The Neuroscience of Learning

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Contents

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Neuroscientific and Cognitive Background

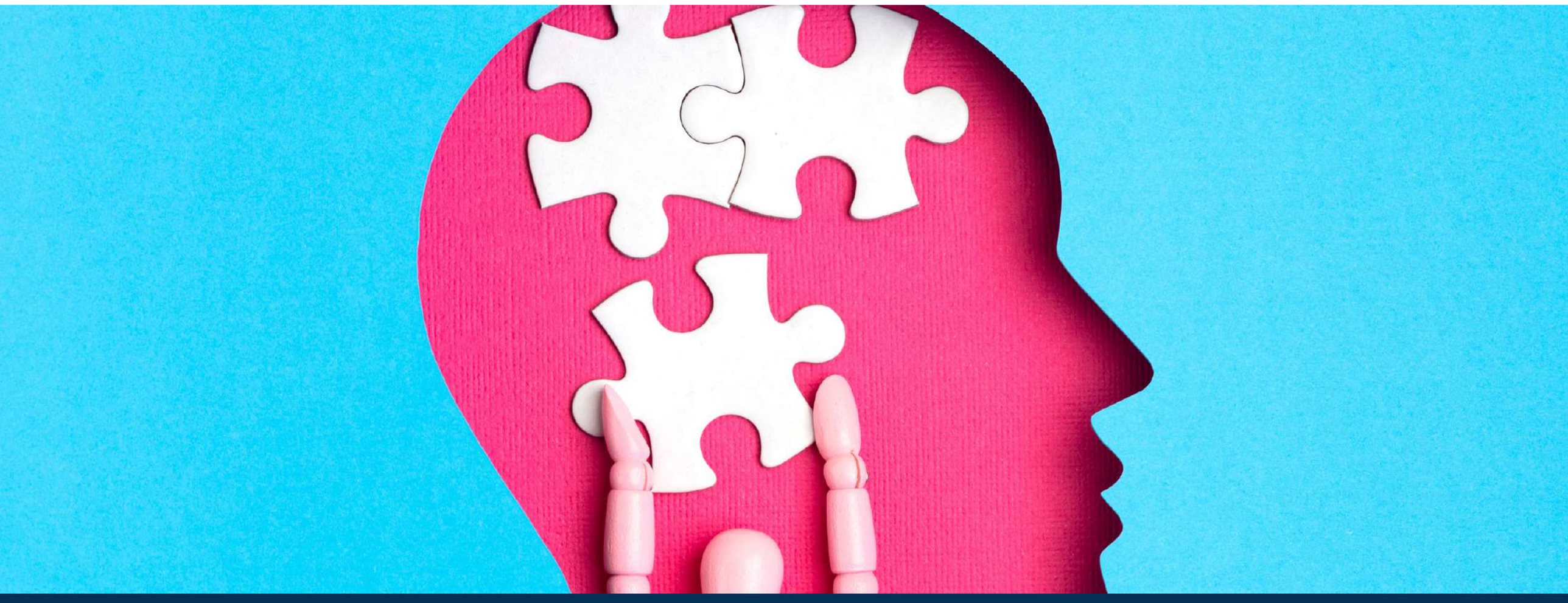
According to the information-processing model, the human brain can be likened to a computer. This is because information is coded, stored, and retrieved by both objects. This analogy from cognitive psychology explains human mental processing in three stages. Firstly, input processes involve the recognition of stimuli. Secondly, storage processes consist of the internal manipulation and coding of stimuli. Finally, output processes involve the development of an appropriate response via the retrieval of relevant information (Searle, 1990).

Attention:

Selective attention is the cognitive mechanism that underpins the first stage of cognitive processing. This is defined as the ability to selectively concentrate on one element of the environment, whilst actively ignoring other distracting stimuli (Yantis, 2008). The prefrontal cortex (PFC) is the part of the brain that is primarily responsible for wilful concentration. The is because the PFC is driven by behavioural goals. It is involved in determining the value or meaning of stimuli (Yantis, 2008).

Language:

The coding and processing of stimuli is enabled by two brain areas that are associated with language. Firstly, Wernicke's area, which is situated in the posterior superior temporal lobe, is responsible for the processing of written or spoken language. As such, this area facilitates the comprehension of information (Weill Institute for Neurosciences, 2021). Secondly, the angular gyrus, which is located in the parietal lobe, allows us to integrate several types of language-related information, including auditory, sensory, and visual stimuli. This area therefore allows us to associate words with different sensations, images, and concepts (Weill Institute for Neurosciences, 2021). Furthermore, according to the transactive memory theory, language can also support individuals to acquire, understand, and retrieve information via communication (Hollingshead & Brandon, 2003). This is because language is a valuable tool for knowledge-sharing, meaning that group collaboration and discussion can facilitate high-quality learning and improve retention.



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Memory:

Memories are formed via the strengthening and weaking of connections in the brain (Ford, 2011). The ability to recall memories is influenced by both frequency and recency. That is, the more often information is rehearsed, and the more recently we have practiced it, the easier it is for our brains to store information for later access (Ford, 2011). Longterm memory characterizes the final stage of the information-processing model, where Page 3 of 19 data is stored permanently, ready for retrieval. Memories that we have conscious access to are referred to as ‘explicit memories’ (Dumper, 2018). These include episodic memories which consist of autobiographical information and experienced events, and semantic memories which hold learnt knowledge and concepts. Explicit memories are encoded by the limbic system (Dumper, 2018). In contrast, ‘implicit memories’, which are unconsciously acquired procedural skills and actions, such as the ability to drive a car, are stored in areas such as the cerebellum, motor cortex, and basal ganglia (Dumper, 2018). Overall, all three types of memory are involved in the learning process, and they often interact with each other. For example, episodic memories can play a role in the retrieval of semantic knowledge (Cherry, 2020). As such, if individuals have positive learning experiences that stick with them, this can improve their memory of the concepts and knowledge that they are taught.

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Factors Affecting Learning

Emotion:

In the context of a learning environment, our emotions are often seen as a disruptive influence that distracts us from engaging in effective thinking (Immordino-Yang & Faeth, 2010). However, evidence from socio-affective neuroscience suggests that our emotions should not be ignored

A Three-Dimensional Taxonomy of Achievement Emotions

	Positive[a]		Negative[b]	
Object Focus	Activating	Deactivating	Activating	Deactivating
Activity Focus	Enjoyment	Relaxation	Anger Frustration	Boredom
Outcome Focus	Joy Hope Pride Gratitude	Contentment Relief	Anxiety Shame Anger	Sadness Disappointment Hopelessness

According to Perkrun, Frenzel, Goetz, and Perry (2007), our emotions can influence a variety of learning factors, such as motivation and strategy use. For example, positive activating emotions, such as enjoyment, can strengthen a learner's interest and increase their motivation (Perkrun, et al., 2007). Learners may experience these emotions when engaging in interesting yet challenging tasks that provide them with a sense of accomplishment. Furthermore, these positive emotions can create a sense of security that gives individuals the confidence to adopt flexible learning strategies that facilitate exploration beyond taught content (Boekaerts, 2011). In contrast, negative deactivating emotions, such as boredom, can decrease motivation and reduce engagement. Also, negative activating emotions, such as anger, can encourage individuals to adopt more rigid learning strategies in which they simply memorise and rehearse material (Perkrun,et al., 2007).

Moreover, a variety of empirical studies have attempted to identify the cognitive mechanisms which may underpin these effects. For example, Betzel, Satterthwaite, Gold, and Bassett (2017) suggest that the relationship between an individual's positive mood and enhanced learning outcomes may be attributed to increased network flexibility in the brain. According to Braun et al. (2015), network flexibility is defined as the changing connectivity between different systems in the frontal lobes of the brain that facilitates Page 5 of 19 working memory and learning. Betzel et al. (2017) found that positive mood increases network flexibility. In addition, Nadler, Rabi, and Minda (2010) found that participants who were primed to experience a positive mood performed better in a rule-based cognitive task than those primed to feel neutral or negative.

The researchers suggested that this could be due to increased flexibility in frontal regions of the brain, such as the PFC and anterior cingulate cortex, which are important for cognitive processes such as rule selection and hypothesis testing. Overall, this therefore suggests that, when learners experience positive emotions, their brains become more capable of learning.

Furthermore, positive emotions can also activate neurotransmitters in the brain that facilitate learning. For example, dopamine is a chemical messenger that is associated with feelings of pleasure and satisfaction (Moseley, 2018). When an individual has a positive experience, such as succeeding in a learning task, their brain releases dopamine which makes them feel good. Their brain then associates this experience with the rewarding feeling of satisfaction, which encourages the individual to further engage in the activity. As a result, dopamine facilitates the creation of personal habits through positive reinforcement, as well as underpinning feelings of motivation, commitment, and selfdiscipline (Bromberg-Martin, Matsumoto, & Hikosaka, 2010). Also, recent research has found that the concept of novelty directly activates the dopamine system (Science Daily, 2020). This means that introducing individuals to new information or skills can encourage a sense of reward.

In contrast, Brand, Reimer and Opwis (2007) found that one of the ways in which negative mood can inhibit learning is by diminishing our ability to transfer and apply acquired knowledge to new, alternative situations. The researchers found that participants who were primed to experience negative emotions later exhibited poorer performance in knowledge transfer tasks than those who were primed to be happier. One possible explanation for this is that ‘sad’ participants lacked the cognitive resources required to evaluate the new situations and apply what they had previously learned. Brand et al. (2007) argue that, unlike happier participants, those experiencing negative emotions may have been engaged in the process of ‘mood repair’ whereby they were also focussing on investigating the source of their bad mood and regaining a better attitude. This might have meant that their cognitive capacity was split between the experimental task and correcting their mood, thus resulting in poorer performance.

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Overall, this research highlights the importance of establishing a learning environment that fosters positive emotions. As a result, instructors should set up tasks that facilitate success – whilst it is well-established that individuals can 'learn from failure', it is better to avoid introducing these negative emotions into the learning environment, and rather focus on providing feedback that highlights how individuals can build on their success and further improve. Moreover, it is also valuable to create a 'safe space' in which individuals feel secure enough to explore and express their knowledge and attitudes. However, this does not mean that the atmosphere should be 'comfortable'. Holley and Steiner (2005) suggest that facilitating discussions where individuals are forced to confront and reflect on their opinions or preconceptions can also encourage learners to engage in critical thinking. This suggests that challenging learners to step out of their comfort zone can lead to development in their skills and understanding.

Furthermore, an environment in which individuals experience a moderate level of pressure or confrontation may also facilitate learning at a neurochemical level. That is, when individuals experience stress, their brains release the chemical messenger adrenaline, which utilises quick energy sources in the body to boost mental concentration and focus (James, 2012). However, it is important to only create a mild amount of 'stress' within the learning environment. This is because the additional neural energy required to focus on objects or situations that provoke anxiety or uncertainty can have negative cognitive effects, such as inhibiting memory, diminishing performance, and distracting individuals from the present situation (Rock, 2009). As such, an 'optimal' amount of stress is required – which means creating a challenging but not confrontational environment.

Motivation:

Our emotions can also influence learning outcomes indirectly, by having a strong influence on learning attitudes. This is because our level of motivation - the extent to which learners care about, and engage in, learning tasks - plays an important role in the learning process. For example, Mega, Ronconi, and De Beni (2013) suggest that positive emotions increase learners' motivation by enhancing their confidence and improving their perceptions of their capabilities. Positive emotions also increase learners' masteryapproach goals which are characterised by a desire to increase one's competency through knowledge acquisition and skills development. This, in turn, can increase learning achievement (Mega, Ronconi, & De Beni, 2013).

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Furthermore, Boekaerts (2010) identified several key principles which further explain the relationship between emotion, motivation, and learning. For example, she suggests that negative emotions can undermine motivation and direct attention away from learning. For example, if learners experience negative feelings, such as disappointment, this can motivate them to actively avoid future tasks that may result in similar emotions. This can also lead to negative thinking patterns which inhibit re-engagement, such as learned helplessness (Boekaerts, 2010). This is the process whereby individuals enter a self fulfilling prophecy of failure. Firstly, the learner believes that they have low ability and are powerless to change their position. This then discourages them from participating in learning tasks due to a lack of motivation. As a result, the learner then fails a task due to the limited effort that they expended. This, in turn, fuels their initial negative beliefs about their ability and further discourages engagement (Maier & Seligman, 1976).

In contrast, Boekaerts (2010) suggests that when learners experience positive emotions, such as pride or enjoyment, this can lead to ‘task attraction’ which encourages and motivates them to pursue similar tasks that may result in the same pleasurable feelings (Boekaerts, 2010). Additionally, the positive emotions that individuals experience as a result of effortful task accomplishment act as a form of intrinsic motivation. Selfdetermination theory suggests that an individual is intrinsically motivated if they are doing something because it is inherently satisfying (Ryan & Deci, 2000). This is the opposite of extrinsic motivation which is defined as doing something due to external rewards or pressures. Overall, intrinsic motivation results in high-quality learning because it is underpinned by two strong desires: the desire to be challenged by a novel or engaging task, and the desire to fulfil our psychological needs for competence and autonomy (Ryan & Deci, 2000).

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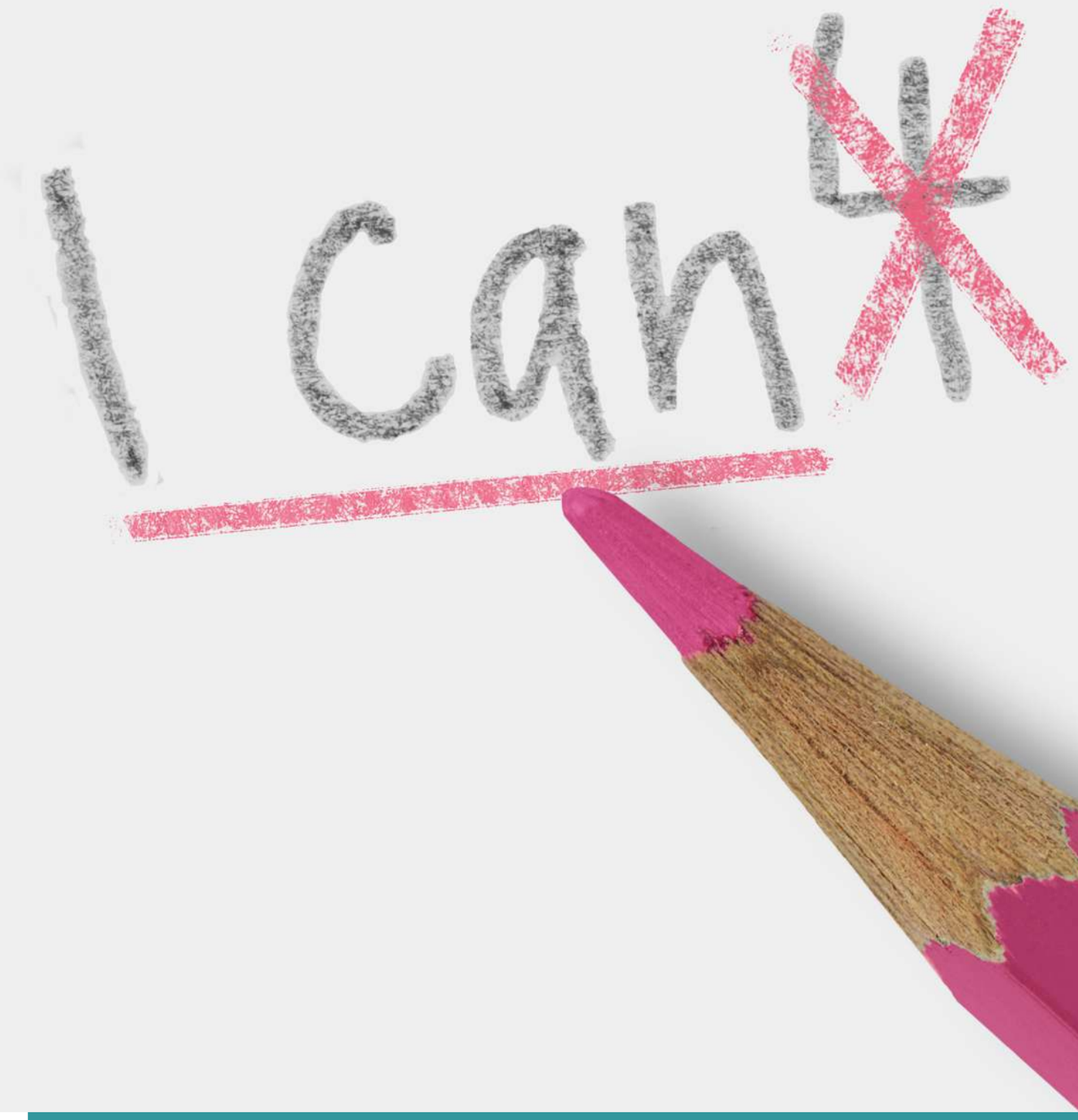
Empirical studies have also highlighted the influence of intrinsic motivation on different elements of learning, such as memory. For example, Gruber, Gelman, and Ranganath (2014) found that states of high curiosity (which are indicative of high intrinsic motivation) can enhance learning and increase the retention of information. In this study, researchers gauged participants' levels of intrinsic motivation by asking them to rate how curious they were to learn the answer to a series of trivia questions. Once they had learnt the answers to the trivia, each experimental trial involved the presentation of one of the questions, followed by a 14-second delay in which participants were also shown photographs of faces. Participants were then given a test on the trivia, as well as a surprise recognition memory test for the faces. This allowed the researchers to determine how participants' levels of curiosity may have affected their learning of both interesting information (trivia answers) and incidental information (faces). Overall, Gruber et al. (2014) found that states of high curiosity were associated with enhanced learning for both types of information. This therefore illustrates the power of intrinsic motivation: it not only enriches the process of learning intended material, but it also improves an individual's capacity to learn additional, incidental information.

Furthermore, it is also important to consider how different groups may be motivated to learn in different ways. For example, Adult Learning Theory focuses on the six unique motivations of different adult learners (Russell, 2006). Firstly, social relationships are often a source of motivation for adult learning, such as the desire to engage in professional networking. Also, external expectations often motivate adult-learning. This involves a need to comply with instructions from an authority. For example, employees may be told to attend a training course by their manager. Thirdly, social welfare, such as the desire to improve one's ability to engage in community work, can also motivate some adults to learn, whilst personal or professional advancement can encourage others. In addition, the desire for escape or stimulation, such as the need to relieve boredom, can also encourage adults to seek out learning opportunities. Finally, some adults may wish to 'learn for the sake of learning', meaning that cognitive interest is also a source of motivation for adult learning (Russell, 2006). Overall, this illustrates how instructors should identify sources of motivation for their students in order to tailor the information to their specific needs.

Self-Belief and Self-Control:

Boekaerts (2010) suggests that learners can often feel more motivated when they believe that they can competently complete tasks. This means that increasing an individual's selfbelief can improve their learning outcomes by enhancing their confidence when approaching challenges and increasing the effort and persistence that they invest in their learning (Boekaerts, 2010). As a result, studies have found that self-efficacy – an individual's belief that they can be successful – has a direct, positive effect on learning achievement (Yusuf, 2011).

According to Lunenburg (2011), self-efficacy affects performance in three ways. Firstly, self-efficacy influences an individual's goals: those with low self-efficacy tend to set low, unambitious goals for themselves due to a lack of self-belief, whilst those with high selfefficacy tend to set high, optimistic goals for themselves which are underpinned by confidence in their own ability (Lunenburg, 2011). Secondly, self-efficacy influences the amount of effort individuals are willing to expend in order to learn. For example, those with low self-efficacy may exert minimal effort during both the learning of skills and the performance of tasks because they pessimistically believe that it is unlikely to result insuccess (Lunenburg, 2011). Finally, self-efficacy influences the determination and perseverance that individuals exhibit when facing new challenges. Those with high selfefficacy possess the confidence to face setbacks and persist in their efforts when tasks are difficult, whilst those with low self-efficacy are likely to give up on challenging tasks because they are fuelled by the belief that they are incapable of mastering the necessary skills (Lunenburg, 2011).



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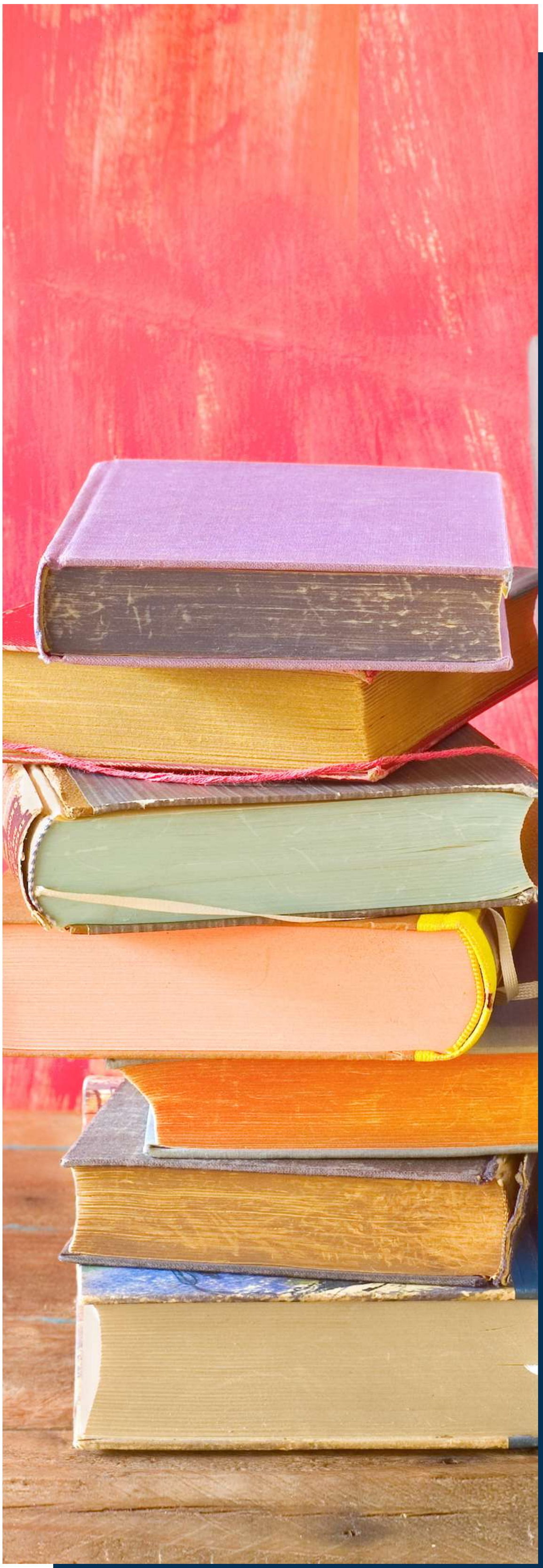
Moreover, Prat-Sala and Redford (2010) found that an individual's level of self-efficacy can also influence their approach to learning. They found that learners who exhibited high self-efficacy often adopted a deep-level processing approach. This is characterised by the intention to extract meaning from learning materials, and thus challenge the ideas and arguments presented. Learners who adopt this approach also aim to establish clear connections between their existing knowledge and taught material (Prat-Sala & Redford, 2010). In contrast, the researchers found that individuals with low self-efficacy often adopt a surface-level processing approach. This is characterized by the intention to extract superficial information from learning materials. Learners who adopt this approach tend to use repetition and rote learning to memorise information, often resulting in a failure to engage with the material in a meaningful way (Prat-Sala & Redford, 2010). Overall, this therefore highlights how, by encouraging learners to believe in their abilities, and thus experience feelings of self-efficacy, instructors can support their students to engage with learning materials in a more meaningful way

Additionally, Themanson and Rosen (2015) identified a possible neural mechanism which may explain how self-efficacy influences learning. The researchers found that self-efficacy was associated with enhanced P3b amplitude. This is a brain signal which exhibits neuronal activity that is believed to reflect task-relevant attentional control. This means that, the bigger the P3b amplitude, the more an individual is believed to be paying attention and remaining focussed on the task.



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Consequently, the results suggest that higher self-efficacy is associated with greater attentional control. This therefore explains why individuals who believe that they can be successful are often able to adopt in-depth learning strategies that require detailed processing and high engagement with materials (Themanson & Rosen, 2015).

Furthermore, another element of self-regulation which influences learning success is selfcontrol. This is defined as the regulation of thoughts, emotions, and behaviours when long-term goals conflict with momentarily more satisfying goals (Duckworth, Taxer, Eskreis-Winkler, Galla & Gross, 2019). For example, an individual would be faced with a self-control conflict when deciding whether to spend their time revising for an exam or scrolling through Twitter. On one hand, looking at social media is more enjoyable in the moment, but is a behaviour that is incongruent with the individual's learning goals. On the other hand, studying is far less enjoyable in the moment, but is a valuable behaviour that is congruent with the individual's learning goals. According to Muraven and Baumeister (2000), this executive function is a limited cognitive resource because exerting self-control is tiring. As a result, this emphasizes the importance of promoting self-care and wellbeing during the learning process, including taking regular breaks.

Self-control is an important element of self-regulatory functioning which is associated with three main brain areas in the prefrontal cortex (PFC). These include the ventromedial PFC (which is involved in inhibiting inappropriate behaviours), the lateral PFC (which is implicated in the planning and execution of behaviours, including complex actions that involve multiple goals), and the anterior cingulate cortex (which is responsible for detecting and signalling the need for increased cognitive control, such as when an individual is faced with temptation) (Heatherton, 2011). Overall, several studies have found that higher self-control is associated with positive learning outcomes. For example, Stadler, Aust, Becker, Niepel, and Greiff (2016) found that self-control significantly contributes to learning achievement, even when controlling for an individual's cognitive ability. This result was found for both objective measures of achievement, such as standardised tests, and subjective measures of achievement, such as personal ratings of satisfaction and success in learning (Stadler, Aust, Becker, Niepel, & Greiff, 2016).

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Learning Culture

Boekaerts (2010) suggests that learners are also often more motivated to engage in learning when the perceived value of a task is high. This can be shaped by the apparent relevance, interest, or importance of the task. For example, according to Adult Learning Theory, adults learn best when they are convinced of the need to know the information presented by an instructor (Russell, 2006). The anticipated satisfaction that the learner will experience after accomplishing the task increases motivation, persistence, and willingness to overcome learning challenges (Boekaerts, 2010).

Furthermore, Boekaerts (2010) highlights how the way in which instructors present the purpose and value of tasks can also influence the 'goal orientation' approaches adopted by learners. For example, when instructors focus on the importance of grades, give competitive instructions, and emphasise the difficulty of the task, learners often adopt a performance avoidance orientation. This is characterised by the view that the purpose of learning tasks is to demonstrate one's abilities and to out-perform others. This can create a negative learning culture whereby individuals fail to ask for feedback because they believe that asking for help is a sign of low ability. This can therefore lead to task avoidance or procrastination (Boekaerts, 2010). In addition, a competitive learning environment can also introduce a fear of social threats, such as being mocked for answering a question incorrectly, which can subsequently lead to negative emotions, such as embarrassment. The amygdala is the area of the brain that is responsible for diverting our attention to potential threats and triggering the 'flight-or-fight' response (Moseley, 2018). In the learning environment, a 'flight' response may be characterised by withdrawal or a lack of enthusiasm, whilst a 'fight' response may involve forcing others to
focus only on topics that we are confident discussing to avoid the social repercussions of exhibiting a lack of understanding. Overall, both of these reactions to perceived social threats inhibit learning by limiting engagement and disrupting group collaboration.

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In contrast, when instructors give non-competitive instructions and link learning tasks to students' interests and goals, learners often adopt a mastery orientation. This is instead characterised by the view that the purpose of learning tasks is to critically engage with new material and to increase knowledge and improve one's skills. This can create a positive learning environment whereby individuals are encouraged to believe that effort leads to success, and that soliciting feedback or help is a useful resource for improvement. This therefore urges learners to actively monitor their own performance to ensure that they understand material, and to adopt deep-learning strategies that increase their engagement and consolidate their comprehension (Boekaerts, 2010).

Furthermore, creating a positive learning culture is valuable because it can facilitate emotional contagion. This is a social phenomenon whereby emotions and related behaviours spontaneously spread across a group of individuals, thus reflecting the idea that 'happiness is contagious' (Naureen, 2012). One way in which instructors can foster a positive emotional contagion is by promoting a culture of psychological safety and belonging. The modern human brain strives to maintain a sense of safety and certainty by satisfying six essential psychological needs: belonging, status, autonomy, fairness, expectations, and certainty (Shooksvensen, 2020). By facilitating high-quality relationships, emphasising the value of individual contributions, and developing practices that establish shared goals and mutual respect, instructors can improve learner performance (Waller, 2020). In addition, instructors can create a sense of psychological safety by engaging in the group's preferred learning approach. For example, adults prefer learning that is; self-directed, goal-oriented, autonomous, practical, and based on an accumulated foundation of experience (Russell, 2008).

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Collaboration:

Additionally, another way in which an instructor can shape the learning culture of the group is by emphasising the importance of social collaboration through cooperative learning. According to Johnson and Johnson (2008), Social Interdependence Theory identifies five basic elements that form a foundation for cooperative learning. These elements can be used to describe the responsibilities of collaborative learning instructors.

Firstly, Johnson and Johnson (2008) suggest that instructors should foster positive interdependence which is characterised by the perception that individuals can only achieve their goals if their cooperative partners also meet their goals. This therefore encourages learners to support their group members by sharing resources and knowledge. This highlights the second element of cooperative learning: promotive interactions which involve individuals providing other group members with effective feedback, as well as challenging their reasoning or arguments to reach the highest-quality group conclusions and engage in deep-learning strategies (Johnson & Johnson, 2008).

Thirdly, instructors should emphasise the importance of personal accountability and responsibility to ensure that group members do not reduce their contributions because individual input is difficult to distinguish from the holistic work of the group. Increasing the salience of learners' responsibility to make significant contributions to the group should reduce social loafing because individuals are then motivated to avoid 'letting the group down' (Johnson & Johnson, 2008). Personal accountability can also be increased within the group structure through practical techniques, such as introducing deadlines.

Fourthly, instructors should teach learners the interpersonal skills that are required to achieve productive cooperation and to foster positive peer relationships, such as clear communication, effective conflict resolution, and the development of trust and acceptance. Finally, according to Johnson and Johnson (2008), instructors can ensure the success of cooperative learning by encouraging individuals to critically reflect on the effectiveness of their group processes. This allows learners to re-evaluate their shared goals and to establish more appropriate methods for achieving their learning outcomes.

A meta-analysis by Kyndt et al. (2013) – which reviewed 65 studies on the effectiveness of cooperative learning – identified a consistent, positive effect of cooperative learning on both performance and attitudes towards learning. One explanation for this effect could be drawn from neuroscientific studies which have identified that engaging in cooperation is socially rewarding. For example, Decety et al. (2004) found that participants who cooperated with another individual during an online game exhibited increased activity in the orbitofrontal cortex and the left anterior frontal cortex. The orbitofrontal cortex is associated with the motivational control of goal-directed behaviour, and both brain areas Page 14 of 19 have been implicated in the processing of positive social feedback. This sense of reward may have therefore underpinned individuals' motivation to engage in positive interdependence and thus increase the success of their group.

Furthermore, Kyndt et al. (2013) also found that these effects were moderated by three variables. The first was subject domain: cooperative learning showed greater positive effects in non-linguistic courses, such as maths and science, than in linguistic courses, such social science and languages. Next, the second variable was age level: cooperative learning appeared more effective for young children and adults, than for adolescent learners. Finally, the third variable was culture: individuals from non-Western cultures appear to benefit from cooperative learning more than those from Western cultures. Kyndt et al. (2013) suggest that this may be due to the collectivist nature of non-Western cultures which value shared responsibility and common goals more than individualistic Western cultures which often prioritise the needs of the individual over the needs of the group. Overall, this highlights an additional responsibility of cooperative learning instructors: they must recognise that some learners may benefit from collaborative approaches more than others.

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The success of collaborative social learning is often attributed to the sense of support that participants experience. For example, Felder and Brent (2007) state that individuals who participated in cooperative learning engaged in positive, supportive relationships with their peers which increased their self-esteem, intrinsic motivation, perspectivetaking, and critical thinking. Furthermore, the positive effects of cooperative learning may be underpinned by neurochemical processes. For example, when individuals engage in social behaviours, their brains release the chemical messenger oxytocin. This neurotransmitter then facilitates a sense of relaxation, trust, and psychological safety which can contribute to emotional wellbeing and increase resistance to stress (Neumann, 2007). These positive cognitive outcomes associated with social collaboration are particularly important because the learning process can be a long and difficult journey. For example, Broadwell (1969), described the process in terms of four stages of competence:

1. **Unconscious incompetence:** The individual is unaware that they lack a certain skill.

2. **Conscious incompetence:** The individual is aware of the skill but is not yet able to perform it.

3. **Conscious competence:** The individual can demonstrate the skill following significant effort and concentration.

4. **Unconscious competence:** Performing the skill becomes automatic.

The second step in this learning process can be overwhelming and demoralising for some leaners (Broadwell, 1969). Although making mistakes is an important part of this stage, this can reduce self-esteem and motivation for some individuals. As such, experiencing encouragement and support from peers, which in turn facilitates resilience and psychological wellbeing, is beneficial to learners during this stage. This therefore illustrates the value of social collaboration during the learning process.

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Conclusion

This paper has examined the psychological processes and neuroscientific mechanisms that underpin the learning process. As highlighted by the above research, an individual's emotions, motivation, and feelings of efficacy and self-control can have a significant impact on their learning outcomes. In fact, the evidence suggests that this can happen at a behavioural, cognitive, biological, and neurochemical level. Consequently, it is important that instructors are aware of how different factors can affect learning so that they can effectively support individuals to perform to the best of their ability. Instructors should therefore aim to create an environment which will ensure that learners; experience positive and activating emotions, feel intrinsically motivated, believe that they are competent enough to be successful, and feel in control of their learning.

Furthermore, the above research also suggested that the most successful learning cultures are those that foster positive emotional contagion, encourage individuals to adopt a mastery orientation, and satisfy the psychological needs of its learners. Instructors can also foster a positive learning culture by facilitating social collaboration. In particular, they should adopt cooperative learning strategies that encourage supportive peer relationships which are characterised by positive interdependence, personal accountability, and promotive interactions.

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