of response selection. Executive control consists in passing the necessary parameters to subordinate processes that are responsible for the on-line handling of stimulus information and response production. If time allows, this programming of subroutines takes place before the first task-relevant stimulus appears and thus represents off-line control.

It is assumed that on-line control solves the problems that cannot be entirely prevented by off-line control. For example, since off-line control settings are apparently unable to prevent the activation of incorrect responses brought about by irrelevant stimuli or stimulus attributes, it is assumed that on-line control processes resolve the response conflict. Kornblum and colleagues (1990) suggest that control processes are responsible for terminating ('aborting') incorrectly activated response programs before the correct program can be retrieved. A further on-line control process is necessary to detect whether an abortion is necessary; this is done by identifying the correct response and verifying whether responses that are already active are congruent or incongruent with it. Ridderinkhof (2002) claims that activated incorrect responses need to be suppressed before the correct response can be carried out. Other on-line control processes are assumed to operate after the response is carried out. As suggested by Carter *et al.* (1998), response monitoring processes may detect the presence of response conflict and adjust stimulus-response associations accordingly. For instance, strong conflict may result in strengthening the 'controlled' pathways and/or weakening or suppressing 'automatic' pathways (e.g., Gratton *et al.*, 1992).

Control and Consciousness

The concept of consciousness is anything but well-defined (cf., Velmans, 1996). While some authors have equated consciousness with the human mind, others have restricted it to self-consciousness or the awareness of states of affairs. Recent approaches distinguish between one (Baars, 1988), two (Block, 2005a), or three (Pinker, 1997) types of consciousness, and there is little hope various authors will agree on one conceptual system, let alone locate their own research within it (e.g., Baars & Laureys, 2005; Block, 2005b). Researchers commonly try to circumvent this problem by resorting to an operational definition, such as verbal reportability (e.g., Chalmers, 1995). However, given that there is no reason to assume that conscious experience or access is restricted to states that can be communicated or even verbalized (e.g., take the Würzburgian concept of *imageless thought*), this practice seems to reflect a rather arbitrary choice that is mainly driven by methodological convenience.

With very few exceptions (e.g., Baars, 1988; Wegner, 2002) control-related models in cognitive science leave little space for a well-defined, functional role for consciousness. This does not prevent researchers from using the concept. Indeed, the way it is used points to an apparently strong belief that consciousness and (endogenous) control are at least highly correlated. Indeed, the belief is often so strong that authors speak of 'conscious control' as if there could be no alternative (i.e., no other type of control is ever mentioned; cf., Wegner & Bargh, 1998). For instance, Norman and Shallice (1986) contrast automatic, stimulus-driven actions with actions that are under 'deliberate conscious control', as if unconscious deliberate control would be inconceivable. In addition, the only control-related entries in the subject index of Johnson and Proctor's (2004) textbook on attention are 'controlled and automatic processing' and 'conscious control'.

Given the ill-defined status of consciousness and conscious processes, one can only speculate why there is such a strong tendency to identify endogenous control with conscious control. One reason is that researchers may find it difficult to ignore the introspective impression that it is their own conscious will that sets their body in motion(Wegner, 2002). Another possible reason is that Atkinson and Shiffrin (1968) suggested such a relationship between endogenous control and consciousness in their controlled-automatic distinction.. Automatic processes are characterized, sometimes even defined by (see Neumann, 1984), the fading out of conscious awareness. Indeed, practice-induced automaticity (however defined) is commonly accompanied by a continuously decreasing awareness of the stimulus events and action components involved (Fitts, 1964). This fading of consciousness may lead some to theorists to the conclusion that since automatic processing is unconscious, control processing should obviously be conscious.

Yet another reason to believe that endogenous control must be conscious is probably the fact that the goals and intentions that are thought to trigger the control processes investigated in psychological experiments are commonly not the subject's own goals and intentions, at least not originally. Subjects need to be convinced through money and social skills to 'take over' the goals and intentions the experimenter wants them to have, and it is difficult to imagine that the communicative process achieving this interpersonal transfer should go unnoticed by the subject. Given that subjects are aware of the transfer and, thus, the goals and intentions imposed on them, researchers may be tempted to assume that the implementation of the goals must be correlated with, and perhaps even dependent upon conscious experience. Indeed, some authors have explicitly claimed that conscious experience is the only agent that is able to carry out control operations (e.g., Umiltà, 1988).

The assumption that control and consciousness must be coupled is particularly popular among attention researchers. How popular it is depends on the particular function attributed to attention. Schneider (1995) has pointed out that there are at least three families of attentional theories: some focus on 'selection for object recognition', some on 'selection for feature integration', and some on 'selection for action', a term introduced by Allport (1987). Theories belonging to the first two families assume that the major purpose of attention is to select stimulus events for conscious perception (e.g., Posner & Snyder, 1975; Treisman & Gelade, 1980). If one considers attention the means by which selection is controlled (e.g., Treisman, 1988; Umiltà, 1988) and conscious experience the ultimate purpose of selection, it seems to be very obvious indeed that control must have something to do with consciousness.

Theories belonging to the third family have a less natural connection with consciousness — and so do the authors defending them (Allport, 1987; van der Heijden, 1992; Neumann, 1987). These theories claim that input selection is not necessitated by limitations related to perception or conscious experience but, rather, by the fact that people can only perform one action at a time. In other words, the ultimate purpose of attention is action control, not perception. This latter view does not assume that consciousness must be involved in the control of attention.

There are also theories that explicitly connect consciousness to action control. Lotze (1852) was among the first to assume that creating a conscious image of an action's trigger stimulus or context is a necessary precondition (actually, the only cognitive precondition) for voluntary action to occur. James (1890) and later ideomotor theorists emphasized the intended consequences of the action, which were assumed to constitute the crucial retrieval cue that mediated the selection of an action (see also Baars, 1992). Norman and Shallice (1986) went one step further and claimed that consciousness is directly involved in regulating and solving conflicts among competing action tendencies. However, they fail to explain exactly why conscious experience is necessary in this process and exactly how it becomes functional. More recent approaches have revived Vygotsky's (1962) idea that inner speech — a commonly conscious activity — may play a major role in action control (Zelazo, 1999; 2004), and some evidence has been gathered in its support (Emerson & Miyake, 2003; Goschke, 2000).

Theories in which consciousness plays a defined, functional role in endogenous control are still the exception but they do exist. It is interesting to note, however, that they do not restrict the role of consciousness to input selection (or even identify consciousness with attention), as many attentional theories seem to imply, or to output selection, as action control theories suggest. Rather, they assign to consciousness some integrative role (for an overview, see Baars, 2002). Baars (1988), for instance, relates consciousness to what he calls a global workspace, a medium where information from different processing modules can be exchanged and related. Koch (2004) claims that consciousness-related states provide a summary of the present states of affairs in the world and one's own body, which informs and provides the basis for further planning and decision-making. This view fits well with that of Milner and Goodale (1995). They distinguish between a ventral processing pathway, which handles and integrates visual information with memory contents to create conscious awareness of the best possible interpretation of the visual world, and a dorsal pathway, which is responsible for the on-line processing of action-relevant information. Consciousness and integration are also connected in the approach of Zelazo (1999; 2004), who assumes that consciousness creates relations between mental representations, which provides the basis for higher cognitive functioning.

We can conclude that the concept of consciousness is much more often used in the context of endogenous control than it is defined, motivated, explained, or justified. Hence, there is some implicit association between consciousness and control that seems so self-evident to many researchers that they do not even bother to explain why there are using it. Researchers that do bother assume that consciousness reflects or is related to some sort of global integration.

The concept of control

If researchers theorize about the control of attention or action they commonly do not define what they mean by control (but see LaBerge, 2002, for an exception) and they do not justify their use of this term. So let us first consider when and in which sense the use of the term is appropriate.

Control is an operation mode of a control system (e.g., Powers, 1973). Minimally, a control system consists of a controller (C), the agent of control, and a controlled system or variable (T for target), the target of control (see Figure 2). To exert control, C must be able to accomplish the following: (i) act upon T, (ii) perceive the resulting impact on T, and (iii) compare this impact (i.e., the actual behaviour of T) with a reference or goal, that is, the intended behaviour of T. The

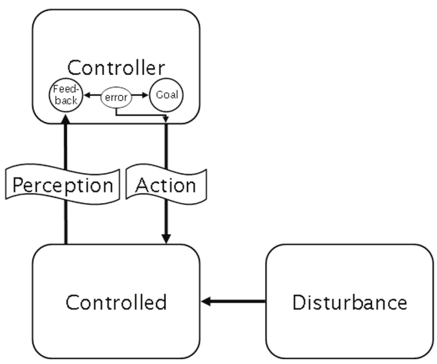

Figure 2. Basic design of a simple control system. See text for further explanation.

difference between the intended behaviour of T and its actual behaviour is called *error*, and control is characterized by Cs attempt to minimize the magnitude of this error. That is, the controller can only be assumed to be in control if it can *compensate for disturbances*, that is, for the effects of other factors on T's behaviour. Indeed, control can be defined by 'consistency produced in the face of disturbance' (Marken, 1986, p. 268).

Probably the most popular example of such control is a central heating system. The goal of the control loop is defined by the user, who specifies a room temperature, say 20° Celsius. The intended temperature is be compared to the actual temperature (the perceptual branch of the control loop). In the case of a negative error (i.e., if the room is colder than 20°) a heat generator is switched on (the action branch of the control loop) and kept working until the error is no longer negative.

The main reason such a control system has perceptual input (i.e., feedback) is that T might be influenced by factors other than C (i.e., disturbances). If these disturbances are unpredictable there is no way to know whether control is effective other than to measure the combined effects of C and disturbances. However, if the disturbances can be assumed to be negligible, or if they can be fully predicted, *feedforward* control is possible. That is, C can take into account possible disturbances and adjust its action on T accordingly, so that the perception branch of the loop is no longer necessary. Obviously, such a control mode is only reasonable in a highly modularized processing system, otherwise C would easily loose control. To the degree that consciousness and control are connected through the need to integrate information, we need to assume that control is not feedforward but, rather, includes feedback.

Conceptual flaws

We have seen that many researchers are tempted to draw a connection between consciousness and control, but it is not clear what this connection is. Determining the nature of this assumed connection is further complicated by the fact that both control and consciousness are not well-defined concepts, and both exist in everyday language. As a result, many authors do not bother to even attempt to define or explain the way they use these concepts. Accordingly, it is far from clear whether different authors using these terms refer to the same phenomena, systems, or functions. Given that we have no a-priori reason to believe that consciousness is a unitary thing (Allport, 1988), and strong reasons to believe that control is not (Duncan *et al.*, 1997;

Miyake *et al*., 2000), it may be the case that apparent contradictions in the literature are due to different statements being made on different issues. Making progress therefore requires some agreement on the phenomena to be addressed and on the way control- and consciousness-related terms are used to theorize about these phenomena. As a first step in this direction I will try to point to some of the most impeding confusions in the discussion of control and conscious phenomena.

(a) Confusing automatic and unintentional processing

When authors refer to or compare automatic and control(led) processes they often refer to the work of Atkinson and Shiffrin (1968) and Schneider and Shiffrin (1977), or the equivalent distinction of Posner and Snyder (1975). The logical and empirical shortcomings of this distinction have been discussed in detail elsewhere (Jonides *et al.*, 1985; Neumann, 1984; Ryan, 1983), and I will not repeat the arguments here. What is important for our purposes, however, is that automatic processes are often, and perhaps always, contingent on the current intention and task goal (Bargh, 1989). As pointed out earlier, people's attention is captured by irrelevant events mainly if these events share some characteristic or feature with the target (Folk, Remington & Johnston, 1992). That is, automatic processes seem to reflect the current task set. The same is true for conflict tasks, where stimuli have been found to activate corresponding or associated responses only if subjects have prepared themselves for responding to these particular stimuli (Valle-Inclán & Redondo, 1998) with these particular responses (Hommel, 1993). These and other examples (Bargh & Ferguson, 2000; Bauer & Besner, 1997; Hommel, 2000; Neumann, 1984) suggest that automatic processes do not represent the opposite of controlled processes but, rather, are functional in realizing intended goals (Bargh, 1989) — even if they may be fooled by highly artificial experimental conditions. Indeed, it is extremely difficult to find cognitive processes that truly fulfill Schneider and Shiffrin's (1977, p. 2) automaticity criteria by being 'difficult to suppress, to modify, or to ignore'.

(b) Confusing exogenous control and disturbance

Imagine you are driving your car on the highway. Suddenly, a strong, unexpected squall emerges from the right. Your car moves to the left. You notice this and turn the steering wheel right. The car is now back on track. This is a perfect example of a control operation in a functioning feedback system. You are in control, which means you constantly compare the current state of affairs (i.e., the actual position of the car) to your goal (to keep the car in the middle) and compensate, if necessary, for unexpected disturbances.

Now compare this situation to attentional capture. You identify your target and plan the appropriate saccade to its location. But then a distractor attracts your attention, perhaps even your eyes, before you eventually home in at the target location. Again, so one would think, a typical demonstration of (endogenous) control: consistency in the face of disturbance. Surprisingly, however, these cases are discussed in the literature as evidence of a (temporary) loss of endogenous control and a takeover of exogenous control. The same argumentative pattern can be found with regard to response selection. Conflict tasks demonstrate that action control is challenged by irrelevant stimuli and the response conflicts they induce, but they also demonstrate that these challenges are commonly overcome: errors are commonly rare and the reaction times are only slightly elevated. This means that people are able to reach their instructed task goals in the face of disturbances: an excellent example of endogenous control but not, as suggested by most authors, a demonstration of exogenous control.

This confusion regarding the relationship between control and disturbance may be the result of utilizing a time-scale of analysis that is of too-fine a grain. A local piecemeal analysis can only measure and compare the relative impacts exogenous and endogenous sources have on a given process or state. But such a piecemeal analysis makes little sense because control takes place on a coarser time scale that involves processing feedback and reacting to it. Hence, the essence of control does not lie in the fact that disturbances can appear and control can be challenged but, rather, in the observation that such challenges are successfully met.

Is this more than a play on words, or might it be possible to replace 'exogenous control' with 'disturbance'? I think the answer strongly depends on one's research strategy. Until now, the strategy express in research on attentional capture and response-conflict conformed rather will with the traditional strategy of posing binary questions, as aptly portrayed by Newell (1973): We argue and design experiments to figure out how automatic or controlled particular processes are, whether pure exogenous control really exists, and so forth, but we have little idea about exactly where this may lead us. A more productive strategy may be to consider the whole interplay of disturbance and compensation as a single act of control, which needs and deserves theoretical explanation. Recent, more comprehensive accounts have demonstrated the fruitfulness of such an approach by investigating, among other things, what output the controller produces (see Logan &

Gordon, 2001) or how disturbances are registered and compensated (Blakemore *et al*., 2002; Carter *et al*., 1998).

In my view, the most interesting implication of treating the whole, temporally extended control loop as an important unit of analysis is that it emphasizes the need and function of global processing. Taking and maintaining control requires the integration of a lot of information: the goal needs to be related to the output of the controller, which needs to be related to the output of the controlled system (i.e., the input of the controller), which again needs to be related back to the goal. Functionally and anatomically speaking this involves quite a number of processing systems and, thus, must be a global operation (Allport, 1988). As pointed out earlier, global operations have been suspected to be more related to conscious experience than local, modular processes (Baars, 2002). In support of this hypothesis, recent studies have shown that conscious awareness of visual events is strongly correlated with global cortical communication (Gross *et al.*, 2004) and that the resolution of stimulus-induced response conflict is tied to conscious awareness (Dehaene *et al.*, 2003; Kunde, 2003; see Mayr, 2004). Hence, running through a whole control cycle may indeed be a consciousness-related global operation.

(c) Confusing conscious control and conscious access to control states

Another conceptual problem that emerges from the common, uncritical use of the term ‘conscious control’ is that it does not specify which causal relationship the term is meant to imply. First, it may mean that any control operation must be conscious and that operations can only control by virtue of being conscious — a view explicitly defended by Umiltà (1988) and implied by the popular model of Norman and Shallice (1986). Second, it may mean that control states or operations are consciously accessible — suggesting that if something is consciously accessible it is likely to be a control state, but not all control states need to be consciously represented. And, third, it may mean that conscious awareness and control are correlated for some, still to be determined reason.

The first option is extremely difficult to test — not only because its supporters commonly fail to describe exactly those aspects of a process that need to be experienced in order to control it, but also because any demonstration that unconscious processes can affect behaviour could be ‘explained away’ by claiming such processes to be ‘automatic’. However, recent findings suggest that people may not only be unable to explain *how* they exert control over a particular event (which the control-through-consciousness account could accommodate) but they sometimes do not even know *whether* they do. For instance, people's feeling that they have caused an event is much more determined by whether they expected that event (even if this expectation is induced by subliminal primes: Aarts *et al*., 2005) than by whether they actually produced it (Wegner & Wheatley, 1999).

These and similar observations (Wegner, 2002) do not confirm the assumption that consciousness and control are equivalent (the first option) and they also let one doubt whether human agents have a privileged conscious access to their own control processes (the second option). By exclusion, this leaves us with the possibility that conscious awareness and control are correlated but do not necessarily depend on each other. As claimed by Wegner (2002), true control may be taking place in an entirely unconscious fashion but the successful prediction of its outcome may trigger the illusion of 'conscious control'.

One may object that Wegner's theory throws out the baby with the bath water. Indeed, demonstrating that people can be made to think that they have caused an action which they didn't rules out the idea that the relationship between consciousness and control is particularly intimate, but it does not prove that conscious contents can never cause an action or that all control experiences are illusions. Moreover, Haggard (2005) has emphasized that some aspects of control, such as the integration of an action and its effects, may depend on the presence of an action intention. Even though this does not require that it is the intention that exerts the control, it would seem premature to close the book before further research has brought some more light into this matter. What seems clear, however, is that the correlation between conscious experience and (endogenous) control is less perfect than some approaches suggest or even presume.

(d) Confusing personal and systems levels of analysis and explanation

The popularity of the concept 'executive control' undoubtedly derives from the translational trick it provides: It exploits the technomorphic analogy to a central processing unit in a digital computer, and thereby signals the promise of a mechanistic account. And it does so without violating our introspective experience of ourselves as a deciding and controlling agent (Goschke, 2003). Given that the term is only a *translation* of a concept defined on a personal explanatory level (where agents control actions) to a concept defined on a systems level (where the executive sends control signals to subroutines), nothing is gained if the translation is all that is provided.[1] Although this seems obvious, a number of models and accounts of aspects of cognitive control have treated the translation as coming with some explanatory surplus. For instance, Posner and Snyder (1975) and Schneider and Shiffrin (1977) have identified 'the conscious control of the subject' as the origin of the control that is exerted on the 'controlled' processes and strategies that are doing the main jobs in their models, and Norman and Shallice (1986) explain the ability to suppress unwanted response tendencies through the intervention of a clever but unspecified 'supervisory attentional system', which they readily equate with the human will. These and other conceptual oddities have been discussed and criticized at length elsewhere (Allport, 1980; Neumann, 1984), so that I can restrict myself to emphasizing what I consider the most problematic consequence of mixing personal and systems levels: the creation, rather than the solution, of theoretical problems.

For instance, Monsell (1996, p. 95) describes 'the mystery of how cognitive processes are controlled' by asking '… what causes me to devote my processing resources, organized in a particular way, to this one task rather than another, and when, and how?' Apart from the fact that this question contains at least two Rylean category mistakes (Ryle, 1949), the need for an executive control mechanism is motivated by pointing out that humans can respond to the same stimulus in different, task-specific ways — an ability that we however share with rats, pigeons, and other animals (e.g., Mackintosh, 1974) that until now were not suspected to have particularly impressive executive functions at their disposal. Another example: In a description of 'the theoretical problem' of 'controlled processing', Shallice (1994, p. 395) takes the fact that people can attend to different stimuli to mean 'that the behavior of human subjects in information-processing experiments depended not only on the structural organization of the cognitive system but also on the strategy employed to carry out such tasks' (Shallice, 1994, p. 395). The concept of strategy also looms large in Logan's (1985) account of the 'executive control of thought and action'; he takes the observation that human subjects exploit contingencies between stimuli (e.g., Logan & Zbrodoff, 1979, p. 197) to

[1] Some authors have chosen to enrich their translation by the assumption that the executive controller resides in the frontal lobe (e.g., Baddeley, 1986; Shallice, 1994). On one hand, this seems to follow a straightforward logic, given that frontal cortical areas are crucially involved in everything that looks like a 'willful' process — be that preparation for actions and tasks, attentional selection, inhibition of reflexes, or the planning of action sequences (see Stuss & Knight, 2002, for an overview). On the other hand, though, this double translation from a personal to *two* systems levels as such does not bring in any more theoretical meat, it just offers two displacements of the problem for the price of one.

'demonstrate that subjects will adopt strategies that allow them to maximize the attainment of their goals'. Given the demonstrations of selective attention (Mackintosh, 1975) and associative stimulus-stimulus learning (Pavlov, 1927/1960) in all sorts of nonhuman animals, it is difficult to see why such observations motivate researchers to resort to a fancy but theoretically opaque mental system, which then is taken to 'explain' the experimental effect, instead of making use of available theoretical principles.

Prospects for a Theory of Consciousness and Control

In view of the flaws and shortcomings in the theorizing about the role of consciousness in the control of cognition and action it seems clear that a lot needs to be done. Fortunately, some lessons are to be learned from the history of the concept of attention: Research started with the commonsense version of the concept, which was rather uncritically translated into a unitary scientific concept (e.g., James, 1890). Even though a unitary view on attention is still nurtured in some areas of the cognitive sciences, researchers increasingly acknowledge that different types of attention, different attentional functions exist, as well as different brain areas housing them and different neurotransmitter systems to make them work (e.g., Allport, 1987; Posner, 2004; Schneider, 1995). This history seems to be recapitulated by the concept of control. While theorizing was first dominated by the discussion of a 'central executive', 'operating system', or 'controller', more recent approaches increasingly favour distributed and specialized 'executive' or 'control functions' (e.g., for an overview, see Monsell & Driver, 2000). Another healthy development is the increasing tendency to break up the traditional dichotomy of automatic and control(led) processes and to consider more integrated conceptualizations in which automatic processes are functional in *achieving* control (Baars & Franklin, 2003; Bargh & Ferguson, 2000). Indeed, if a systems level analysis aims at explaining how cognition and action (as defined on the personal level) are controlled, it makes sense to assume that it is the organization of the processes that achieves the control, not the characteristics of isolated individual processes. Accordingly, there is little use in assigning the labels 'automatic' and 'controlled' to individual processes unless we understand how they interact with each other and how this interaction creates the phenomenon of control (objectively defined as persistence in the face of disturbance).

Important next steps to be taken are, first, to make stronger attempts to concretize the possible or likely roles of consciousness awareness in control. It seems inappropriate to treat consciousness and control almost as a synonym without explaining how the having of a phenomenal experience can cause (rather than reflect) the organization of cognitive processes in the service of a goal. Weaker claims, such as that control states are consciously accessible, must be specified and empirically tested, not simply taken for granted on the basis of personal introspection. Of special interest will be the further investigation of the causal (or only correlative) relationship between conscious intentions and actions (Aarts *et al.*, 2005; Wegner, 2002), as the outcome of such research will be particularly informative with respect to the relevance of introspective evidence. Finally, it seems important to avoid the mixing of analytical and, even more important, explanatory levels. Describing a simple process in fancy terms is unlikely to serve the progress of the scientific understanding of control, especially if it conceals the view on less imaginative but presumably more appropriate and already available explanations.[2]

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