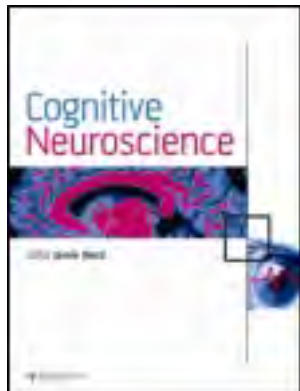


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### The role of consciousness in the urge-for-action

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in Tourette syndrome that patients experience such distress in relation to actions that are not only nonessential but also nonproductive. We do not yet understand when or how this association is made. Third, following the tic, the bothersome sensation is not eliminated, but only reduced in intensity. Finally it is not clear why tics must be performed in a particular way in order to achieve relief and diminishment of the bothersome sensations. Continued research into the circuitry that mediates both normal and pathological urges, as described by Jackson et al., will help our understanding and treatment of Tourette syndrome and other impulse-control disorders.

Features of normal and tic-related urges

<i>Characteristic</i>	<i>Normal</i>	<i>Tic</i>
Sensory input from bodily organs	Yes	?
Sensation reaches awareness when action delayed	Yes	Yes
Sensation is uncomfortable	Yes	Yes
Experience urgency and need to take action	Yes	Yes
Action can be suppressed (minutes), and then must occur	Yes	Yes
Relief from discomfort with action taken	Yes	Some
Action is necessary to organism survival	Yes	No

\* \* \*

## The role of consciousness in the urge-for-action

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**Abstract:** A neuroanatomical model of urge-for-action phenomena has been proposed based on the “motivation-for-action” network (e.g., insula and mid-cingulate cortex). Notwithstanding the sound evidence presented regarding the functional and anatomical correlates of this model, the nature

of the relationship between urges and conscious awareness remains to be addressed. Moreover, this model does not seem to explain (1) how a conscious access threshold is reached, and (2) the way in which the urges are related to more general contents of consciousness.

Jackson et al. have proposed a novel model of urge-for-action. This model considers the nature and functional anatomy of urge-for-action in the context of normal life and clinical disorders. Through a meta-analysis, the authors show that there is an overlap between limbic sensory and motor neural circuits related to urges of everyday behaviors such as swallowing and tics in Tourette syndrome. The primary merit of this work is unquestionable; the authors propose an empirical and theoretical model of urge-for-action incorporating actions that do not necessarily require conscious awareness of the sensory stimulation that triggered them. Nevertheless, there are important issues that this model does not explicitly incorporate.

First, it is not clear how urge-for-action, as defined in this paper, can be a fully unconscious phenomenon. If the momentary inhibition of the action is an integral part of the definition of these urges, then that inhibition should be unconscious as well. In this paper, we find a lack of evidence on this topic, perhaps reflecting more than a mere lack of interest on this matter. Having searched the literature on unconscious inhibition of action, we found several instances in which willed intention is involved (e.g., go/no go tests in Eimer & Schlaghecken, 2002, and van Gaal, Ridderinkhof, van den Wildenberg, & Lamme, 2009). It is hard to imagine a fully unconscious inhibition of the kinds of actions considered to be representative of urge-for-action (coughing, swallowing, yawning, etc.). As long as that inhibition plays an important role in this process, we should be consciously aware of our urge-for-action as opposed to our reflexes.

The second issue concerns the nature of the relationship between urges and conscious awareness. Jackson et al. explained that the intensity of physiological afferent stimulation relates directly to the awareness of the urge’s strength during a phenomenon such as swallowing, but it is not clear how this phenomenon could be explained by their proposed model.

Despite the straightforward relationship between insular cortex and interoceptive conscious awareness (e.g., Ibáñez, Gleichgerrcht, & Manes, 2010), this fact

is not explicitly taken into account in terms of the neuronal activity of the cortical and subcortical regions considered in this model. More importantly, even if we consider that urge-for-action could be an unconscious phenomenon, it remains unclear how this model could explain the transition between urges the subject is not conscious of and those of which the subject is consciously aware. Along these lines, is it the strength of activation of the right insular cortex, the anterior cingulate cortex (ACC), or the circuit between these regions that is responsible for setting the threshold between unconscious and conscious awareness of urges? This point is far from being addressed in Jackson et al.'s model.

Finally, how could the urge-for-action model of Jackson et al. be integrated with more general models of consciousness? Current models have determined the activation of widespread cortical regions during goal-directed visual awareness (e.g., Dehaene et al., 2001) and have specified some neuronal markers for reaching the threshold of conscious perception (e.g., Del Cul, Baillet, & Dehaene, 2007). How does this urge-for-action circuit interact with more general circuits of conscious perception? Interoceptive awareness is conceptualized as the capacity of being aware of some specific *content* of consciousness; that is, of visceral perception (Ibáñez et al., 2010). Therefore, the authors should clarify the way in which interoceptive awareness might be related to other contents of consciousness, such as goal-directed cortical circuits underlying more general conscious perception phenomena.

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## Urges, inhibition, and voluntary action

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**Abstract:** It is constitutive of the notion of an urge that it must precede the action it urges. For the duration of an urge to be non-zero, some process must keep the action being urged in check. Urges therefore inevitably involve inhibition of action, and perhaps conflict between action and inaction. In

any event, they cannot form a critical part of the phenomenology that many argue must precede voluntary action, for if they play any part at all, it is only in situations where the action is to some degree inhibited.

The notion of “urge” has come to play a pivotal role in current conceptions of voluntary action. Curiously, it has done so without detailed exploration of the kinds of actions—involuntary or atypically voluntary—where the need to invoke it is arguably much greater, and where an understanding of its neural basis is far more plausibly within reach. And when one analyzes such actions—as Jackson and his colleagues lucidly and comprehensively do—the notion of urge that emerges is radically at odds with one that gives it a critical role in voluntary action. This is just as important a conclusion as the independent clarification of the neural substrate of urges itself.

It is surely right that urges must be dissociated from the sensations that in some cases prompt them. The urge to yawn, for example, is not plausibly any kind of sensation: One can only describe it with reference to the action it compels. What is minimally constitutive of the notion of an urge is that it is an urge *to do something*: it is both transitive and directed at a specific action. It is also true, as Jackson and his colleagues point out, that an urge must temporally *precede* the action: If it post-cedes it, we would not call it an urge, and if it parallels it in time, then it could not be an urge to perform the action because the action is already being performed. But the implication goes further. Since the urge is to perform the action, the necessary interval between it and the action during which the urge is experienced must involve *inhibition* of the action, for otherwise the action would be performed immediately. Inhibition is therefore an inevitable consequence of the notion of an urge.

Indeed, it is striking that the actions commonly associated with urges—both in the normal and in the pathological state—are usually of the kind that cannot be actively *chosen* but only *withheld*. One cannot actively choose to yawn or sneeze, and if one coughs or voids one's bladder voluntarily one tends to do so pre-emptively of the normal action. To the extent to which we have control over such actions, it is to keep them in check, to be released at the time when their performance is convenient. There are, of course, other comparably “automatic” actions, such as blinking, where urges play a much less prominent role, but it is notable that they tend to be of a kind one rarely has

reason to suppress. Equally, the actions associated with urges in movement disorders such as Gilles de la Tourette syndrome are perceived as unwanted; where no such strong perception exists—in many cases of chorea, for example—patients do not complain of urges.

An urge to act, then, cannot be empirically dissociated from the inhibition of the action, and presumably also from the conflict between action and inaction: this is so not because we lack the experimental tools but because inhibition is constitutive of the notion of an urge. This implies that the neural substrate Jackson and his colleague identify must also subservise these processes. More importantly, it casts further doubt on the notion that an urge is a signature of the phenomenology that is argued to precede voluntary action and to take part in its self-ascription. For if an urge signifies the inhibition of an action, it can hardly be thought of as the “idea” driving it. This also explains why urges are often reported during macrostimulation of the dorsomedial frontal cortex: The set of multiple neuronal pools inevitably severally activated at that scale of stimulation is bound to contain units that inhibit as well as drive active movement.

There are, of course, numerous unanswerable arguments against the ideomotor theories of action popularized by Libet’s work, but keeping the lid on that coffin is so extraordinarily difficult another nail can never go amiss.

\* \* \*

## Unaware urges? Let’s not complicate matters further

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**Abstract:** The model put forward for the neuroanatomical basis of urges-for-action is compelling. The arguments based on meta-analyses of existing neuroimaging data are elegant and convincing. However, I am not convinced by the suggestion

that there are conscious urges and urges that remain unaware. In my view, awareness is a defining feature of an urge.

Jackson et al. develop a convincing case for the existence of a neuroanatomical system that is responsible for the “urge-for-action.” The role of the (right) insula and the dorsal anterior cingulate cortex is inferred on the basis of a number of separate meta-analyses looking at associated brain activations in response to specific stimulation—in this case different triggers of urges. The idea that there are separate systems for “willed” or planned actions and “urged” actions makes sense and is clearly supported by the clinical and neuroimaging data.

The definition of “urges-for-action” proves more complicated. The beginning is relatively straightforward. These urges involve a limited set of actions that are habitual, standardized routines, such as scratching, yawning, or swallowing. They typically do not require feedback, and they are functional in that they alleviate specific negative or unpleasant bodily states. Things become tricky when we are offered the suggestion that we have conscious and unconscious urges (cf. Dijkerman & De Haan, 2007). We are told that urges and desires are not synonymous, and the main reason for this is that urges may also remain unaware to the person who “experiences” them. Indeed, we may find ourselves swallowing or yawning without having had a conscious urge, but it is not clear to me why this behavior cannot be classified as “reflexive.” Indeed, the Davenport, Sapienza, and Bolser (2002) study seems to indicate that we are dealing with a system where the intensity of the (negative) stimulation is directly related to strength of the perceived urge. This makes sense, the limbic system including the insula, registers the amount of bodily discomfort, and depending on the severity of this discomfort, a more or less “urgent” urge is felt.

I also agree with the authors that what distinguishes a reflex from an urge is the fact that a reflex—by definition—is immediate and proceeds without conscious interference. An urge, however, may need to be postponed as the execution of the required action is socially or emotionally compromising. Here I would like to suggest a different interpretation from the one put forward by Jackson et al. that an urge may be construed as an interrupted reflex. The reflex entails a complex sequence of detecting a specific negative

bodily state coupled to a proven alleviating motor action. The fact that this motor action is not socially or emotionally acceptable is in essence culturally defined, and therefore, is a learned response.

Thus, and this is my central thesis, the defining aspect of an urge is a learned interruption of a reflexive sequence. The result of this interruption is a conscious awareness of the pending action *and* the fact that this action is not acceptable in the current situation. In this view, an unconscious urge is a contradiction in terms, as an urge constitutes the awareness of the desire to perform an action coupled with the learned response to inhibit this action.

Jackson et al. state that it is “difficult to reconcile the concept of a ‘desire,’ which is often defined as ‘a longing or craving for something that brings satisfaction or enjoyment,’ with unwanted actions, the execution of which is experienced as unpleasant and distressing” (p. 229). I find this surprising and I cannot subscribe to this “difficulty” felt by the authors, as in my experience this is often exactly what patients with obsessive compulsive disorder or Gilles de la Tourette syndrome report. The simultaneous experience of the urge to carry out an action and the concurrent realization that this is not acceptable, socially or emotionally, could be posited as the hallmark of obsessive compulsive disorder. In fact, after the act has been performed, there is again a simultaneous experience but now one of relief (because the act has—somewhat—alleviated the negative bodily state) and shame (because the executed act was socially or emotionally unacceptable). Interestingly, when I was reading the article for the first time, I thought that, toward the end, the authors would propose a role for the right insula in becoming aware of an urge. They did not do so, and I am glad they did not, because it is not important for their main conclusion.

This review provides strong evidence for a separate network in the brain involved in the detection of well-defined negative bodily states and a set of habitual, standardized routines to alleviate the discomfort. When the required action is consciously flagged because of learned associations with negative social or emotional connotations, the execution of these actions is—temporarily—inhibited, and an “urge” is experienced.

\* \* \*

## My urge, my tic – a missing link between urges and tic inhibition

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**Abstract:** Despite the fact that premonitory urges precede most tics in patients with Gilles de la Tourette syndrome (GTS), the voluntariness of tic elicitation and its suppressibility as a response to these urges still remains unclear. Moreover, there are no systematic studies examining the association between urge intensity and the ability to suppress tics. As shown by behavioral, neurophysiological, and imaging data, sensorimotor networks in GTS exhibit altered patterns of organization modulated through interactions with frontomesial networks of volitional inhibition.

In their nice and elaborated review, Jackson et al. provide a functional basis for a distinction between reflexive behaviors and actions that come from urges helpful in daily life (such as the urge to yawn, urinate, and cough) and those possibly interfering with daily life (such as the urge to tic). They argue that the latter are associated with *unwanted actions*, principally as their *interoceptive gatekeepers*, allowing their conscious *suppression or deferment*. Particularly for Gilles de la Tourette syndrome (GTS), they propose that premonitory sensations are represented within the somatosensory (SII) and mid- and posterior insular cortices, leading to *habitual actions*. They argue that the urge for action is associated with activity of the anterior insular cortex, which is then relayed to the cingulum and the ventral striatum for reward-based prediction analysis, and then forwarded again to the insular and inferior frontal cortices, which in their turn satisfy or propagate the urge for action.

Examining the properties of the urge in GTS, and already before Leckmann’s seminal paper (Leckmann,

Walker, & Cohen, 1993) on the subject, Bliss, a clinician and GTS patient himself, published (Bliss, 1980) a thorough description of his own premonitory sensations and, as a result, argued for the voluntariness of tics. In the following years, systematic studies showed that more than 90% of patients with GTS report these urges and consider tics as, if at all, only partial involuntary. It has been consistently found that the development of the urge is reported with a lag of about 3 years after the onset of tics (Banashewski, Woerner, & Rothenberger, 2003; Kwak, Dat Vuong, & Jankovic, 2003; Leckmann et al., 1993). The delayed appearance of this phenomenon has led to a series of hypotheses: Is the association of urges and tics a compensatory evolutionary development as a basis for the option to suppress these phenomena, or are urges and tic suppressibility co-existing phenomena, as suggested by recent tic-suppression studies? (Banashewski et al., 2003; Conelea & Woods, 2008).

As for the neurophysiology of tic generation, the zeitgeist led to the study of the correlates of the voluntariness of movement disorders, with the pioneering work of Obeso, Rothwell, and Marsden (1981), followed 14 years later by another work (Karp, Porter, Toro, & Hallett, 1996), which examined the presence of the Bereitschaftspotential (BP) in tics. The results were equivocal, with the first study showing that tics were not preceded by the BP, and the second demonstrating its presence in 2 out of 5 patients. This led to the hypothesis (Kwak et al., 2003) that only tics associated with a premonitory sensation—and therefore consciously perceived and voluntarily initiated—are preceded by the BP. This has been shown in three patients in the only study to date that addressed this question (Duggal & Nizamie, 2002). Additionally, and in accordance with the latter study, which, surprisingly, found a shorter than normal BP, Moretto showed that patients with GTS have a delayed experience of volition (Moretto, Schwingenschuh, Katschnig, Bhatia, & Haggard, 2011). This would imply that not only the formation of tics but also the formation of normal movements would necessitate an altered pattern of motor organization through fronto-striato-thalamo-cortical pathways, as supported by current findings (Heise et al., 2010; Roessner et al., 2011). Furthermore, in the absence of direct evidence to support the notion that the awareness of urges correlates positively with the ability to suppress tics—a suppression, which, according to Jackson et al., would lead to the propagation of the urge and further activation of the

anterior insula—the role of frontomesial networks of volitional inhibition (Kühn, Haggard, & Brass, 2009) and tic suppression has to be addressed in detail. These networks presumably influence the pre-supplementary motor area activity in a top-down fashion, as supported by a recent EEG experiment showing elevated inter-regional interactions between these and sensorimotor and prefrontal areas during tic inhibition, paralleled by an increasing urge to tic (Serrien, Orth, Evans, Lees, & Brown, 2005).

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## An urge to act or an urge to suppress?

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**Abstract:** There is no doubt that there exist urges to act, but are these really the cause of the action or is an urge a shorthand term to describe the effort involved in suppressing an action that is triggered automatically by some other process?

There is no doubt that there exist urges to action—just think back to Zidane’s uncontrolled and badly timed urge to head-butt an opponent. But can we go quite as far as Jackson and colleagues in believing that they all arise from activity in the same anterior insular and caudal cingulate regions of the cortex? Furthermore, does activity in these regions then drive the premonitory sensations that are sometimes described by patients with Tourette’s syndrome prior to their tics? The argument of Jackson and colleagues is erudite and informed, but there seems to be a certain sleight of hand in the logical steps of the argument which lead to the definition of a “motivation for action” network.

The authors begin with the highly reasonable assertion that an urge to act is, at least in the majority of instances, an awareness of the effort involved in restraining the act. That is, some other factor (perhaps only dimly perceived) is the trigger for this latent action, and when we become aware of the impending

action, we are able to prevent it from being released by effort of will. Effectively, this seems to be saying that stimulus–response associations exist that can give rise to actions. Consistent with this idea, the authors point out that some actions that can be associated with urges on one occasion (e.g., yawning) can, on another occasion, emerge without the sensation of an urge. The rule seems to be that if the stimulus or impending action is perceived before the action occurs, and if the action is subsequently withheld, then we experience an urge to act (unless the stimulus disappears). We can feel an itch or a “desire” to scratch and we can decide to withhold the scratch; if the itch persists, then we may develop an urge to scratch. Paradoxically, an urge to act turns out to be an intention to suppress. The action itself is triggered by some other factor in an automatic fashion.

This seems to be a very simple and reasonable interpretation that involves two interacting processes: the basic stimulus–response coupling and a supervisory system with a power to withhold the response. However, the authors then seem to pursue quite a different interpretation about halfway through the article. The turning point comes after the analysis of the first set of imaging data. Here they find common

activation in anterior insula and caudal cingulate cortex during yawning and micturition. They then say that activity in these common areas is responsible for the urge to act and then causes the action, as illustrated in Figure 9. At this stage, we have lost the low-level stimulus–response coupling and all mention of inhibition. We are now told that inputs to the anterior insula produce an urge to act (not to suppress a prepotent action). This constitutes a feeling that we have to make a particular movement, which is then achieved via activation of caudal cingulate cortex.

We accept that it is difficult to decide which of these interpretations is true. What strikes us as odd is that the authors begin by emphasizing the importance of inhibition, yet end by talking about motivation to act. Would it not be simpler to suppose that stimulus–response associations exist at all levels of the sensorimotor system from spinal reflexes to striatal habits. These are all to a greater or lesser extent modifiable by a supervisory system we may equate with volitional control. An urge to act is an expression of the interaction between these systems, not a separate system itself.

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