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[−] Abstract and Keywords

This chapter reviews three classes of unconscious action: actions that can occur when the subject appears to be in an unconscious state or that transpire without any identifiable conscious mediation (first section); actions that are influenced by stimuli of which the subject is unaware (second section); and actions prompted by supraliminal (consciously-experienced) stimuli that influence the subject's consciously-mediated actions in ways that the subject is unaware of (third section). The final section reviews the fundamental difference between conscious and unconscious action tendencies.

Keywords: unconscious action tendencies, unconscious action, consciousness, automaticity, priming, voluntary action, involuntary action, volition, unconsciousness, automatisms, subliminal stimuli, unconscious behavior, subliminal priming, backward masking, involunt

As revealed in classic research (Festinger, 1957; Heider, 1958; Lewin, 1935), the study of the basic mechanisms giving rise to human action has always informed theories about social phenomena (e.g., conflicted versus non-conflicted action; controlled versus automatic processes; automatic stereotyping; Bargh, 1984). This cross-fertilization of research on action and social psychology continues today, when there is an even greater appreciation of the various kinds of actions that humans are capable of expressing and of the distinct cognitive and neural underpinnings of the different forms of action.

An action such as glancing rightwards, for example, may at times be due to one kind of nervous system event, as when one's attention is grabbed by a stimulus on the right (the visual grasp reflex; Sumner & Husain, 2008); at other times it may be due to a very different kind of event, as when one voluntarily looks rightwards to check the time on a wall clock. Indistinguishable to most observers, these actions differ at least phenomenologically and even with respect to their cognitive and neurobiological underpinnings (Floyer-Lea & Matthews, 2004; Pacherie, 2000; Puttemans, Wenderoth, & Swinnen, 2005; Raichle et al., 1994). Similarly, voluntary blinking (Bodis-Wollner, Bucher, & Seelos, 1999), saccades (Curtis & D'Esposito, 2003; Munoz & Everling, 2004), breathing (McKay, Evans, Frackowiak, & Corfield, 2003), and swallowing (Kern, Jaradeh, Arndorfer, & Shaker, 2001) differ in various ways from their reflexive counterparts. For instance, reflexive swallowing is believed to involve substantially fewer brain regions than volitional swallowing (Ortinski & Meador, 2004). (p. 336) In addition, novel and well-learned actions appear to rely on distinct cognitive and neural mechanisms (Floyer-Lea & Matthews, 2004; Pacherie, 2000; Poldrack et al., 2005; Puttemans, Wenderoth, & Swinnen, 2005): A habitual, automatized action requires less attentional and goal-directed processes (and less activation of their associated prefrontal regions; Raichle et al., 1994; Sakai et al., 1998) than when the action was first learned. (See Sumner & Husain, 2008, for a treatment regarding how both kinds of actions may rely on the same neural machinery.) Thus, what appears to be the same action can actually be carried out by vastly different mechanisms, mechanisms which often have different operational principles, phylogenetic origins, and neural underpinnings.

Regardless of the nature of the mechanisms, what matters most from an evolutionary perspective are the

consequences of actual, *expressed action*, because natural selection operates at the level of overt (rather than covert) action (Roe & Simpson, 1958). In evolution, what one does is more consequential than what one feels, believes, imagines, or is inclined to do—potentialities that, though intimately related to action, fall outside the jurisdiction of natural selection (Roe & Simpson, 1958). Hence, because overt action can lead to situations that diminish evolutionary fitness and can incur high opportunity costs (the expression of one action oftentimes precludes the expression of other actions), overt action is both risky and costly. Thus, it is beneficial that we are not always compelled to act one way or another but that we can be *inclined* to act in certain ways (Chomsky, 1988) and can also mentally simulate actions in a covert, off-line manner. Knowledge of outcomes can thus be learned without the risks of performing the actions (Bargh & Morsella, 2008). Though inclinations and imagery operate in a realm shielded from that of expressed action, they are still intimately related to action. Thorndike (1905) asserts,

> "The function of thoughts and feelings is to influence actions… Thought aims at knowledge, but with the final aim of using the knowledge to guide action" (p. 111).

Sometimes the organism is aware of inclinations and can report about them, as in the case of consciously experienced urges; other times the organism is unaware of such inclinations, as in unconscious action tendencies, the topic of this chapter. In this chapter, we will review three classes of unconscious action: Actions that can occur when the subject appears to be in an unconscious state or that transpire without any identifiable conscious mediation (first section), actions that are influenced by stimuli of which the subject is unaware (second section), and actions prompted by supraliminal (consciously experienced) stimuli that influence the subject's consciously mediated actions in ways that the subject is unaware of (third section). In the fourth section, we review the fundamental difference between conscious and unconscious action tendencies.

Unconscious Actions

Unconscious events in the nervous system are those processes that, though capable of systematically influencing behavior, cognition, motivation, and emotion, do not influence the organism's subjective experience in such a way that the organism can directly detect, understand, or report the occurrence or nature of these events. Regarding behavior, it is well documented that several kinds of actions can occur while subjects are in what appears to be an unconscious state (Laurey, 2005). For example, actions such as automatic ocular pursuit and some reflexes (e.g., pupillary reflex) can occur in some forms of coma and persistent vegetative states (Klein, 1984; Laurey, 2005; Pilon & Sullivan, 1996), and it seems that licking, chewing, swallowing, and other behaviors can occur unconsciously once the incentive stimulus activates the appropriate receptors (Bindra, 1974; Kern et al., 2001). Research on the kinds of behaviors (automatisms) exhibited during epileptic seizures in which the patient appears to be unconscious, or to not have any conscious control, has revealed that stereotypic actions such as simple motor acts (Kutlu et al., 2005), humming (Bartolomei et al., 2002), spitting (Carmant et al., 1994), and oroalimentary automatisms (Maestro et al., 2008) can occur independently of conscious mediation. (For what it is worth as an anecdote, one of us [EM] recalls with great vividness coming out of general anesthesia and hearing someone repeatedly complain about physical discomfort, only to learn moments later that it was he himself who was the person producing the vociferations.) More complex acts such as written and spoken (nonsense) utterances (Blanken, Wallesch, & Papagno, 1990), sexual behaviors (Spencer, Spencer, Williamson, & Mattson, 1983), and rolling, pedaling, and jumping (Kaido et al., 2006) have also been found to occur in a reflexive manner during seizures. Most dramatically, there are cases in which, during seizures, patients sing recognizable songs (Doherty et al., 2002) or express repetitive (p. 337) affectionate kissing automatisms (Mikati, Comair, & Shamseddine, 2005). Similarly, research on narcolepsy (Zorick, Salis, Roth, & Kramer, 1979) and somnambulism (Plazzi, Vetrugno, Provini, & Montagna, 2005; Schenk & Mahowald, 1995) reveals that complex behaviors (e.g., successfully negotiating objects) can be mediated unconsciously.

Corroborating that such actions can occur unconsciously, following brain injury in which a general awareness is spared, actions can be decoupled from consciousness, as in *blindsight* (Weiskrantz, 1997), in which patients report to be blind but still exhibit visually guided behaviors. Analogously, in blind-smell (Sobel et al., 1999), people can learn to associate odorants with certain environments (e.g., a particular room), even though the concentration of odorants presented during learning was consciously imperceptible. Similarly, in *alien hand syndrome* (Bryon & Jedynak, 1972), *anarchic hand syndrome* (Marchetti & Della Sala, 1998), and *utilization behavior syndrome*

(Lhermitte, 1983), brain damage causes hands and arms to function autonomously. These actions include relatively complex goal-directed behavior (e.g., the manipulation of tools; Yamadori, 1997) that are maladaptive and, in some cases, at odds with a patient's reported intentions (Marchetti & Della Sala, 1998).

In addition, Goodale and Milner (2004) report neurological cases in which there is a dissociation between action and conscious perception. Suffering from visual form agnosia, patient D. F. was incapable of reporting the orientation of a tilted slot, but could nonetheless negotiate the slot accurately when inserting an object into it. Other patients with lesions in the ventral-visual system (the "perception pathway"; Goodale & Milner, 2004) cannot identify (recognize) the object, but are still able to reach for it correctly when the experimenter casually asks them to take it. Conversely, patients with lesions in the parietal lobe region are able to correctly identify an object held up to them by an experimenter, but are not able to reach for it correctly based on its spatial orientation (horizontal or vertical). Thus, one group exhibited appropriate action tendencies toward the object in the absence of conscious awareness of what the object was (i.e., action without perception), while the other group was aware of what the object was but could not act towards it appropriately (i.e., perception without action).

Theorists have concluded from this and related studies that two different cortical visual pathways are activated in the course of perception, a dorsal pathway that supports actional responses ("what to do") and a ventral pathway supporting semantic knowledge regarding the object ("what it is"; see review in Westwood, 2009). Importantly, mounting evidence suggests that it is the dorsal (actional) system that operates largely outside of conscious awareness, while the operation of the ventral system is normally accessible to awareness (Decety & Grèzes, 1999; Jeannerod, 2003). (See Ro, 2008, for recent evidence involving the selective disruption of the pathways by use of transcranial magnetic stimulation.)

Such a dissociation between action and consciousness is evident in the ways that neurologically intact subjects respond to visual illusions (Wraga, Creem, & Proffitt, 2000): Although subjects' self-reports reflect the illusion, such as that one circle appears larger than another in the Ebbinghaus/Titchener illusion, their manual behavior toward the visual objects responsible for the illusion is accurate and does not reflect what subjects report. (For arguments against the notion of perception-action dissociations, see Franz, Gegenfurtner, Bülthoff, & Fahle, 2000; Jeannerod, 2003.) Stottinger and Perner (2006) conclusively demonstrated the dissociation using an illusion (the diagonal illusion) that is free of the kinds of limitations found in previous experiments.

Findings regarding perception-action dissociations corroborate what motor theorists have long known—that one is unconscious of the motor programs guiding action (Rosenbaum, 2002). In addition to action slips and spoonerisms, highly-flexible and "online" adjustments are made unconsciously during an act such as grasping a fruit. Because the spatial relationship between the objects of the world and one's body is seldom fixed (e.g., a fruit is sometimes at left or right), each time an action is performed new motor programs are generated unconsciously to deal with peculiarities of each setting (Rosenbaum, 2002). One is unconscious of these complicated programs (see compelling evidence in Helen & Haggard, 2005) that calculate which muscles should be activated at a given time, but is often aware of their proprioceptive and perceptual consequences (e.g., perceiving the hand grasping; Gray, 2004; Gottlieb & Mazzoni, 2004). (See Berti & Pia, 2006, for a review of motor awareness and its disorders.)

For example, Fourneret and Jeannerod (1998) showed that when one's hand is controlling a computer-drawing device but is prevented from seeing the hand in motion (because it is behind a screen), participants can be easily fooled into thinking that their hand moved one direction when it had (p. 338) actually moved in a different direction (through false feedback on the computer display). Participants reported great confidence that their hand had actually moved in the direction of the line drawn on the screen, when in reality substantial bias had been programmed into the translation of their actual movement into what was displayed. Importantly, this result is obtainable only if participants have little if any conscious access to their actual hand movements. In addition, though the planning of action (e.g., identifying the object that one must act towards) shares resources with conscious perceptual processing, the online, visually guided control of ongoing action does not (Liu, Chua, & Enns, 2008). In short, there is a plethora of findings showing that one is unconscious of the adjustments that are made "online" as one reaches for an object (Fecteau, Chua, Franks, & Enns, 2001; Heath, Neely, Yakimishyn, & Binsted, 2008; Rossetti, 2001).

Dissociations between actions and conscious experience are also evident in compulsions and addiction. For example, though resembling "wanting" because of their repetitive and persistent nature, some addiction-related

behaviors are actually unaccompanied by "liking," that is, by the congruent subjective drives (Berridge & Robinson, 1995). Accordingly, research suggests that subjective cravings do not always predict failures in self-control in addiction and that they may not be the only source of drug abuse (Tiffany & Carter, 1998). Automatic processes may also be at play.

Additional evidence that actions of striking complexity can occur without consciousness is evident in the complex reflexive behaviors of the neonate (Berne, 2006) and in the actions exhibited by nonhuman animals. (For a treatment regarding the presence of consciousness in nonhuman animals, see Gray, 2004.) The behavior of most organisms living today—the fly, the Venus fly trap, and perhaps the alligator and its fellow reptiles—is presumably under the guidance of unconscious control. Ethologists have done a thorough job at cataloging the various kinds of intelligent, animal behaviors that appear to occur in a quasi-automatic manner (Gould, 1982). One need only consider the stereotypic egg-retrieving behavior of the goose, the nest-building behavior of the love bird, and the rabbit pup's reflexive nipple-search behavior in response to maternal odor cues (Montigny, Coureaud, & Schaal, 2006). For example, a caged squirrel seems "sated" after expressing digging behaviors toward a nut even though the nut remains unburied and in plain view (Thorpe, 1964). It remains unclear the degree to which conscious processing is required for these actions (see Gray, 2004).

Unconscious action tendencies are also evident in the classic studies by Benjamin Libet (cf., Libet, 2004). In these experiments, participants are free to make hand movements whenever they choose and are asked only to note when they had made the intention to respond. Libet at the same time was measuring brain activation potentials associated with the instigation of action. This action potential consistently came 200 to 500 milliseconds before the participant's conscious awareness of intending to make the response. (For a related finding involving an even greater span of time, see Soon, Brass, Heinze, & Haynes, 2008.) Current research suggests that the judgment of conscious intention is associated with activity in the presupplementary motor area and the intraparietal sulcus (Berti & Pia, 2006).

In conclusion, there is substantial evidence that complex actions can transpire without conscious mediation. At first glance, these actions are not identifiably less flexible, complex, controlling, deliberative, or action-like than their conscious counterparts (Bargh & Morsella, 2008).

Actions That are Influenced by Stimuli of Which the Subject is Unaware

In an experiment (Logothetis & Schall, 1989), subjects (rhesus monkeys) were trained to "self report" the contents of their conscious experience under conditions of binocular rivalry, a perceptual phenomenon in which visual inputs cannot be resolved into a single percept. In this kind of experiment, subjects are first trained to respond in certain ways when presented with certain visual stimuli (e.g., to button-press when presented with the image of a house). After training, a different visual stimulus is presented to each eye (e.g., an image of a house to one eye and of a tree to the other). Surprisingly, the subject does not consciously perceive both objects (e.g., a tree overlapping a house), but responds as if perceiving only one object at a time (e.g., a house followed by a tree). Each percept occupies consciousness for only a few seconds, even though both images are continuously present and each exerts a nontrivial influence over nervous processing (e.g., activation of the visual system and other brain regions). (For a treatment of the factors that influence the outcome of the visual competition, see Maruya, Yang, & Blake, 2007.) (Interestingly, the self-generated actions [moving a computer mouse] **(p. 339)** of the subject can influence the duration of suppression during rivalry, even when the object being controlled falls outside of visual awareness; Maruya et al., 2007.) At any given moment, the subject is unaware of the computational processes leading to this bizarre "one at a time" outcome and of the systematic influence that the un-experienced percept has upon neural, cognitive, and even emotional processes. For example, emotion-related amygdala activation increases bilaterally in response to fearful versus neutral faces, even when the face was suppressed because of binocular rivalry (Williams et al., 2004).

Similar responses have been expressed toward stimuli that have been rendered imperceptible ("subliminal") through techniques such as backward masking, in which a stimulus (e.g., a word) is presented for a brief duration (17 msec) and is then followed by a pattern mask (e.g., #####). Under such conditions, subjects report that they were unable to perceive the stimulus. It has been shown that subliminal stimuli can still influence motor responses, attention shifts, emotional responses, and semantic processes (Ansorge, Neumann, Becker, Kalberer, & Cruse,

2007), at least to a certain extent. For example, in a choice response time (RT) task, RTs for responses to subliminal (masked) stimuli are the same as those for responses to supraliminal stimuli (Taylor & McCloskey, 1990). In addition, subjects can select the correct motor response (one of two button presses) when confronted with subliminal stimuli, suggesting that "appropriate programs for two separate movements can be simultaneously held ready for use, and that either one can be executed when triggered by specific stimuli without subjective awareness" (Taylor & McCloskey, 1996, p. 62). (See review in Hallett, 2007.)

The Self-Report Paradox

If humans can perform accurate choice-responses to stimuli of which they are unaware, perhaps monkeys in rivalry experiments, too, are unaware of the stimulus to which they respond motorically. The former is regarded as unconscious action, but the latter for some reason is regarded as conscious "self-report." Yet, both tasks are identical in that each involves a perceptual discrimination that is reflected in overt action. Hence, given the backward masking findings mentioned above, we can no longer be sure that the animals were conscious when responding accurately (and as humans do) to the rivalrous stimuli (though there are good arguments, by analogy, that they were; Gray, 2004). We refer to this as the "self-report paradox": In terms of overt behavior and from an objective standpoint, when does a discrimination constitute "self-report"?

Pessiglione et al. (2007) showed an automatic effort-increase effect in response to increases in incentive or reward on a hand-grip exertion task, both when the reward cue (amount of money to be won on that trial) was presented to conscious awareness as when it was presented subliminally. Neurophysiological recordings also show that the same brain regions are invoked whether the goal pursuit is conscious or unconscious (Pessiglione et al., 2007). In addition, some forms of Pavlovian, evaluative, and operant conditioning may occur unconsciously (Duckworth et al., 2002; Field, 2000; Olson & Fazio, 2001; Olsson & Phelps, 2007; Pessiglione et al., 2008). According to Strahan, Spencer, and Zanna (2002), certain action plans (e.g., eating popcorn) can be influenced by subliminal stimuli only when those plans are already motivated (e.g., when one is hungry). Subliminal stimuli can influence behavioral inclinations such as motivation and emotional states (e.g., as indexed by the skin conductance response; Olsson & Phelps, 2007; Pessiglione et al., 2008.)

Actions Prompted by Supraliminal Stimuli That Influence the Subject's Actions in Ways That the Subject is Unaware of

Unconscious Activation of Action Plans through Supraliminal Stimuli

Ambient, supraliminal stimuli in our immediate environment can exert forms of unconscious "stimulus control," leading to unconscious action tendencies. Consistent with this standpoint, findings suggest that incidental stimuli (e.g., hammers) can automatically set us to physically interact with the world (Tucker & Ellis, 2004; see neuroimaging evidence in Grézes & Decety, 2002; Longcamp, Anton, Roth, & Velay, 2005). For example, perceiving a cylinder unconsciously potentiates one's tendency to perform a power grip (see review in Ellis, 2009). In addition, it has been shown that in choice RT tasks, the mere presence of musical notation influences the responses of musicians but not of nonmusicians (Levine, Morsella, & Bargh, 2007; Stewart et al., 2003).

Unconscious action tendencies are readily evident in classic laboratory paradigms such as the Stroop task (Stroop, 1935) and the flanker task (Eriksen & Schultz, 1979). In the Stroop task, participants name the colors in which stimulus words are written. When they are congruous (e.g., RED (p. 340) presented in red), there is little or no interference (see review in MacLeod & MacDonald, 2000). When the word and color are incongruous (e.g., RED presented in blue), participants must suppress the automatic tendency to word read, leading to increased error rates and RTs (Cohen, Dunbar, & McClelland, 1990). In the Eriksen flanker task (Eriksen & Schultz, 1979), participants are first trained to press one button with one finger when presented with the letter S or M and to press another button with another finger when presented with the letters P or H. After training, participants are instructed to respond to targets that are flanked by distracters. For example, they are instructed to respond to the letter presented in the center of an array (e.g., SSPSS) and to disregard the flanking letters (the distracters). In terms of response time and errors, the least interference is found when the distracters are identical to the target (e.g., SSSSS). Interference is greatest when the distracters are associated with responses that are different from those associated with targets (response interference) and is less when they are different in appearance (stimulus

interference) but associated with the same or a similar response. The strong and reliable effect of response interference, reflecting conflict at the response rather than stimulus identification level (van Veen, Cohen, Botvinick, Stenger, & Carter, 2001), suggests that flanking letters can activate response codes to some extent; see Starreveld, Theeuwes, and Mortier (2004). In support of *continuous flow* (Eriksen & Schultz, 1979) and *cascade* (McClelland, 1979; Navarrete & Costa, 2004) models, psychophysiological research shows that, in such response-interference tasks, competition involves simultaneous activation of the brain areas associated with the target- and distracter-related responses (DeSoto, Fabiani, Geary, & Gratton, 2001). This is a case of "activation before selection."

Unconscious Modulation of Behavioral Dispositions through Supraliminal Stimuli

In studies involving supraliminal priming of complex social behavior, it has been demonstrated that many of our complex behaviors occur automatically, determined by causes far removed from our awareness. Behavioral dispositions can be influenced by covert stimuli—when presented with supraliminal words associated with the stereotype "old," people walk slower (Bargh, Chen, & Burrows, 1996); when presented with stimuli associated with the concept "library," people make less noise (Aarts & Dijksterhuis, 2003); and when primed with "hostility," people become more aggressive (Carver, Ganellen, Froming, & Chambers, 1983).

How may such effects take place? It has been documented that merely hearing action verbs pronounced out loud activates the same brain regions as does witnessing a meaningful action (Jeannerod, 1999) and that both events activate the implicit motor representations needed to carry out that type of behavior (Perani et al., 1999). Motor programs thus appear to be part of the very meaning of action-related verbs (Grèzes & Decety, 2002; Pulvermuller, 2005), and this fact is likely responsible for the many successful behavioral priming demonstrations using verbal stimuli. (For the limitations of this "embodied cognition" standpoint, see Mahon & Caramazza, 2008; Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009.) According to Schacter and Badgaiyan (2001), neuroimaging evidence reveals that the priming of a response is then followed by decreased activation in the brain regions associated with processing that response, which presumably reflects more efficient processing of the response.

These effects have been found not only with verbal stimuli that are semantically related to the goal (as in many studies), but also with material objects. For example, backpacks and briefcases prime cooperation and competitiveness, respectively (Kay, Wheeler, Bargh, & Ross, 2004); candy bars prime tempting hedonic goals (Fisbach, Friedman, & Kruglanski, 2003); dollar bills prime greed (Vohs, Mead, & Goode, 2006); scents such as cleaning fluids prime cleanliness goals (Holland, Hendriks, & Aarts, 2005); sitting in a professor's chair primes social behaviors associated with power (Chen, Lee-Chai, & Bargh, 2001; Custers, Maas, Wildenbeest, & Aarts, 2008); control-related words prime the reduction of prejudice (Araya, Akrami, Ekehammar, & Hedlund, 2002); and the names of close relationship partners (e.g., mother, friend) prime the goals that those partners have for the individual as well as those goals the individual characteristically pursues when with the significant other (Fitzsimons & Bargh, 2003; Shah, 2003). In addition, there is evidence that one can unconsciously process task-irrelevant facial expressions (Preston & Stansfield, 2008) and be automatically vigilant toward negative or harmful stimuli (Öhman, Flykt, & Esteves, 2001; Okon-Singer, Tzelgov, & Henik, 2007) or toward undesirable tendencies such as stereotyping (Glaser, 2007). (See Rakison & Derringer, 2008, for evidence that infants possess an inborn, spider-detecting mechanism.)

(p. 341) Regarding the higher mental processes, automatic effects of environmental stimuli were found to drive evaluation (e.g., Fazio, 1990), stereotyping and prejudice (Devine, 1989), social behavior (e.g., Dijksterhuis & van Knippenberg, 1998), and motivated goal pursuit (e.g., Chartrand & Bargh, 1996)—in each case, without any awareness by the individual of the role played by these external stimuli in the production of his or her behavior. (See Sparrow & Wegner, 2006, for demonstrations of behavior-dependent "unpriming.")

Automatic Imitation

Regarding the effects of social stimuli as primes, it has been demonstrated that people automatically imitate the postures, facial expressions, emotional expressions, and speaking styles of others (e.g., Chartrand & Bargh, 1999; Giles, Coupland, & Coupland, 1991; Hatfield, Cacioppo, & Rapson, 1993). Once informed, subjects report that they are unaware that they had engaged in these imitative behaviors. Not only do people tend to adopt the physical

behavior (posture, facial gestures, arm and hand movements) of strangers with whom they interact, without intending to or being aware they are doing so, such unconscious imitation also tends to increase liking and bonding between the individuals—serving as a kind of natural "social glue" (Wiltermuth & Heath, 2009). It has been proposed that automatic imitation is a natural outcome of the basic architecture responsible for perception-to-action mapping (see review in Wilson, 2002).

In neuropsychological populations, imitative response tendencies are displayed dramatically in patients with frontal brain lesions (Brass, Derffuss, Mattes-von Cramon, & von Cramon, 2004). (See Chong, Cunnington, Williams, & Mattingley, 2008, for a treatment of the necessary role of attention in automatic imitation effects.) These automatic imitation effects have been explained by appealing to the notion of *mirror neurons* (Rizzolatti, Sinigaglia, & Anderson, 2008). These neurons become active both when you perceive a given type of action and when you engage in that action yourself (Frith & Wolpert, 2003; Meltzoff & Prinz, 2002). At this high level of encoding, neurons fire with respect to motor acts rather than with respect to the movements that form them. As proposed by several theories (Ashe et al., 1993; Iacoboni & Dapretto, 2006), these neural events seem to be more related to encoding end-state representations, which form part of a "vocabulary" of action representations. In humans, the mirror system encompasses large segments of the premotor cortex and the inferior parietal lobule. Mirror neurons are particularly relevant to "common code" theories of speech perception (e.g., Liberman & Mattingley, 1985). (See Georgopoulos, 2002, regarding shortcomings of the mirror-neuron hypothesis.)

The Difference between Conscious and Unconscious Action Tendencies

In the three sections above, we surveyed the different kinds of unconscious action tendencies that have been well documented in the literature. The mounting evidence leads one to conclude that actions of considerable complexity can transpire even when (a) the actor is unconscious (e.g., automatisms), (b) the actor is conscious but the action is not mediated consciously (e.g., anarchic hand syndrome), (c) the action is influenced or triggered by subliminal stimuli (e.g., backward masking), or (d) the action is influenced by supraliminal stimuli in ways that the actor is unaware of (e.g., supraliminal priming). At first glance, the combined evidence reveals that unconscious actions are not identifiably less flexible, complex, controlling, deliberative, or action-like than their conscious counterparts (Bargh & Morsella, 2008). The principled difference between conscious and unconscious action tendencies is thus less straightforward than what intuition suggests.

Integrated versus Un-integrated Action

Building on a theoretical framework (Morsella, 2005), we propose that the difference between unconscious action and conscious action is that the former is always a case of "un-integrated action," and the latter can be a case of "integrated action." *Integrated action occurs when two (or more) action plans that could normally influence behavior on their own (when existing at that level of activation) are simultaneously co-activated and trying to influence the same skeletal muscle effector.* Thus, integrated action occurs when one holds one's breath, refrains from dropping a hot dish, suppresses the urge to scratch an itch, suppresses a pre-potent response in a laboratory paradigm, or makes oneself breathe faster (Morsella, 2005; Morsella, Krieger, & Bargh, 2009). Suppressing (or over-expressing) a saccade, cough, blink, or some other reflexive behavior is also a case of integrated action. Co-activation can be indexed by behavioral and neural measures; there are several behavioral and neural features that could be used to distinguish integrated from un-integrated action. For example, like any behavior of low strength, (p. 342) conflicted action (a form of integrated action) is easier to perturb than un-conflicted or un-integrated action (Skinner, 1957). Moreover, integrated action is usually accompanied by, or followed by, increases in cognitive control (as in "Gratton effects"; MacLeod & MacDonald, 2000), and it seems to involve the activation of more neural processes than un-integrated action (DeSoto et al., 2001; Ortinski & Meador, 2004).

It is important to note that the level of activation of the plans involved in integrated action is far beyond that of "sub-threshold" activations. For example, in psycholinguistic research, there is substantial evidence that naming "dog" primes the action plan for naming a member of the same category (e.g., "horse"; Levelt, 1989). The level of activation that we are speaking of in our definition of integrated action is far above this threshold—it is at the level of activation at which action plans would not only influence overt action but trigger action.

From this standpoint, conscious mediation is not needed to inhale or withdraw one's hand from a painful stimulus

(e.g., un-integrated action plans *x* and *y* can do these things autonomously; Morsella, 2005), but conscious mediation is necessary to curb these actions through the activation of another action plan. This idea is based on a theory proposing that consciousness is a physical state that establishes a form of "cross-talk" that permits otherwise encapsulated systems to influence (specifically) the skeletal muscle system, collectively and adaptively (Morsella, 2005). From this standpoint, skeletal muscle is the "steering wheel" of systems with different operating principles and phylogenetic histories, actional systems that can cross-talk and be integrated only in virtue of conscious states. (According to the theory, the role of these states is limited to skeletal muscle effectors; see Morsella et al., 2009, for an explanation regarding why smooth muscle effectors are not associated with conscious mediation.)

In addition, this view is consistent with the view that conscious action reflects a rational, reflective process (Block, 1995; Johnson & Reeder, 1997). A hallmark of conscious action is its capacity to take various kinds of information into account (Baars, 2002). The answer is also consistent with the *integration consensus* (Morsella, 2005), in which conscious states bring together diverse forms of information in order to guide action adaptively. Irrational action, on the other hand, seems to operate blindly of such considerations. Accordingly, in disorders and phenomena in which action is decoupled from consciousness (e.g., blindsight, automatisms, tics, spoonerisms, action slips, alien hand syndrome, anarchic hand syndrome, and utilization behavior) actions are perceived as impulsive and often as situationally inappropriate and uncooperative (Chan & Ross, 1997), meaning that they occur without taking other kinds of information into account. Under normal circumstance, such information would activate other action plans that would concurrently modulate overt action. Such co-activation of action plans does not occur when one reflexively looks rightwards, but it does occur when one "voluntarily" looks away from an attention-grabbing stimulus (as in the anti-saccade task; Curtis & D'Esposito, 2003).

Conclusions for Neuroscience: Three Kinds of Binding in the Brain
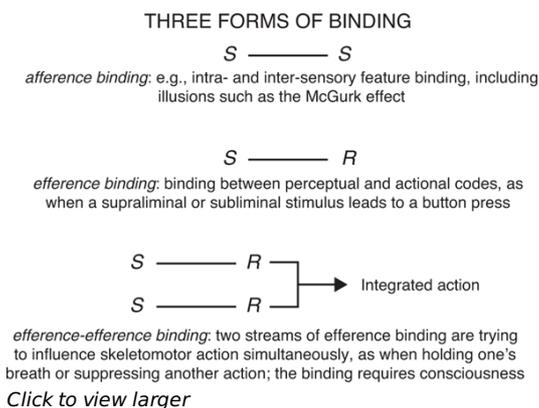

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Fig. 22.1 Three forms of binding in the brain, with only efference-efference binding requiring consciousness. *S* (sensory) signifies "perceptual/afference," and *R* (response) signifies "motor response."

Research on simple actions and on more complex, social actions (e.g., suppressing the tendency to say something) reveals that, in the nervous system, there are three distinct kinds of integration or "binding." *Perceptual binding* (or *afference binding*) is the binding of perceptual processes and representations. This occurs in intersensory binding, as in the McGurk effect, and in intrasensory, feature binding (e.g., the binding of shape to color; Zeki & Bartels, 1999). Another form of binding, linking perceptual processing to action/motor processing, is known as *efference binding* (Haggard, Aschersleben, Gehrke, & Prinz, 2002). This is kind of stimulus-response binding is what allows one to learn to press a button when presented with a cue in a laboratory paradigm. Responding on the basis of efference binding can occur unconsciously. As mentioned above, Taylor and McCloskey (1990) demonstrated that choice response-times for responses to subliminal stimuli were the same as those for responses to supraliminal stimuli. The third kind of binding, *efference-efference binding*, occurs when two streams of efference binding are trying to influence skeletomotor action at the same time. This occurs in the incongruent conditions of interference paradigms, in which stimulus dimensions activate competing action plans. It also occurs when one holds one's breath, suppresses a prepotent response, or experiences another form of conscious conflict (e.g., suppressing an inappropriate impulse in a social setting). In the present framework, it is the instantiation of conflicting efference-efference binding that requires consciousness (Figure 22.1). Consciousness is the "cross-talk" medium that allows such actional processes to influence action collectively. Absent

consciousness, behavior can be influenced by only one of the efference streams, (p. 343) leading to unintegrated actions such as unconsciously inhaling while underwater or reflexively removing one's hand from a hot object, but behavior cannot be "integrated," as when one "voluntarily" avoids checking the time on a wall clock in order to focus on the task at hand.

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Ezequiel Morsella

Ezequiel Morsella is a professor in the Department of Psychology at San Francisco State University and Neurology at University of California, San Francisco in San Francisco, CA.

John A. Bargh

John A. Bargh, Department of Psychology, Yale University.