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Involuntary polymodal imagery involving olfaction, audition, touch, taste, and vision

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ABSTRACT

Percepts and urges often enter consciousness involuntarily. The Reflexive Imagery Task (RIT) reveals how high-level cognitions, too, can enter consciousness involuntarily. In the task, the eliciting stimuli are visual (e.g., picture of a cat), and the involuntary imagery is verbal (e.g., the subvocalization "cat"). The generalizability of the RIT effect has been questioned because verbal imagery is an easily elicited form of imagery. Do such effects arise for other kinds of imagery? It is known that imagery is more elicitable in some senses (e.g., vision) than in other senses (e.g., olfaction). We found such differences in an RIT in which food items were presented as orthographic stimuli or as drawings. Although subjects were instructed to suppress mental imagery, involuntary imagery still arose: Olfactory (effect in ~40% of trials), taste (~54%), touch (~60%), and visual/auditory (~79%). Of theoretical import, effects were comparable when the eliciting stimuli were orthographs or visual objects.

1. Introduction

Percepts and urges often enter consciousness involuntarily. Take, for instance, the following scenario. One is seated at a table, and an apple is placed before one. In such a circumstance, one cannot help but to perceive the apple as red and to desire it, if one is hungry. To the thinker, *conscious contents,*[1] such as the experience of the color red or the urge to eat, often "just happen" (Morsella, Godwin, Jantz, Krieger, & Gazzaley, 2016), despite one's intentions.

The Reflexive Imagery Task (RIT; Allen, Wilkins, Gazzaley, & Morsella, 2013) was developed to investigate how high-level conscious contents can be activated involuntarily by the presence of external stimuli. The paradigm (see review in Bhangal, Cho, Geisler, & Morsella, 2016) is based on a rich research tradition, stemming from the experimental approaches of Ach (1905/1951), Wegner (1989), and Gollwitzer (1999). In the initial, most basic version of the task (Allen et al., 2013), subjects are instructed to not subvocalize (i.e., say in their head but not aloud) the names of objects (e.g., line drawings from Snodgrass & Vanderwart, 1980). Subjects were presented with the instruction, "*Don't Think of the Name of the Object*" before an object was presented for 4 s, during which time subjects indicated by button press if they did happen to subvocalize the name of the object. Subjects failed to suppress such subvocalizations on the majority of the trials (86% in Allen et al., 2013; 87% in Cho, Godwin, Geisler, & Morsella, 2014; and 73% in Merrick, Farnia, Jantz, Gazzaley, & Morsella, 2015). To demonstrate this basic version of the RIT effect, we will momentarily present to you, the reader, an object enclosed within parentheses (as in Allen et al., 2013). Your task is to *not* subvocalize the name of

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[1] A "conscious content" is any thing that one is aware of (Merker, 2007); for example, it might be a color, an urge, or a spontaneous autobiographical memory.

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the object. Here is the stimulus (▲). When presented with these instructions (which induce a certain *action set*) and then presented with this stimulus, most people cannot suppress the conscious experience of the phonological form of the word "triangle."

This RIT effect requires the process of object naming, a sophisticated, multi-stage process in which only one of tens of thousands of phonological representations is selected for production in response to an object (e.g., CAT yields /k/, /œ/, and /t/; Levelt, 1989). After the presentation of the stimulus, the RIT effect arises after a few moments (M = 1451.27 ms [SD = 611.42] in Allen et al., 2013; M = 2323.91 ms [SD = 1183.01] in Cho et al., 2014; M = 1745.97 ms [SD = 620.86] in Merrick et al., 2015). More complex versions of the task have been developed. In one of these versions, RIT effects arose even though the involuntary effect involved a word-manipulation task similar to the childhood game of Pig Latin (e.g., "CAR" becomes "AR-CAY"). In that variant of the RIT (Cho, Zarolia, Gazzaey, & Morsella, 2016), subjects were instructed to not transform stimulus words according to the rule. Despite these instructions, involuntary transformations still arose on more than 40% of the trials. The effect of Cho et al. (2016) is noteworthy because the involuntary transformation of the word stimulus requires symbol manipulation, a complex operation that is known to be associated with the frontal cortex (Miller & Cummings, 2007).

1.1. Validity of subjects' self-reports

Evidence suggests that the RIT effect is both robust and reliable, even though the paradigm relies on the technique of self-report. As is well known, self-reports can be inaccurate as a result of (a) inaccurate memories of fleeting conscious contents (Block, 2007), or (b) subjects basing their reports on a strategy of how to comport oneself during an experiment (see discussion in Morsella et al., 2009). Evidence obtained from studies involving neuroimaging suggests that subjects are not confabulating about the occurrence of these mental events. In these studies, neural activations corroborate what subjects report regarding the occurrence of involuntary conscious contents (Mason et al., 2007; McVay & Kane, 2010; Mitchell et al., 2007; Pasley et al., 2012; Wyland, Kelley, Macrae, Gordon, & Heatherton, 2003). Additional corroboration for subjects' self-reports stems from one variant of the RIT (Cushing, Gazzaley, & Morsella, 2017) in which subjects (a) indicated by button press the basic RIT effect and (b) had to press another button if the involuntary subvocalization happened to rhyme with a word held in mind. Accurate performance (> 80% mean accuracy across trials) on this rhyming task provided evidence that subjects experienced involuntary subvocalizations of the name of the object, for detecting a rhyme requires the retrieval of either the whole object name or, at minimum, the coda of the object name.

1.2. Evidence that the effect resembles a reflex

Empirical evidence and theory (including Wegner's [1994] model of ironic processing[2] see discussion of relationship between Wegner's [1994] model and the RIT in Bhangal et al., 2016) suggest that, for subjects, the effect 'just happens.' The effect does not seem to be an artifact of high-level strategic processes. Hence, in one version of the RIT, subjects reported on the majority of trials that the involuntary subvocalization felt "immediate" (Bhangal, Merrick, & Morsella, 2015). Other evidence supports the notion that the effect is not an artifact of strategic processes. First, on many trials, the effect arises too quickly to be caused by strategic processing (Allen et al., 2013; Cho et al., 2014). Second, the RIT effect still arises under conditions of cognitive load, in which it is difficult for subjects to implement any kind of strategic processing (Cho et al., 2014). Third, the effect habituates (i.e., is less likely to arise) after repeated presentation of the same stimulus object, which suggests that the RIT effect is activated in a reflex-like manner (Bhangal, Allen, Geisler, & Morsella, 2016). (Importantly, this habituation is stimulus-specific: Upon the presentation of a new stimulus, any habituation effect disappears.) Last, the nature of the subvocalizations is influenced systematically by stimulus dimensions such as word frequency (Bhangal et al., 2015): An RIT effect is more likely to arise, and to arise more quickly, for a visual object having a name of high frequency (e.g., DOOR) than for a visual object having a name of low frequency (e.g., KITE). If such an effect were an artifact of experimental demand, then it would require for subjects to know the ways in which the variable of word frequency should influence latencies in an object-naming experiment.

1.3. Mental imagery and the nature of mental representation

The nature of perceptuo-semantic representations underlying mental imagery, including that of the RIT effect, has been the subject of controversy for some time. In "classical," propositional theories of mental representation (see review in Markman & Dietrich, 2000), meaning is instantiated in "amodal" symbols that do not retain any of the properties of the sensorimotor states that gave rise to them: things of all kinds could be represented by binary digits, truth tables, feature lists, frames, schemata, semantic nets,

[2] Ironic effects arise when one is more likely to think about a given thing when attempting to not think about that thing. Wegner (1994) proposes that these effects arise from an interaction between two distinct processes. One process is an *operating* process, which is associated with the conscious intention to maintain a particular mental state. This process actively scans mental contents (e.g., thoughts, sensations) that can help maintain the desired mental state (e.g., to be calm). This process tends to be effortful, capacity-limited, and consciously mediated (Wegner, 1994). The other mechanism is an 'ironic' *monitoring* process that automatically scans activated mental contents to detect contents signaling the failure to establish the desired mental state. When the monitor detects contents that signify failed control of the operating mechanism, it increases the likelihood that the particular content will enter consciousness, so that the operating mechanism can then process the content and change its own operations accordingly. The ironic monitor mechanism is usually unconscious, autonomous, and requires little mental effort. Harmony between the two kinds of processes fails when the goal in mental control is to *not* activate a particular mental content (e.g., content *X*), because (a) the operating process can bring only goal-related contents into consciousness and cannot actively exclude contents, and (b) the ironic monitor will reflexively bring into consciousness mental contents (e.g., content *X*) that are incongruent with the goal. Hence, there will be the automatic activation of content *X* in consciousness. (For reviews of ironic processing and thought suppression, see Rassin, 2005; Wegner, 1989.)