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The Unconscious Allocation of Cognitive Resources to Task-Relevant and Task-Irrelevant Thoughts[1]

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ABSTRACT

Conscious allocation of cognitive resources to task-relevant thoughts is necessary for learning. However, task-irrelevant thoughts often associated with fear of failure can enter the mind and interfere with learning. Effects like this prompt the question of whether or not learners consciously shift their cognitive resources from task-relevant to task-irrelevant thoughts. This review examines the effect of learners' unconscious cognitive and affective processes on their resource allocation. The review concludes by calling for further research into how learners unconsciously allocate cognitive resources to task-relevant and task-irrelevant thoughts.

Keywords: cognitive resources, resource allocation, emotional states, motivation, conscious mind, unconscious mind

A widely recognised determinant of human learning is the processing limitation of working memory in capacity as well as in duration. Due to the limitation, learners cannot all the time allocate their available cognitive resources to the integration of various verbal and pictorial representations, to the reformation of existing knowledge in long-term memory, or to every thought relevant to a cognitive learning task (Baddeley, 2012). Otherwise the working memory capacity will be overloaded or the cognitive resources will be used without making a significant contribution to learning (Mayer & Moreno, 2003). Better learning requires encouraging learners consciously to use the resources for processing task-relevant thoughts (Sweller, Van Merriënboer, & Paas, 1998).

The conscious resource expenditure starts by deliberately paying attention to the task, noticing similarities and differences between words and their particular meanings in relation to relevant prior knowledge in order to build coherent cognitive schemata (Schmidt, 1990). The emphasis on conscious expenditure raises the question as to what extent learners "consciously" use the resources. Do learners unconsciously use resources for processing task-relevant and task-irrelevant thoughts? Task-relevant cognitive or affective thought processes can occur either when the task is the focus of one's conscious attention, indicating conscious thoughts, or when one's conscious attention is directed elsewhere, standing for unconscious thoughts (Dijksterhuis & Nordgren, 2006).

For instance, after not being able consciously to decide between A and B, one might stop thinking about them, but a day later, the correct choice A might pop into consciousness. The transition from indecision to the decision is the result of unconscious thought processes, although the thought itself is consciously incubated (Dijksterhuis, 2004). By contrast with task-relevant thoughts, task-irrelevant ones are any attention-diverting thoughts that increase cognitive load and interfere with task

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performance. Thoughts "about internal states such as those relating to the experience of an emotional state, about irrelevant features of a criterion task, and about any other distractions" (Seibert & Ellis, 1991, p. 508) are examples of task-irrelevant thoughts.

Thoughts of failure concomitantly occurring with one's negative emotional states are not necessarily generated consciously. Affective thought processes act "as the on/off switch to motivation, which is the process by which goal directed behavior is initiated and sustained either consciously or unconsciously" (Moreno, 2010, p. 137). Affective/motivational processing determines how learners perceive a cognitive learning task in terms of the amount of cognitive resource needed to deal with it (Schnotz & Kürschner, 2007). This process can often be formed and activated unconsciously, generating the unconscious evaluation of perceived information and leading to unconscious behaviour (Bargh & Morsella, 2008; Berridge & Winkielman, 2003). Examples of this unconscious behaviour are documented and deserve scrutiny in a considerable number of diverse literatures of psychology, providing neuropsychological, perceptual, cognitive, educational, social, and psychoanalytic perspectives (Gilhooley, 2008; Westen, 1998, 1999).

The relation of unconscious processing to the allocation of cognitive resources for affective/motivational thought processes needs scrutiny because it concerns the issue of how unconscious cognitive and affective processing contributes to educational interventions, facilitating or inhibiting cognitive learning and task performance (Kuldas, Ismail, Hashim, & Bakar, 2013; Schilhab, 2007). Paying attention to this relationship would enhance the understanding of how conscious and unconscious learning occurs and how to benefit from unconscious cognitive and affective processing.

The main purpose of this review is to examine the relation of cognitive and affective/motivational processing with the allocation of cognitive resources to task relevant and task-irrelevant thoughts. First, the review presents a critical discussion about whether conscious learning occurs without help from unconscious learning. Second, the review highlights the benefit of the unconscious cognitive processing system. Third, the review examines whether learners unconsciously allocate their cognitive resources to task-irrelevant thoughts under the motivational effect of their emotional states. Finally, the review draws attention to the unconscious allocation of cognitive resources to task-irrelevant affective thought processes.

Learning and Conscious and Unconscious Cognitive Processing Systems

Learning is conceived as a potential change in human behaviour (Walker, 1996), a permanent change in mental associations (Ormrod, 2006), or a reformation of existing knowledge in long-term memory (Schnotz & Kürschner, 2007). A permanent or potential change in human behaviour occurs as the result of one's conscious or unconscious combination of mental processes, bringing information patterns into the mind, forming the associations, retaining, and using them (Mayer & Moreno, 2003). Although conscious and unconscious acquisition of knowledge can, in a parallel manner, overlap one another (Aizenstein et al., 2004), Sweller and Sweller (2006) contended that better learning occurs when learners are conscious of their learning processes, devoting cognitive resources to task-relevant thoughts.

Conscious learning usually refers to the use of working memory in which all conscious cognitive processing occurs (Paas, Renkl, & Sweller, 2003). Paas and colleagues argued that working memory "can handle only a very limited number, possibly no more than two or three, of novel interacting elements. This number is far below the number of interacting elements that occurs in most substantive areas of human intellectual activity" (p.2). The human cognitive system is capable of storing more information in and retrieving from long-term memory via its unconscious channel than the conscious one (Lewicki, Czyzewska, & Hoffman, 1987). Unlike unconscious processing (Baddeley, 2012), conscious processing is severely limited in duration (processing and maintaining information in a specific time-limit) and in capacity (processing a specific amount of information). Cowan (2001) demonstrated that working memory is capable of processing only two-to-four chunks of novel information at a time for no longer than a few seconds.

Due to the limitations on conscious processing, humans often can be unconscious of how and what they have learnt, coping with the complexity of their learning tasks but unable to explain how they did so (Cleeremans, Destrebecqz, & Boyer, 1998; Lewicki, Hill, & Czyzewska, 1992; Reber, 1989). However, Hammonds (2006) and Shanks and John (1994) have argued that lack of a verbal description of learning does not mean that a person is unaware or unconscious of his learning. That is, verbal expression and awareness should be disassociated. This argument, however, provides no explanation of how to disassociate lack of verbal expression from lack of conscious awareness. Verbal expression requires conscious awareness of how learning occurs (Hartman, Knopman, & Nissen, 1989; Willingham & Goedert-Eschmann, 1999). When learners are unable to explain what or how they have learnt, their learning can be seen as lacking volitional attention and conscious awareness (see Vandekerckhove & Panksepp, 2009).

The research noted in the previous paragraph brings into question the extent to which humans learn by drawing on unconscious processes (obviating the need for conscious awareness, conscious control, conscious intention, or volitional attention). A growing consensus over this question suggests that, using unconscious processing, humans effortlessly perceive and readily access, evaluate, and integrate various visual and verbal patterns of information. They engage in the mental formation of associative links within and between novel and existing information units, thereby forming, retaining, and recalling a goal-directed activity and generate the same outcomes as they would via a conscious goal-directed activity (Bargh & Morsella, 2008; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Custers & Aarts, 2010; Kuldas, Bakar, & Ismail, 2012; Kuldas et al., 2013; Ritter, Van Baaren, & Dijksterhuis, 2012; Scott & Dienes, 2010).

The consensus is that with conscious processing alone humans cannot constantly monitor the interaction between perceptual, cognitive, and emotional information processing stages, and are unable to readily access, recognise, and manipulate each verbal and pictorial pattern of information. A good part of information processing, ranging from haptic, visual, auditory, gustatory, and olfactory processes to speech production is not subject to the intervention of the conscious mind (Kuldas et al., 2012). Perceptual and cognitive processes can spontaneously engage with one another and generate mental images or meanings at any moment through neural activities of human organisms. Related studies have shown that both sides of the brain reflect this engagement, which is unavailable to instantaneous conscious inspection (Berman & Lyons, 2007; Driver, Haggard, & Shallice, 2007; Kosslyn, Ganis, & Thompson, 2001; Pylyshyn, 2003). According to Anderson (2005) and Kosslyn (2005), this engagement can also bring about verbal representations of images.

As Schnotz and Kürschner (2007) have argued, conscious processing should not be reckoned as the only prerequisite for any change to be labelled as learning. A goal-directed cognitive activity, such as text comprehension, decision-making, planning, or problem-solving, is unlikely to operate without some contribution from unconscious processing. Unconscious engagement in encoding, storage, and retrieval processes is inevitable (Anderson, 1992, 2005; Anderson et al., 2004; Henningsen, 2010; Jacoby, Lindsay, & Toth, 1992). This engagement is not less goal-oriented, deliberate, adaptive, or controlling than conscious processing (Aarts & Van Den Bos, 2011; Bargh & Morsella, 2008; Chartrand & Barg, 1996; Custers & Aarts, 2010).

Unconscious cognitive processing is not "dumb" as asserted by Loftus and Klinger (1992). It is structurally and functionally much more sophisticated than the conscious system (Bargh & Morsella, 2008). Drawing upon the system, one can retrieve verbal information from long term memory even when one undergoes a surgical operation during general anaesthesia (see Andrade & Deeprose, 2007; Deeprose & Andrade, 2006; Deeprose, Andrade, Varma, & Edwards, 2004). The possibility of such effortless retrieval leads to the question of how the unconscious processing system can help conscious learning processes.

Benefit of an Unconscious Cognitive Processing System: Automatizing Consciously Acquired Cognitive Schemata

A way benefiting from unconscious processing is the automation of consciously acquired cognitive schemata (encoded, classified, rehearsed, and stored information units with their common features in long-term memory). Better automation happens by encouraging learners, regardless of their levels of expertise, to apply, repeatedly and successfully, the acquired schemata to related cognitive learning tasks (Sweller et al., 1998; Van Merriënboer, Kirschner, & Kester, 2003; Van Merriënboer, Schuurman, De Croock, & Paas, 2002). Once the schemata have been automated, "human cognitive architecture handles complex material that appears to exceed the capacity of working memory" (Paas et al., 2003, p. 2). This reduces cognitive load on working memory (Cooper, Tindall-Ford, Chandler, & Sweller, 2001; Ericsson & Kintsch, 1995; Sweller, 2004), frees working memory capacity for other cognitive activities (Van Merriënboer & Sweller, 2005), thus allowing learners to exert little conscious effort in processing information (Marcus, Cooper, & Sweller, 1996; Sweller et al., 1998; Van Gog et al., 2005; Van Merriënboer & Sweller, 2005).

Working memory limitations do not constrain unduly the processing of automated schemata but do impede the processing of novel or unorganised information. Sweller (2004) noted that: "Whereas there are severe capacity limits to the amount of information from sensory memory that working memory can process, there are no known limits to the amount of information from long-term memory that can be processed by working memory" (p. 13).

To facilitate conscious construction and automation of cognitive schemata, the intention of Cognitive Load Theory is ''to provide guidelines intended to assist in the presentation of information in a manner that encourages learner activities that optimize intellectual performance" (Sweller et al., 1998, p. 25). Using the theory, it makes sense to align instruction about a task with learners' expertise levels, that is, their relatively lower or higher level of prior domain-specific knowledge about the task (Bannert, 2002; Kalyuga, 2011; Paas, Renkl, & Sweller, 2004; Schnotz & Bannert, 2003; Sweller, 2010). This alignment is necessary because "instructional techniques that are highly effective with inexperienced learners can lose their effectiveness and even have negative consequences when used with more experienced learners" (Kalyuga, Ayres, Chandler, & Sweller, 2003, p. 23). This is referred to as the expertise reversal effect (Kalyuga, 2007).

For instance, as learners increase the knowledge necessary for a learning task, the advantages of integrating verbal explanations with static or animated pictorial illustrations disappear. Learners would learn more effectively using pictorial presentations alone because pictorial rather than verbal processing facilitates the construction of mental representations, easing the acquisition and automation of schemata (Chandler & Sweller, 1991; Kalyuga, 2012; Leahy et al., 2003).

According to Lewicki et al. (1987) and Schnotz and Kürschner (2007), consciously acquired and automated knowledge structures free up capacity in working memory. In addition, learners can benefit from their unconsciously learned experiences without being aware of it, particularly for acquisition of conceptual knowledge. The unconscious acquisition and application of knowledge (promptly and continually recognising and producing or priming appropriate responses to stimuli, improving the complexity of perceived information, and identifying and disregarding random elements) is an evolved general property of the human cognitive system. This unconscious function is evolutionarily older than its conscious counterpart, enabling humans to survive before they became active conscious learners (Seger, 1994).

Learning how to speak, how to listen, and how to communicate with others via one's first language (Chomsky, 1986) are examples of unconscious learning, referred to as effortlessly and rapidly acquired, biologically primary knowledge. Humans have gradually evolved to acquire and use this primary knowledge for processing biologically secondary knowledge, such as learning how to write and to read (Geary, 2002; Sweller & Sweller 2006), as well as how to cope with the processes of socialisation and acculturation (Kulkofsky, Wang, & Hou, 2010; Lewicki et al., 1987, 1992; Reber, 1992).

The evolved unconscious function allows perception and manipulation of bulk information that could not be operated consciously. This enables humans to compensate for the limited capacity and duration of conscious processing, and lays the foundation of human learning (Lewicki et al., 1987; Scott & Dienes, 2010). The unconscious "releases the controlled processing from the responsibility of dealing with numerous tasks supporting every act of consciously controlled cognition" (Lewicki et al., 1987, p. 529). This includes speech production, recognising shapes and locations of objects in three-dimensional space, and forming first impressions of an emotional and social stimulus. Calling upon the unconscious system, one can successfully cope with the complexity of cognitive tasks (Lewicki et al. 1992; Dijksterhuis & Nordgren, 2006). In addition, the outcomes of unconscious cognitive activities are more durable in long-term memory and less affected by cognitive insults such as brain injury, amnesia, and dementia (Seger, 1994).

However, the acquisition, reformation, application, or automation of cognitive schemata is unlikely to happen without motivation (Schnotz, 2010; Schnotz, Fries, & Horz, 2009). The extent to which motivation determines the allocation of cognitive resources is a recurring issue in psychological studies (Paas, Tuovinen, Van Merrienboer, & Darabi, 2005). Moreno (2010) calls for more work in this area. Are learners consciously motivated to allocate their resources?

Motivational Effects of Learners' Emotional States on the Conscious Allocation of Cognitive Resources to Task-Relevant Thoughts

Motivational values surrounding a task and its instructional format increase or decrease a learner's motivation level and thereby determining the learner's expenditure of cognitive resources (Paas & Van Merriënboer, 1994). Learners' achievement goals are examples of the connection between motivation and cognition (Fried & Chapman, 2012). A series of related studies concluded that learners allocate resources either to the construction of cognitive schemata to achieve a mastery goal (the goal of long-term durable learning) or to achieve a performance goal (the goal of performing better on a task than others) (e.g., Elliot & Moller, 2003; Linnenbrink, Ryan, & Pintrich, 1999; Linnenbrink & Pintrich, 2002; Pekrun, Elliot, & Maier, 2009; Senko, Hulleman, & Harackiewicz, 2011). Bargh and colleagues (2001) argued that "goals can be triggered outside of awareness and then run to completion, attaining desired outcomes. No conscious intervention, act of will, or guidance is needed for this form of goal pursuit" (p, 1014). They showed that performance goals can become activated without conscious and deliberate choice and these unconscious goals can promote attainment of the desired outcome and persistence in the face of obstacles. They did not have the data to show a similar pattern for mastery goals.

Mastery goals are linked to learners' interest in an area. Because of their heightened interest, learners devote their cognitive resources to the task (Linnenbrink et al., 1999). Unlike learners with low interest in their learning tasks, learners with high interest devote more cognitive resources to these tasks (Renninger, Hidi, & Krapp, 1992; Hidi & Renninger, 2006). Learners are influenced by their beliefs about their ability to complete the task and their level of interest in the task. When learners do not believe they can perform the task successfully, they exert fewer cognitive resources (Weiner, 2000). They allocate more cognitive resources when they believe they are likely to succeed (Wigfield & Eccles, 2000).

Learners bring more than their conscious interests, beliefs, or wants into the learning process (Brewer & Schommer-Aikins, 2006; Henningsen, 2010; Jacoby et al., 1992; Johnson & Hasher, 1987; Kellogg, 1980; Lewicki, 1985; Marks, 1999). They also unconsciously manipulate their wishes, desires, and thoughts (Kavanagh, Andrade, & May, 2005). A person cannot easily avoid the effect of unconscious desires and expectations on conscious thoughts and affective responses, particularly negative affective responses (Bunce, Bernat, Wong, & Shevrin, 1999; Greenwald, 1992; Haggerty, Siefert, & Weinberger, 2010; Schacter, 1992; Wong, Bernat, Bunce, & Shevrin, 1997).

Learners' Negative Emotional States

Learners can allocate significant cognitive resources to processing task-irrelevant thoughts and this interferes with learning. Studies show that learners allocate some of their cognitive resources to worrisome or distracting thoughts about failure and its consequences as well as other task-irrelevant thoughts (e.g., thinking of being somewhere else while taking an exam) (Putwain, Connors, Symes, & Douglas-Osborn, 2012). The allocation of cognitive resources to the avoidance of undesirable consequences increases anxiety levels and leaves fewer cognitive resources to use for task performance (Brophy, 2005; Elliot & McGregor, 1999; Linnenbrink & Pintrich, 2002; Pekrun et al., 2006, 2009; Senko et al., 2011; Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000). Such evidence is congruent with Resource Allocation Theory. This theory is concerned with the effect of negative emotional states on the performance of memory tasks. Negative affective states bring about an increase in task-irrelevant thoughts and thus diminish cognitive resources necessary for performance (Ellis, 1990; Ellis, Moore, Varner, Ottaway, & Becker, 1997; Ellis, Ottaway, Varner, Becker, & Moore, 1997; Ellis, Varner, Becker, & Ottaway, 1995; Kliegel et al., 2005; Seibert & Ellis, 1991). Ellis et al.

(1997) demonstrated that negative emotions (sadness and hopelessness) increased task-irrelevant thoughts, brought more thoughts into conscious processing of memory tasks (learning and recalling letter sequences), diverted attention from the task, and impaired task performance.

Resource allocation theory and cognitive load theory focus for the most part on conscious allocation of cognitive resources. This leaves unclear the question of how learners shift resource allocation from task-relevant thoughts to task-irrelevant thoughts. Do learners consciously allocate their cognitive resources to task-irrelevant thoughts? If they do so, what does conscious learning mean in this case? Learning is not conceived of as a process when learners attend to task-irrelevant thoughts without noticing those thoughts that are relevant (see Schmidt, 1990).

Marland and Edwards (1986) documented through their observation and interviews that learners' emotional states and desires often directed the learners' thought processes and gave rise to the shift from task-relevant to task-irrelevant thoughts. The learners were unaware of how the shifts occurred or how their attention was split. When they became aware of it, they were unable to articulate how the shift happened. Cleeremans et al. (1998) reviewed neuropsychological evidence and theoretical positions for unconscious influences and concluded that learners cannot be conscious of every shift in their learning processes. Conscious acquisition and application of knowledge as well as resource allocation could vary according to levels of expertise, emotional states, motivational factors, learning time, task difficulty, instructional format, and teacher guidance (Schnotz et al., 2009). For example, when performing a difficult task under time pressure (e.g., comprehending a text in an examination), novice learners may be hindered from efficiently applying their prior knowledge to the acquisition of new knowledge (Veenman & Beishuizen, 2004). Possession of prior knowledge does not mean that one has the conscious awareness and control to access that knowledge or to use it in a particular situation.

As Freud (1915/1957, 1938/1964) noted, cognitive processes are often affected by the unconscious interaction within and between one's desires, beliefs, and affects/motives. Freud's assertion of the existence of unconscious affective thought processes is one of the basic propositions of psychoanalysis (Westen, 1999). However, most studies on cognitive learning processes leave little or no room for the unconscious (Gilhooley, 2008). Findings relevant to the proposition, but largely referring to the fields of social psychology and cognitive neuroscience, are presented in the next section.

Unconscious Allocation of Cognitive Resources to Task-Irrelevant Affective Thought Processes: The Unconscious Mind

Whether or not a conscious behaviour is unconsciously initiated is a controversial issue in psychological and philosophical studies (Radder & Meynen, 2013). Recent research on the decision making process (e.g., Libet, 1999; Schlosser, 2012; Soon, Brass, Heinze, & Haynes, 2008) indicated that the unconscious activation of thoughts (urges) precedes their conscious elicitation (deciding to act arises prior to conscious awareness of activated urges). Participants could consciously follow or reject unconsciously elicited urges. Some other findings were relevant to affective thought processes. Emotional stimuli evoked concurrent activations in several cortical areas of the brain; participants showed fear, anger, or disgust without being aware of their affective responses (Siegel & Weinberger, 2009; Weinberger & Westen, 2008; Westen, 2006). One could question whether it is possible to detect initiation of a conscious thought process by neural actives of the brain (see Radder & Meynen, 2013). However, the existence of unconscious cognitive and affective thought processes is hard to refute.

Unconsciously, humans tend to keep desirable thoughts in mind while avoiding undesirable ones. A series of related studies (e.g., Epstein, 1992, 1994; Chen & Bargh, 1999; Salas-Auvert & Felgoise, 2003) demonstrated that humans unconsciously approach making a new decision that is associated with desirable thoughts but avoid an approach when the thoughts are undesirable. Desire-based unconscious behaviour is a basic tenet of the theory of the unconscious (Erdelyi, 2006; Freud, 1915/1957). Research investigating the influence of undesirable thoughts (leading to approach and avoidance behaviour) has provided some support for the theory of the unconscious mind. Conscious behaviour has preliminary unconscious guidance (see Andersen, 1992; Bargh & Morsella, 2008;

Beutel, Stern, & Silbersweig, 2003; Baumeister, 1992; Erdelyi, 2006; Gilhooley, 2008; Mcllwain, 2007; Meissner, 2006, 2008; Westen, 1998, 1999; Westen & Gabbard, 2002a, 2002b).

However, Kihlstrom (1987) argued that research investigating thoughts and behaviours that happen outside conscious awareness and control provides no compelling evidence for the theory of the unconscious mind. According to Kihlstrom (2008), the evidence does not suggest that "the unconscious is a repository of primitive sexual and aggressive instincts. Nor is there any evidence for the idea that mental contents are rendered unconscious by means of a defensive process of repression" (p, 595). Instead, there is evidence for "the cognitive unconscious—cognitive processes that operate automatically and unconsciously, and percepts, memories, knowledge, and thoughts that are inaccessible to phenomenal awareness" (p, 589). Implicit perception, memory, learning, and thoughts comprise the domain of the cognitive unconscious. The cognitive unconscious manipulates information implicitly and associatively. This operation resembles the functions of the unconscious mind (Kihlstrom, 2008). However, Gilhooley (2008) maintained that the cognitive unconscious cannot be easily dissociated from the unconscious mind. Both propose mental processes that operate outside conscious awareness, thereby influencing conscious experience, thought, and behaviour. According to both theories, the human mind can launch and navigate associative memory networks, animating thoughts, beliefs, wishes, and spreading activation to the related functions without conscious awareness and control (Greenwald, 1992; Kihlstrom, Barnhardt, & Tataryn 1992; Westen, 1998, 1999, 2006).

These arguments raise two questions. Are conscious and unconscious perceptual, cognitive, and affective processes mutually exclusive? Is unconscious processing primarily an emotional/motivational, cognitive, or a perceptual phenomenon? Findings suggest dual processing accounts of the human mind: the conscious with a limited capacity to process information, and an unconscious with a relatively unlimited processing capacity (Evans, 2008). The findings point to a distinction between functions described as controlled and automatic (Schneider & Shiffrin, 1977), reflective and impulsive (Strack & Deutsch, 2004), rational and experiential (Epstein, 1994), explicit and implicit (see Reber, 1976), analytic and intuitive (Hammond, 2010), analytic and heuristic (Evans, 2006), analytic and holistic (Nisbett, Peng, Choi, & Norenzayan, 2001), systematic and heuristic (Chen, Duckworth, & Chaiken, 1999), adoptive conscious and adoptive unconscious (Wilson, 2002), and rule based and associative information processing (Sloman, 1996; Smith & DeCoster, 2000).

Another distinction is made in terms of neural activities of the brain. These activities form associations within and between information patterns at the outset and subsequently affect retrieval processes (see Sohn et al., 2005). A further distinction is made in terms of perceptual information processing. There may be an unconscious perceptual defence whereby humans unconsciously suppress or even block some sensory information patterns related to negative events (see McGinnies, 1949; Pratto & John, 1991). A mechanism for blocking or suppressing information is also attributable to the limited conscious capacity for visual information processing. The human mind cannot encode every visual message from simultaneous presentations of multiple visual messages. It has unconsciously to suppress (through suppressive function of sensory information processing) some of the messages in order to encode those messages that can be represented in the conscious mind (Kastner, De Weerd, Desimone, & Ungerleider, 1998; Kastner & Ungerleider, 2000; Reynolds, Chelazzi, & Desimone, 1999). Is it possible that both perceptual and cognitive mechanisms suppress undesirable information patterns, supporting the theory of the unconscious mind? Further investigations would provide more evidence on this matter.

There is evidence that the evocation of associative memory networks guide human behaviour and learning processes outside of conscious awareness. The assertion that the evidence does not support the unconscious mind is inconclusive (Gilhooley, 2008; Westen, 1999, 2006). Unconscious emotional/motivational processing cannot easily be grouped under a single heading of the unconscious mind, but the terms "conscious processes" and "unconscious processes" may be used to refer to such a distinction (Westen, 1999). Evans (2008) suggested using "System 1" (unconscious) and "System 2" (conscious) processes as neutral terms (see Kahneman & Frederick, 2002; Stanovich, 1999).

The perceptual, cognitive, and emotional/motivational functions appear to be sharing the same neural networks. This indicates that they are not mutually exclusive. The functions, sooner or later, work associatively in processing information, and forming and retrieving thoughts (see Ball & Little, 2006; Berntsen & Jacobsen 2008; Mace, 2006). The thought formation and retrieval processes are elementary associative learning processes (see Dienes, 1992). As Westen (1998) explained, conscious goal-directed activity is often accompanied with unconscious associative “memory networks” (e.g., beliefs, wishes, desires, and thoughts) and “unconscious procedures” (e.g., affects, motives, and defences). These unconscious networks and procedures guide human behaviour by activating associated thoughts and emotional states (Kuldas et al., 2012, 2013). This activation brings with it the emotional/motivational influence.

Activated expectations, needs, desires, or fears motivate or demotivate learners. They engage the cognitive resources in learning, facilitating or inhibiting conscious learning. To what extent the emotional/motivational influence inhibits or facilitates learning is a recurring issue in educational and psychological fields. Further examination would cast light on the question of when unconscious processes inhibit or facilitate teaching and learning activities.

Conclusion

This review has collated evidence for the unconscious allocation of cognitive resources to task-relevant and task-irrelevant thoughts. One basic requirement of learning (construction and automation of cognitive schemata) is to tailor instruction to learners’ level of expertise, optimising cognitive load or the use of working memory capacity. The other requirement is to encourage learners consciously to allocate cognitive resources in working memory to task-relevant thoughts. The literature reviewed on the second requirement raises the question of how do learners consciously allocate their resources from task-relevant to task-irrelevant thoughts? Given this process, can learning be viewed solely as a conscious activity?

The literature remains unclear about how affective/motivational thought processes affect conscious allocation. Resource allocation theory and unconscious mind theory provide alternative explanation for how this occurs. How do negative emotional states and unconscious associative memory networks steer learners’ cognitive performance, motivating them to allocate or not to allocate their available cognitive resources to task-relevant thoughts?

The general consensus by researchers on the cognitive, perceptual, and affective/motivational processes of learning is that learners care not always conscious of their learning processes. Further, it may not be desirable solely to be conscious learners. Conscious processing is restricted. Information processing must have an unconscious processing system in addition to the conscious so that humans can react readily to environmental stimuli and learning activities. Research lacks consensus about the main factors that obstruct the conscious allocation of cognitive resources to task-relevant thoughts. Is it cognitive processing capacity alone? On the other hand, are there unconscious associative memory networks (wishes, beliefs, and thoughts) and unconscious procedures (motives, defences, and emotions) at play? The theory of the unconscious mind suggests that both sensory organs and the unconscious mind prevent some information from entering the conscious mind. Other perspectives point out the constraints of cognitive capacity. Notwithstanding a lack of consensus, there is evidence that unconscious cognitive processing reduces the expenditure of limited cognitive resources on completing a task.

To conclude, learners need unconscious cognitive and affective processing as much as they need their conscious counterparts. Further studies are required to examine how learners might benefit from the unconscious cognitive and affective/motivational processing systems. Without the unconscious, humans can respond only to a fraction of the information that enters their system via sight, hearing, taste, smell, and touch. With unconscious processing, they can find an association or disassociation within and between various patterns of information and then generate conscious responses. Neither conscious nor unconscious processing always facilitates learning. Either method of processing may impede learning especially when there are time constraints, a high level of uncertainty, or strong emotional/motivational factors at play.

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REFERENCES

Aarts, H., & Van Den Bos, K. (2011). On the foundations of beliefs in free will intentional binding and unconscious priming in self-agency. *Psychological Science, 22*, 532-537. doi:10.1177/0956797611399294

Aizenstein, H. J., Stenger, V. A., Cochran, J., Clark, K., Johnson, M., Robert, D., & Carter, C. S. (2004). Regional brain activation during concurrent implicit and explicit sequence learning. *Cerebral Cortex, 14*, 199-208. doi:10.1093/cercor/bhg119

Andersen, S. M. (1992). Toward a psychodynamically relevant empirical science. *Psychological Inquiry, 3*, 14-21. doi:10.1207/s15327965pli0301_2

Anderson, J. R. (1992). Automaticity and the ACT* theory. *American Journal of Psychology, 105,* 165-180. Retrieved from http://www.jstor.org/stable/1423026

Anderson, J. R. (2005). Human symbol manipulation within an integrated cognitive architecture. *Cognitive Science, 29*, 313-341.

Anderson, J. R., Bothell, D., Byrne, M. D., Douglass, S., Lebiere, C., & Qin, Y. (2004). An integrated theory of the mind. *Psychological Review, 111*, 1036-1060. doi:10.1037/0033-295X.111.4.1036

Andrade, J., & Deeprose, C. (2007). Unconscious memory formation during anaesthesia. *Best Practice & Research Clinical Anaesthesiology, 21*, 385-401. doi:10.1016/j.bpa.2007.04.007

Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology, 63*, 1-29. doi: 10.1146/annurev-psych-120710-100422

Ball, C. T., & Little, J. R. (2006). A comparison of involuntary memory retrievals. *Applied Cognitive Psychology, 20,* 1167-1179. doi:10.1002/acp.1264

Bannert, M. (2002). Managing cognitive load–recent trends in cognitive load theory. *Learning and Instruction, 12,* 139-146. doi:10.1016/S0959-4752(01)00021-4

Bargh, J. A., & Morsella, E. (2008). The unconscious mind. *Perspectives in Psychological Science, 3,* 73-79. doi:10.1111/j.1745-6916.2008.00064.x

Bargh, J. A., Gollwitzer, P. M., Lee-Chai, A., Barndollar, K., & Trötschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81*, 1014-1027. doi:10.1037/0022-3514.81.6.1014

Baumeister, R. F. (1992). Neglected aspects of self-theory: motivation, interpersonal aspects, culture, escape, and existential value. *Psychological Inquiry, 3,* 21-25. doi:10.1207/s15327965pli0301_3

Berntsen, D., & Jacobsen, A. S. (2008). Involuntary (spontaneous) mental time travel into the past and future. *Consciousness and Cognition, 17*, 1093-1104. doi:10.1016/j.concog.2008.03.001

Beutel, M. E., Stern, E., & Silbersweig, D. A. (2003). The emerging dialogue between psychoanalysis and neuroscience: Neuroimaging perspectives. *Journal of the American Psychoanalytic Association, 51,* 773-801. doi:10.1177/00030651030510030101

Berman, D., & Lyons, W. (2007). The first modern battle for consciousness: J. B. Watson's rejection of mental images. *Journal of Consciousness Studies, 14,* 4-26. Retrieved from http://www.imprint.co.uk/jcs_14_11.html

Berridge, K. C, & Winkielman, P. (2003). What is an unconscious emotion? *Cognition and Emotion, 17*, 181-211. doi:10.1080/02699930302289

Brewer, W. F., & Schommer-Aikins, M. (2006). Scientists are not deficient in mental imagery: Galton revised. *Review of General Psychology, 10*, 130-146. doi:10.1037/1089-2680.10.2.130

Brophy, J. (2005). Goal theorists should move on from performance goals. *Educational Psychologist, 40*, 167-176. doi:10.1207/s15326985ep4003_3

Bunce, S. C., Bernat, E., Wong, P. S., & Shevrin, H. (1999). Further evidence for unconscious learning: Preliminary support for the conditioning of facial EMG to subliminal stimuli. *Journal of Psychiatric Research, 33*, 341-347. doi:10.1016/S0022-3956(99)00003-5

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences, 24*, 87-114. doi:10.1017/S0140525X01003922

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction, 8*, 293-332. doi:10.1207/s1532690xci0804_2

Chartrand, T. L., & Bargh, J. A. (1996). Automatic activation of impression formation and memorization goals: Nonconscious goal priming reproduces effects of explicit task instructions. *Journal of Personality and Social Psychology, 71*, 464-478. doi:10.1037/0022-3514.71.3.464

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin, 25*, 215-224. doi:10.1177/0146167299025002007

Chen, S., Duckworth, K., & Chaiken, S. (1999). Motivated heuristic and systematic processing. *Psychological Inquiry, 10*, 44-49. doi:10.1207/s15327965pli1001_6

Chomsky, N. (1986). *Knowledge of language: Its nature, origin, and use*. New York: Praeger.

Cleeremans, A., Destrebecqz, A., & Boyer, M. (1998). Implicit learning: News from the front. *Trends in Cognitive Sciences, 2,* 406-416. doi:10.1016/S1364-6613(98)01232-7

Custers, R., & Aarts, H. (2010). The unconscious will: How the pursuit of goals operates outside of conscious awareness. *Science, 329,* 47-50. doi:10.1126/science.1188595

Cooper, G., Tindall-Ford, S., Chandler, P., & Sweller, J. (2001). Learning by imagining. *Learning of Experimental Psychology: Applied, 7,* 68-82. doi:10.1037/1076-898X.7.1.68

Deeprose, C., & Andrade, J. (2006). Is priming during anesthesia unconscious? *Consciousness and Cognition, 15,* 1-23. doi:10.1016/j.concog.2005.05.003

Deeprose, C., Andrade, J., Varma, S., & Edwards, N. (2004). Unconscious learning during surgery with propofol anaesthesia. *British Journal of Anaesthesia, 92,* 171-177. doi:10.1093/bja/aeh054

Dennett, D. C. (2002). Does your brain use the images in it, and if so, how? *Behavioral and Brain Sciences, 25,* 189-190. doi:10.1017/S0140525X02290044

Dienes, Z. (1992). Connectionist and memory-array models of artificial grammar learning. *Cognitive Science, 16,* 41-79. doi:10.1016/0364-0213(92)90017-O

Dijksterhuis, A. (2004). Think different: The merits of unconscious thought in preference development and decision making. *Journal of Personality and Social Psychology, 87,* 586–598. doi:10.1037/0022-3514.87.5.586

Dijksterhuis, A., & Nordgren, L. F. (2006). A theory of unconscious thought. *Perspectives on Psychological Science, 1,* 95-109. doi:10.1111/j.1745-6916.2006.00007.x

Driver, J., Haggard, P., & Shallice, T. (2007). Introduction. Mental processes in the human brain. *Philosophical Transactions of the Royal Society, B 362,* 757-760. doi:10.1098/rstb.2007.2085

Elliot, A. J., & McGregor, H. A. (1999). Test anxiety and the hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 76,* 628-644. doi:10.1037/0022-3514.76.4.628

Elliot, A. J., & Moller, A. C. (2003). Performance-approach goals: Good or bad forms of regulation? *International Journal of Educational Research, 39,* 339-356. doi.org/10.1016/j.ijer.2004.06.003

Ellis, H. C. (1990). Depressive deficits in memory: Processing initiative and resource allocation. *Journal of Experimental Psychology: General, 119*, 60-62. doi:10.1037/0096-3445.119.1.60

Ellis, H. C., Moore, B. A., Varner, L. J., & Ottaway, S. A., Becker, A. S. (1997). Depressed mood, task organization, cognitive interference, and memory: Irrelevant thoughts predict recall performance. *Journal of Social Behavior & Personality, 12*, 453-470.

Ellis, H. C., Ottaway, S. A., Varner, L. J., Becker, A. S., & Moore, B. A. (1997). Emotion, motivation, and text comprehension: The detection of contradictions in passages. *Journal of Experimental Psychology: General, 126,* 131-146. doi:10.1037/0096-3445.126.2.131

Ellis, H. C., Varner, L. J., Becker, A. S., & Ottaway, S. A. (1995). Emotion and prior knowledge in memory and judged comprehension of ambiguous stories. *Cognition & Emotion, 9,* 363-382. doi:10.1080/02699939508408972

Epstein, S. (1992). Coping ability, negative self-evaluation, and overgeneralization: Experiment and theory. *Journal of Personality and Social Psychology, 62*, 826-836. doi:10.1037/0022-3514.62.5.826

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American Psychologist, 49,* 709-724. doi:10.1037/0003-066X.49.8.709

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211-245. doi:10.1037/0033-295X.102.2.211

Erdelyi, M. H. (1974). A new look at the new look: Perceptual defense and vigilance. *Psychological Review, 81(1),* 1-25. doi:10.1037/h0035852

Erdelyi, M. H. (2006). The unified theory of repression. *Behavioral and Brain Sciences, 29,* 499-551. doi:10.1017/S0140525X06009113

Evans, J. St. B. T. (2006). The heuristic-analytic theory of reasoning: Extension and evaluation. *Psychonomic Bulltein & Review, 13*, 378-95

Evans, J. St. B. T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology, 59*, 255-278.

Freud, S. (1957). The unconscious. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 14, pp. 159-216). London: The Hogarth Press and the Institute of Psycho-analysis. Retrieved from http://www.pep-web.org/document.php?id=se.014.0000a (Original work published 1915)

Freud, S. (1964). An outline of psycho-analysis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 23, pp. 139-291). London: The Hogarth Press and the Institute of Psycho-analysis. Retrieved from http://www.pep-web.org/document.php?id=se.023.0139a#p0141 (Original work published 1938)

Fried, L., & Chapman, E. (2012). An investigation into the capacity of student motivation and emotion regulation strategies to predict engagement and resilience in the middle school classroom. *The Australian Educational Researcher,* 1-17. doi:10.1007/s13384-011-0049-1

Geary, D. C. (2000). Principles of evolutionary educational psychology. *Learning and Individual Differences*, *12*, 317-345. doi:10.1016/S1041-6080(02)00046-8

Gilhooley, D. (2008). Psychoanalysis and the cognitive unconscious: Implications for clinical technique. *Modern Psychoanalysis, 33*, 91-127.

Greenwald, A. G. (1992). New look 3: Unconscious cognition reclaimed. American Psychologist, 47, 766-779.

Haggerty, G. D., Siefert, C. J., & Weinberger, J. (2010). Examining the relationship between current attachment status and freely recalled autobiographical memories of childhood. *Psychoanalytic Psychology, 27*, 27-41. doi:10.1037/a0018638

Hammond, K. R. (2010). Intuition, No!… Quasirationality, Yes! *Psychological Inquiry, 21*, 327-337. doi:10.1080/1047840X.2010.521483

Hammonds, F. (2006). Toward an “awareness” of the relationship between task performance and own verbal accounts of that performance. *The Analysis of Verbal Behavior, 22,* 101-110. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2774592/

Hartman, M., Knopman, D. S., & Nissen, M. J. (1989). Implicit learning of new verbal associations. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 1070-1082. doi:10.1037/0278-7393.15.6.1070

Hegarty, M., & Just, M. A. (1993). Constructing mental models of machines from text and diagrams. *Journal of Memory and Language, 32,* 717-742. doi.org/10.1006/jmla.1993.1036

Henningsen, H. P. (2010). How the NETofANs-model explains representation, intentionality, and much of the process that generates the contents of awareness. *Neurocomputing, 74*, 57-75. doi:10.1016/j.neucom.2009.10.032

Hidi, S., & Renninger, K. A. (2006). A four-phase model of interest development. *Educational Psychologist, 41*, 111-127. doi:10.1207/s15326985ep4102_4

Jacoby, L. L., Lindsay, D. S., & Toth, J. P. (1992). Unconscious influences revealed: Attention, awareness, and control. *American Psychologist, 47,* 802-809. doi:10.1037/0003-066X.47.6.802

Johnson, M. K., & Hasher, L. (1987). Human learning and memory. *Annual Review of Psychology, 38,* 631-668. doi:10.1146/annurev.ps.38.020187.003215

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *heuristics & biases: The psychology of intuitive judgment* (pp. 49-81). New York. Cambridge University Press.

Kavanagh, D. J., Andrade, J., & May, J. (2005). Imaginary relish and exquisite torture: The elaborated intrusion theory of desire. *Psychological Review, 112*, 446–467. doi:10.1037/0033-295X.112.2.446

Kalyuga, S. (2007). Expertise reversal effect and its implications for learner-tailored instruction. *Educational Psychology Review, 19*, 509-539. doi:10.1007/s10648-007-9054-3
Kalyuga, S. (2011).Cognitive load theory: How many types of load does it really need? *Educational Psychology Review, 23*, 1-19. doi:10.1007/s10648-010-9150-7
Kalyuga, S. (2012). Instructional benefits of spoken words: A review of cognitive load factors. *Educational Research Review, 7*, 145-159. doi:10.1016/j.edurev.2011.12.002
Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist, 38*, 23-31. doi:10.1207/S15326985EP3801_4
Kastner, S., & Ungerleider, L. G. (2000). Mechanisms of visual attention in the human cortex. *Annual Review of Neuroscience, 23*, 315-341. doi:10.1146/annurev.neuro.23.1.315
Kastner, S., De Weerd, P., Desimone, R., & Ungerleider, L. G. (1998). Mechanisms of directed attention in the human extrastriate cortex as revealed by functional MRI. *Science, 282*, 108-111. doi:10.1126/science.282.5386.108
Kellogg, R. T. (1980). Is conscious attention necessary for long-term storage? *Journal of Experimental Psychology: Human Learning and Memory, 6*, 379-390. doi:10.1037/0278-7393.6.4.379
Kliegel, M., Jäger, T., Phillips, L. H., Federspiel, E., Imfeld, A., Keller, M., & Zimprich, D. (2005). Effects of sad mood on time-based prospective memory. *Cognition & Emotion, 19*, 1199-1213. doi:10.1080/02699930500233820
Kihlstrom, J. F. (1987). The cognitive unconscious. *Science, 237*, 1445-1452. doi:10.1126/science.3629249
Kihlstrom, J. F. (2008). The psychological unconscious. In O. P. John, R. Robins & L. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed., pp. 583-602). New York: Guilford.
Kihlstrom, J. F., Barnhardt, T. M., & Tataryn, D. J. (1992). The psychological unconscious: Found, lost, and regained. *American Psychologist, 47*, 788-791. doi:10.1037/0003-066X.47.6.788
Kosslyn, S. M. (2005). Mental images and the brain. *Cognitive Neuropsychology, 22*, 333-347. doi:10.1080/02643290442000130
Kosslyn, S. M., Ganis, G., & Thompson, W. L. (2001). Neural foundations of imagery. Nature reviews: *Neuroscience, 2*, 635-642. doi:10.1038/35090055
Kuldas, S., Bakar, A. Z., & Ismail, H. N. (2012). The role of unconscious information processing in the acquisition and learning of instructional messages. *Electronic Journal of Research in Educational Psychology, 10*, 907-940.
Kuldas, S., Ismail, H. N., Hashim, S., & Bakar, Z. A. (2013). Unconscious learning processes: Mental integration of verbal and pictorial instructional materials. *SpringerPlus, 2*(1), 105. doi:10.1186/2193-1801-2-105
Kulkofsky, S., Wang, Q., & Hou, Y. (2010). Why I remember that: The influence of contextual factors on beliefs about everyday memory. *Memory & Cognition, 38*, 461-473. doi:10.3758/MC.38.4.461
Leahy, W., Chandler, P., & Sweller, J. (2003). When auditory presentations should and should not be a component of multimedia instruction. *Applied Cognitive Psychology, 17*, 401-418. doi:10.1002/acp.877
Lewicki, P. (1985). Nonconscious biasing effects of single instances on subsequent judgments. *Journal of Personality and Social Psychology, 48*, 563-574. doi:10.1037/0022-3514.48.3.563
Lewicki, P., Czyzewska, M., & Hoffman, H. (1987). Unconscious acquisition of complex procedural knowledge. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*, 523-530. doi:10.1037/0278-7393.13.4.523
Lewicki, P., Hill, T., & Czyzewska, M. (1992). Nonconscious acquisition of information. *American Psychologist, 47*, 796-801. doi:10.1037/0003-066X.47.6.796
Libet, B. (1999). Do we have free will? *Journal of Consciousness Studies, 6*, 47–57.
Linnenbrink, E. A., & Pintrich, P. (2002). The role of motivational beliefs in conceptual change. M. Limon & L. Mason (2002), *Reconsidering conceptual change: Issues in theory and practice* (pp. 115-135). Netherlands: Springer. doi:10.1007/0-306-47637-1_6
Linnenbrink, E. A., Ryan, A. M., & Pintrich, P. R. (1999). The role of goals and affect in working memory functioning. *Learning and Individual Differences, 11*, 213-230. doi:10.1016/S1041-6080(00)80006-0
Loftus, E. F., & Klinger, M. R. (1992). Is the unconscious smart or dumb? *American Psychologist, 47*, 761-765. doi:10.1037/0003-066X.47.6.761

Mace, J. H. (2006). Episodic remembering creates access to involuntary conscious memory: Demonstrating involuntary recall on a voluntary recall task. *Memory, 14*, 217-224. doi:10.1080/09658210600759766

Marcus, N., Cooper, M., & Sweller, J. (1996). Understanding instructions. *Journal of Educational Psychology, 88*, 49-63. doi:10.1037/0022-0663.88.1.49

Marks, D. F. (1999). Consciousness, mental imagery and action. *British Journal of Psychology, 90*, 567-585. doi:10.1348/000712699161639

Marland, P. W., & Edwards, J. (1986). Students' in-class thinking. *Instructional Science, 15*, 75-88. doi:10.1007/BF00139605

Mayer, R. E. (2003). The promise of multimedia learning: Using the same instructional design methods across different media. *Learning and Instruction, 13*, 125-139. doi:10.1016/S0959-4752(02)00016-6

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*, 43-52. doi:10.1207/S15326985EP3801_6

Mayer, R. E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal of Educational Psychology, 93*, 187-198. doi:10.1037/0022-0663.93.1.187

McGinnies, E. (1949). Emotionality and perceptual defence. *Psychological Review, 56*, 244-251. doi:10.1037/h0056508

Mcllwain, D. (2007). Special Section: Rezoning pleasure drives and affects in personality theory. *Theory & Psychology, 17*, 529-561. doi: 10.1177/0959354307079303

Meissner, W. W. (2006). Psychoanalysis and the Mind-Body Relation: Psychosomatic Perspectives. *Bulletin of the Menninger Clinic, 70*, 295-315. doi:10.1521/bumc.2006.70.4.295

Meissner, W. W. (2008). Mind-brain and consciousness in psychoanalysis. *Bulletin of the Menninger Clinic, 72*, 283-312. doi:10.1521/bumc.2008.72.4.283

Moreno, R. (2010). Cognitive load theory: More food for thought. *Instructional Science, 38*, 135-141. doi:10.1007/s11251-009-9122-9

Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: holistic versus analytic cognition. *Psychological Review, 108*, 291- 310. doi:10.1037/0033-295X.108.2.291

Ormrod, J. E. (2006). *Educational psychology* (7th ed.). Upper Saddle River, NJ: Merrill Prentice-Hall.

Paas, F., & Van Merriënboer, J. J. G. (1994). Variability of worked examples and transfer of geometrical problem-solving skills: A cognitive-load approach. *Journal of Educational Psychology, 86*, 122-133. doi:10.1037/0022-0663.86.1.122

Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist*, *38*, 1-4. doi:10.1207/S15326985EP3801_1

Paas, F., Renkl, A., & Sweller, J. (2004). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science, 32*, 1-8, doi:10.1023/B:TRUC.0000021806.17516.d0

Paas, F., Tuovinen, J. E., Van Merrienboer, J. J. G, & Darabi, A. A. (2005). A motivational perspective on the relation between mental effort and performance: Optimizing learner involvement in instruction. *Educational Technology Research and Development, 53*, 25-34. doi:10.1007/BF02504795

Pekrun, R., Elliot, A. J., & Maier, M. A. (2006). Achievement goals and discrete achievement emotions: A theoretical model and prospective test. *Journal of Educational Psychology, 98*, 583-597. doi:10.1037/0022-0663.98.3.583

Pekrun, R., Elliot, A. J., & Maier, M. A. (2009). Achievement goals and achievement emotions: Testing a model of their joint relations with academic performance. *Journal of Educational Psychology, 101*, 115-135. doi:10.1037/a0013383

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61*, 380-391. doi:10.1037/0022-3514.61.3.380

Pylyshyn, Z. W. (2003). Explaining mental imagery: Now you see it, now you don’t. *Trends in Cognitive Sciences*, *7*, 111-112. doi:10.1016/S1364-6613(03)00004-4

Putwain, D. W., Connors, L., Symes, W., & Douglas-Osborn, E. (2012). Is academic buoyancy anything more than adaptive coping? *Anxiety, Stress & Coping*, *25*, 349-358. doi:10.1080/10615806.2011.582459

Radder, H., & Meynen, G. (2013). Does the brain "initiate" freely willed processes? A philosophy of science critique of Libet-type experiments and their interpretation. *Theory & Psychology*, *23*, 3-21. doi:10.1177/0959354312460926

Reber, A. S. (1976). Implicit learning of synthetic languages: The role of instructional set. *Journal of Experimental Psychology: Human Learning and Memory, 2*, 88-94. doi:10.1037/0278-7393.2.1.88

Reber, A. S. (1989). Implicit learning and tacit knowledge. *Journal of Experimental Psychology: General, 118*, 219-235. doi:10.1037/0278-7393.2.1.88

Reber, A. S. (1992). An evolutionary context for the cognitive unconscious. *Philosophical Psychology*, *5*, 33-51. doi:10.1080/09515089208573042

Renninger, A., Hidi, S., & Krapp, A. (1992). *The role of interest in learning and development*. Mahwah, NJ: Erlbaum.

Reynolds, J. H., Chelazzi, L., & Desimone, R. (1999). Competitive mechanisms subserve attention in macaque areas V2 and V4. *The Journal of Neuroscience, 19*, 1736-1753. Retrieved from http://www.jneurosci.org/content/19/5/1736.full.pdf+html

Ritter, S. M., Van Baaren, R. B., & Dijksterhuis, A. (2012). Creativity: The role of unconscious processes in idea generation and idea selection. *Thinking Skills and Creativity, 7*, 21-27. doi:10.1016/j.tsc.2011.12.002

Salas-Auvert, J. A., & Felgoise, S. H. (2003). The rational-experiential information processing system model: It's implication for cognitive therapy. *International Journal of Clinical and Health Psychology*, *3*, 123-140. Retrieved from http://www.aepc.es/ijchp/articulos_pdf/ijchp-64.pdf

Schacter, D. L. (1992). Understanding implicit memory: A cognitive neuroscience approach. *American Psychologist*, *47*, 559-569. doi:10.1037/0003-066X.47.4.559

Seibert, P. S., & Ellis, H. C. (1991). Irrelevant thoughts, emotional mood states, and cognitive task performance. *Memory & Cognition*, *19*, 507-513. doi:10.3758/BF03199574

Schilhab, T. S. S. (2007). Knowledge for Real: On implicit and explicit representations and education. *Scandinavian Journal of Educational Research, 51*, 223-238. doi:10.1080/00313830701356034

Schlosser, M. E. (2012). Free will and the unconscious precursors of choice. *Philosophical Psychology, 25*, 365-384. doi:10.1080/09515089.2011.622366

Schmidt, R. W. (1990). The role of consciousness in second language learning. *Applied linguistics*, *11*, 129-158. doi:10.1093/applin/11.2.129

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human processing: I. detection, search and attention. *Psychological Review, 84*, 1-66. doi:10.1037/0033-295X.84.1.1

Schnotz, W. (2010). Reanalyzing the expertise reversal effect. *Instructional Science, 38*, 315-323. doi:10.1007/s11251-009-9104-y

Schnotz, W., & Bannert, M. (2003). Construction and interference in learning from multiple representation. *Learning and Instruction*, *13*, 141-156. doi:10.1016/S0959-4752(02)00017-8

Schnotz, W., & Kürschner, C. (2007). A reconsideration of cognitive load theory. *Educational Psychological Review, 19*, 469-508. doi:10.1007/s10648-007-9053-4

Schnotz, W., Fries, S., & Horz, H. (2009). Motivational aspects of cognitive load theory. In M. Wosnitza, S. A. Karabenick, A. Efklides, & P. Nenniger (Eds.), *Contemporary motivation research: From global to local perspectives* (pp. 69–96). New York: Hogrefe & Huber.

Scott, R. B., & Dienes, Z. (2010). Knowledge applied to new domains: The unconscious succeeds where the conscious fails. *Consciousness and Cognition, 19*, 391–398. doi:10.1016/j.concog.2009.11.009

Seger, C. (1994). Implicit learning. *Psychological Bulletin, 115*, 163–196. doi:10.1037/0033-2909.115.2.163

Senko, C., Hulleman, C. S., & Harackiewicz, J. M. (2011). Achievement goal theory at the crossroads: Old controversies, current challenges, and new directions. *Educational Psychologist, 46*, 1, 26-47. doi:10.1080/00461520.2011.538646

Shanks, D. R., & St John, M. F. (1994). Characteristics of dissociable human learning systems. *Behavioral and Brain Sciences*, *17*, 367-447. doi:10.1017/S0140525X00035032

Siegel, P., & Weinberger, J. (2009). Very brief exposure: The effects of unreportable stimuli on fearful behavior. *Consciousness and Cognition, 18,* 939-951. doi:10.1016/j.concog.2009.08.001

Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin, 119,* 3-22

Smith, E. R., & DeCoster, J. (2000). Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. *Personality and social psychology review*, *4,* 108-131. doi:10.1207/S15327957PSPR0402_01

Soon, C. S., Brass, M., Heinze, H. J., & Haynes, J. D. (2008). Unconscious determinants of free decisions in the human brain. *Nature Neuroscience*, *11*, 543-545. doi:10.1038/nn.2112

Sohn, M. H., Goode. A., Stenger, V. A., Jung, K. J., Carter, C. S., & Anderson, J. R. (2005). An information-processing model of three cortical regions: Evidence in episodic memory retrieval. *NeuroImage, 25*, 21-33. doi:10.1016/j.neuroimage.2004.11.001

Stanovich, K. E. (1999). *Who is rational? Studies of individual differences in reasoning*. Mahwah, NJ: Elrbaum

Steele-Johnson, D., Beauregard, R. S., Hoover, P. B., & Schmidt, A. M. (2000). Goal orientation and task demand effects on motivation, affect, and performance. *Journal of Applied Psychology, 85*, 724–738. doi:10.1037/0021-9010.85.5.724

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8,* 220-247. doi:10.1207/s15327957pspr0803_1

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Instructional Science, 32,* 9-31. doi:10.1023/B:TRUC.0000021808.72598.

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review, 22,* 123-138. doi:10.1007/s10648-010-9128-5

Sweller, J., & Sweller, S. (2006). Natural information processing systems. *Evolutionary Psychology, 4*, 434-458.

Sweller, J., Van Merriënboer, J., & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*, 251-296. doi:10.1023/A:1022193728205

Tindall-Ford, S., Chandler, P., & Sweller, J. (1997). When two sensory modes are better than one. *Journal of Experimental Psychology: Applied, 3*, 257-287. doi:10.1037/1076-898X.3.4.257

Vandekerckhove, M., & Panksepp, J. (2009). The flow of anoetic to noetic and autonoetic consciousness: A vision of unknowing (anoetic) and knowing (noetic) consciousness in the remembrance of things past and imagined futures. *Consciousness and Cognition, 18*, 1018-1028.

Van Gog, T., Ericsson, K. A., Rikers, R. M. J. P., & Paas, F. (2005). Instructional design for advanced learners: Establishing connections between the theoretical frameworks of cognitive load and deliberate practice. *Educational Technology Research and Development, 53,* 73-81. doi:10.1007/BF02504799

Van Merriënboer, J. J. G., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review, 17*, 147–177. doi:10.1007/s10648-005-3951-0

Van Merriënboer, J. J. G., Kirschner, P. A., & Kester, L. (2003). Taking the load off a learner's mind: Instructional design for complex learning. *Educational Psychologist, 38,* 5-13. doi:10.1207/S15326985EP3801_2

Van Merriënboer, J. J. G., Schuurman, J. G., De Croock, M. B. M., & Paas, F. (2002). Redirecting learners' attention during training: Effects on cognitive load, transfer test performance and training efficiency. *Learning and Instruction*, *12,* 11-37. doi:10.1016/S0959-4752(01)00020-2

Veenman, M. V. J., & Beishuizen, J. J. (2004). Intellectual and metacognitive skills of novices while studying texts under conditions of text difficulty and time constraint. *Learning and Instruction, 14,* 621-640. doi:10.1016/j.learninstruc.2004.09.004

Walker, J. T. (1996). *The psychology of learning: Principles and processes*. Upper Saddle River, NJ: Prentice Hall.

Weinberger, J., & Westen, D. (2008). RATS, we should have used Clinton: Subliminal priming in political campaigns. *Political Psychology*, *29*, 631-651. doi:10.1111/j.1467-9221.2008.00658.x

Weiner, B. (2000). Interpersonal and intrapersonal theories of motivation from an attributional perspective. *Educational Psychology Review, 12,* 1-14. doi:10.1023/A:1009017532121

Westen, D. (1998). The scientific legacy of Sigmund Freud: Toward a psychodynamically informed psychological science. *Psychological Bulletin, 124,* 333-371. doi:10.1037/0033-2909.124.3.333

Westen, D. (1999). The scientific status of unconscious processes: is Freud really dead? *Journal of the American Psychoanalytic Association, 47*, 1061-1106. doi:10.1177/000306519904700404

Westen, D. (2006). Implications of research in cognitive neuroscience for psychodynamic psychotherapy, *Focus, 4,* 215-222. Retrieved from http://psychiatryonline.org/article.aspx?articleid=50573

Westen, D., & Gabbard, G. O. (2002a). Developments in cognitive neuroscience: I. conflict, compromise and connectionism. *Journal of the American Psychoanalytic Association, 50,* 53-98. doi:10.1177/00030651020500011501

Westen, D., & Gabbard G. O. (2002b). Developments in cognitive neuroscience: II. Implications for theories of transference. *Journal of the American Psychoanalytic Association, 50*, 99-134. doi:10.1177/00030651020500011601

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68-81. doi:10.1006/ceps.1999.1015

Willingham D. B., & Goedert-Eschmann, K. (1999). The relation between implicit and explicit learning: Evidence for parallel development. *Psychological Science, 10*, 531-534. doi:10.1111/1467-9280.00201

Wilson, T. D. (2002). *Strangers to ourselves: Discovering the adaptive unconscious*. Cambridge, MA: Belknap Press of Harvard University Press.

Wong, P. S., Bernat, E., Bunce, S., & Shevrin, H. (1997). Brain indices of nonconscious associative learning. *Consciousness and Cognition, 6,* 519-544. doi:10.1006/ccog.1997.0322