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THE EUREKA SCALE:

From “Oh” to “Uh-huh” to “Aha!”

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Consistent innovation is a gold standard for bringing organizations to the forefront of competition (Lee & Yu, 2019). One of the scientifically proven methods for increasing innovation is to foster environments for insight, which can boost motivation, enable better recall, and improve performance (Davis et al., 2015; Jung-Beeman et al., 2008). Recent research has revealed different features of the "aha" phenomenology that can be measured and placed onto separate scales and is beginning to provide a more nuanced view of the (often variable) insight experience (Danek et al., 2014a; Webb et al., 2016). Here, we unpack our Eureka Scale, first presented by the NeuroLeadership Institute in 2015. This scale pulls together various measures of insight into one memorable, usable framework for measuring the intensity of insight in real time or after the fact. This is the first framework that can be used to measure and improve the intensity of insight across all contexts, whether in written, audio, video, or experiential content. It is useful for improving the impact of all kinds of change initiatives, including one-to-one coaching or group teachings, training of all types, advertising and marketing campaigns, communications programs, strategy development, or anywhere you are trying to share or develop an understanding of an issue. We first solidify the scientific underpinnings of insight and how they relate to the outcome variables that define its scalable nature and then directly apply the scale as a tool for measuring and improving the impact of many kinds of interventions within organizations.

Key takeaways:

1. In the current environment, organizations that can demonstrate agility and adapt more quickly may have the competitive edge they need.
2. Achieving these benchmarks requires the ability to learn and relearn, at scale and speed.
3. The heart of client-facing interactions is being able to successfully challenge points of view and create value in the work together, building lasting relationships.
4. Insight generation is the key to all three of these issues and more. Here, we show the science underlying how the benefits of insights scale with their intensity on the Eureka Scale.

The Measurable Scientific Underpinnings of an Insight

Insights are often described by individuals both in and out of the laboratory as a sudden feeling of awareness, a "knowing" of a solution that comes along with an array of positive emotions (Salvi, 2021). Supporting this notion are results using techniques such as electroencephalography (EEG) or functional magnetic resonance imaging (fMRI) that reveal underlying predictable neural signatures of what happens when someone experiences insight (Bowden & Jung-Beeman, 2003a; for an extensive and thorough review, see: Sprugnoli et al., 2017). Prior to insight, a brief increase in the alpha frequency EEG waveform over the right parietal-occipital area is thought to dampen new sensory input, which then switches to a burst within the gamma frequency band over the right temporal area at the moment of insight and is associated with the formation of new synaptic connections (Bowden & Jung-Beeman, 2003b; Jung-Beeman et al., 2004).

Specific areas involved in preparing for insight and integrating distant information are the anterior cingulate cortex and the superior temporal gyrus (Salvi, 2021; Jung-Beeman et al., 2004). Deeper dopaminergic, hippocampal, and amygdala regions, as well as the prefrontal cortex (PFC), all support the feelings of reward and learning that occur when insight happens (Subramaniam et al., 2009; Zhou et al., 2013; Kizilirmak et al., 2016; Santarnecchi et al., 2019; Csorba et al., 2021). Finally, engagement of an area involved in receiving our interoceptive feelings (or feelings from inside our body), the dorsal anterior insula, has even been implicated in the experience of clarity, enlightenment, and certainty (Bartolomei et al., 2019). Below, we expand on this foundational work by exploring the rich cognitive and neurophysiological evidence for a Eureka Scale, a product of the combined impact of five behavioral factors.

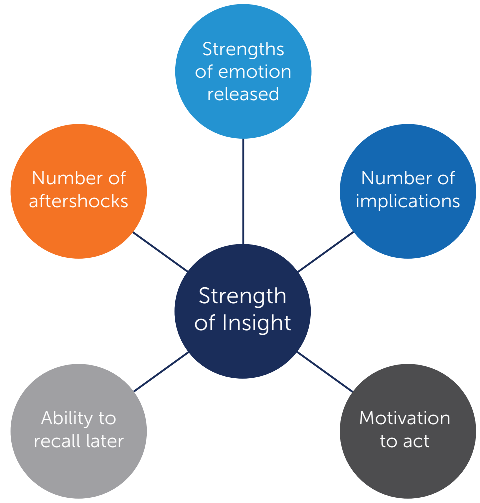

Figure 1: Variables that contribute to the strength of insight.

The Scientific Evidence for the Eureka Scale: The Variable Strength of Insights

A eureka moment can be described as a result of the combined impact of five variables (Figure 1): the emotions felt, motivational drive, number of aftershocks (post-insight reflections, described as spontaneous feelings of amazement that can prime future problem-solving and improve performance and engagement) (Shen et al., 2018; Kraus & Holtgraves, 2018), ability to recall the moment, and number of implications that result. It is important to note that the sum of these variables comprise what neuroscientists argue as the affective human experience. The terms "affective" and "affect" refer to emotions or feelings, and often in relation to behavioral drive or outcomes. The dominant theory suggests that "affect" is not only composed of the hedonic dimension (i.e., pleasant or unpleasant) but also the internal physiological underpinnings such as valence (i.e., positive or negative) and arousal (i.e., level of intensity). They underlie the motivational drive and other behavioral expressions that may enable aftershocks, implications, and memory formation (Barrett et al., 1999, 2007). In fact, this further validates our exploration of insight through the lens of each variable, as they are each individually critical to the experience as a whole. How an individual reports an insight may vary, and some 20% of the population may not even be able to recognize the experience (Ovington, 2018), yet those who do, reveal phenomena that are both multidimensional and quantifiable, validating the use of a scale to quantify a subjectively qualitative experience. As each of the five variables intensifies, so does the overall eureka experience (Danek & Wiley,

	1 No insight	2 Weak insight	3 Moderate insight	4 Strong insight	5 Intense insight
What we say out loud	**"I sense something in the background."**	**"What was that idea again?"**	**"That's an interesting idea."**	**"That's an important idea."**	**"This changes everything!"**
What our brains "say out loud"	• *No felt emotions* • *No ability to recall* • *No change in motivation* • *No implications* • *No aftershocks*	• *Weak emotions* • *Weak recall* • *Low motivation* • *Unclear implications* • *Low aftershocks*	• *Positive emotions* • *Short-term recall* • *Can be motivating* • *Some implications* • *Few aftershocks*	• *Good emotions* • *Long-term recall* • *Highly motivating* • *More implications* • *Many aftershocks*	• *Greatest emotions* • *Lifelong recall* • *Most motivating* • *Highest number of implications* • *Most aftershocks*

Figure 2. NLI's Eureka Scale. This represents how we experience insights and the underlying measurable neural underpinnings.

2017), leading us to apply insights as they vary in strength — via the Eureka Scale (Figure 2), a concept well supported by rich neurocognitive research and expanded on below (Subramaniam et al., 2009; Bowden & Jung-Beeman, 2003a; Salvi et al., 2016; Smith & Kounios, 1996). This tool can be used to increase metacognition, or an intentional reflection of one's own thought or learning processes, and facilitate heightened awareness of the experience of insight by having individuals rate on a five-point Likert scale (1 = weak to 5 = strong) the strength of insight and how much the insight motivates them to act. The Eureka Scale is similar to the five-point scale used in research demonstrating the relationship between the reported strength of insight and differential neural patterns (Tik et al., 2018). In fact, neural signatures of insight scale in magnitude, along with the experience, and explicitly support the five variables lending to its intensity (Salvi et al., 2020; Jung-Beeman et al., 2004; Rothmaler et al., 2016; Sprugnoli et al., 2017). Below we examine each variable separately as it relates to the neural and cognitive underpinnings and how they contribute to the scalable nature of insight.

Emotional

Central to insight is the emotional experience, and this correlates with measurable activity in emotional processing brain regions, which is also highly variable. To begin, the affective or emotional experience may include a dramatic increase in warmth or, in this case, certainty in regards to the solution (Metcalf, 1986), along with a rich emotional description (Laukkonen & Tangen, 2018). Thus, in addition to general mood increases with insight, an emotional experience often includes varying levels of suddenness (or a dramatic awareness of the solution), surprise, certainty, and relief. In fact, the ability to recall and solve problems gets better as feelings of happiness, surprise, and suddenness grow (Subramaniam et al., 2008; Danek et al., 2014b; Danek & Wiley, 2017; Stuyck et al., 2021). Notably, the highest levels of confidence are reported for problems solved via insight compared to analytical methods (85% vs. 63%), which was also linked to an increased likelihood of correctness (Danek et al., 2014a; Salvi et al., 2016; Webb et al., 2016).

Published insight scales suggest that the "radicality" of the emotional experience correlates with ratings of its intensity (Jarman, 2014) and are strongly supported by underlying physiological mechanisms (Bowden & Jung-Beeman, 2003b), such as those revealed through EEG metrics. For example, gamma waveforms covary in magnitude with levels of reported emotional "suddenness" (Sandkühler & Bhattacharya, 2008). In addition, a separate gamma burst detected over the orbitofrontal cortex, an area associated with pleasurable emotions, varies in strength with each insight (Oh et al., 2020). Finally, fMRI analysis reveals an increase in activity within the anterior cingulate cortex that matches reported positive mood changes and solutions via insight (Subramaniam et al., 2008).

Thus, stronger insights lead to a more positive emotional experience (Ludmer et al., 2011; Danek et al., 2014b; Danek & Wiley, 2017; Laukkonen & Tangen, 2018). In the realm of application and cognitive performance, emotional strength is crucial for determining whether information will be integrated into memory (Davachi et al., 2010; Davis et al., 2015). For example, when participants report solving problems via insight, the level of activity in brain regions that underlie our emotional experience, such as the amygdala, correlates with the amount of recall a week after the initial learning. Here, greater amygdala activity is related to greater long-term recall (Ludmer et al., 2011). What this means for organizations is that enabling space for insights will create an emotionally rewarding work environment that will enable individuals to generate better memories and maintain higher executive and cognitive control (Rock & Cox, 2012), ultimately leading to enhanced performance.

Motivation

Higher insights are also associated with a boost of motivational drive. These studies reveal greater neural activity in reward and pleasure centers as a function of eureka intensity. Thus, fMRI techniques have revealed that as insight strength increases, neural activity increases as well in reward brain regions, such as the ventral tegmental area and the nucleus accumbens, and there is a scalable increase in dopaminergic release, all of which drive motivation and its behavioral outcomes (Oh et al., 2020; Sandkühler & Bhattacharya, 2008; Tik et al., 2017). Finally, synchronized activity at the moment of insight occurs within areas of the PFC that encode and value the reward (Csorba et al., 2021), likely stemming from dopaminergic input of the deeper reward-based regions.

What this means for employees is that solving problems via insight may allow individuals to benefit from the motivational boost obtained from the receipt of intrinsic rewards, often stronger than rewards from other sources, such as bonuses. In fact, these types of rewards can be most effective and are linked to increased curiosity, exploration, learning, and creativity (Eccles & Wigfield, 2002).

Recall

Referred to as the "insight memory advantage," solving problems via insight leads to better recall, likely due to a combination of the above variables of positive emotions and greater motivation (Wills et al., 2000; Danek et al., 2013; Danek & Wiley, 2020; Duon et al., 2020). Mechanistically, this is dependent on the hippocampus, and as insight strength grows, so does hippocampal activity, which directly supports memory formation (Davachi et al., 2010; Tik et al., 2017). In fact, the strongest and most generalizable memory formation stems from experiences that are both positive emotionally, as well as those that trigger intrinsic motivation. Thus, as insight strength increases, so does the memory of the insight and the environment in which it occurred (Van de Cruys et al., 2021). So, when employees experience stronger, highly meaningful insights, this will pave the way to more innovative ideas and lead to increased competitiveness of the organization.

Aftershocks

After the initial experience of insight, many individuals experience aftershocks, which are affective, post-insight reflections described as spontaneous feelings of amazement that can prime future problem-solving and improve performance and engagement (Shen et al., 2018; Kraus & Holtgraves, 2018). Physiological support of experiencing aftershocks is reflected in the measured change in pupil dilation prior to insight, which is directly tied to the release of norepinephrine (NE) from the brainstem. Research has revealed that NE is often released in bursts, differing in amount and presumably the proportion of which can map to different levels of insight. Moreover, NE release has been shown to be predictive of realization and continued cognitive arousal (Salvi et al., 2020; Sara & Bouret, 2012; Lindström & Gulz, 2008).

In fact, the existence of post-insight aftershocks is how creative advertising works to trigger follow-up engagement in regards to items (Shen et al., 2021). For example, the award-winning, successful campaign for "#LikeAGirl" by feminine products maker Always has forever changed the impact this phrase has on action, from one of devaluing girls to one that encourages girls to grow and challenge themselves. Using this example, organizations that create space for more insight-induced aftershock experiences can expect increased and continuous employee excitement, interest, and engagement.

Implications

Finally, the physical restructuring of neural networks leads to a multitude of impactful implications for organizations, as individuals are more likely to generalize this learning and apply it to other scenarios, which will trigger behavioral action. Coined the "eureka effect," this may enable individuals to solve tougher problems after having an insight by boosting behavioral flexibility without any additional experience (Ahissar & Hochstein, 2004; Vaidya et al., 2021). Thus, if employers create space for insights (Jung-Beeman et al., 2008), this may be the starting point for innovative ideas and solutions, thinking outside the box, and benefitting from experimentation in a variety of scenarios. The scientific underpinnings of this may lie again in the release of NE, which can occur in bursts and to different levels impacting cognitive arousal (Salvi et al., 2020; Sara & Bouret, 2012; Lindström & Gulz, 2008). Important here, is that it has also been shown to mediate cognitive flexibility in problem-solving, a characteristic critical for creativity, innovation, and adaptive behavior (Sara, 2009).

The Eureka Scale can be a thoughtful and intentional tool for developing people, as this is one of the best ways to drive performance, learning, and behavior change. It can also help develop and assess the success of organizational change initiatives. In a great example of its usage, after the rollout of a learning experience with a client looking to improve the quality of its conversations, more than 300 individuals were surveyed by NLI on their experienced insight strength, motivation to act, and the frequency that learned behaviors were acted on. More than 80% of participants reported level 4 or 5 insights, and two-thirds of them changed their behavior at least one to three times per week. Thus, integrating new initiatives that involve self-generated insights can drive motivation and lead to measurable action in organizations. On the individual level, in a process we call the "Dance of Insight" (Rock, 2009), methods for fostering more insights begin with the act of establishing or asking "permission" of others. This opens a cognitive "floor" for their own thinking and gives them autonomy over how and where a conversation will progress. Asking for permission can often be accomplished best at the beginning of a conversation, when an individual can ask a co-worker or employee whether they are open to discussing a new goal, way of thinking about a problem, or a deeper view of a topic. The process continues by providing "placement" for others, enabling all individuals to be informed equally about the conversation. For example, placement can encourage thinking around the focus, intention, and overall objective of the problem or conversation. And finally, "clarification" of the conversation is a final piece of this process, which works by summarizing critical points. This is not the same as paraphrasing but is a way to confirm understanding in fewer, but different, words. This is a critical step that enables others to feel heard and understood. For example, these questions may involve what the other is trying to say, what they are not saying, and the emotional context of what the person is saying. In all, the "Dance of Insight" is a powerful way to help generate insights in others.

The results are clear: Stronger insights engage motivation-, memory-, and connection-forming pathways to the highest levels, leading to the greatest performance benefits. So how do the individual variables of great insights benefit organizations?

The Value of the Eureka Scale, in Practice

The Eureka Scale has broad applications for measuring and improving the impact of many kinds of interventions within organizational life. In addition, it can be used to measure and improve a wide range of activities, from government interventions to the creation of books, movies, documentaries, to the way we teach K-12 education and beyond. We will focus here on organizational implications, in three broad categories.

1. Communication and change strategies of all types

The purpose of change and communication strategies in organizations is to share ideas and move people to take action. As the research suggests, the stronger the insight people have, the more likely they will take a desired action. Using the Eureka Scale, practitioners can develop communication strategies and test them against the strength of insight, and then tweak and improve, using hard data for greater objectivity. For example, if launching a communications campaign to announce a change to how performance management will be delivered, a company could test several different approaches to messaging with small groups and ask them for the strength of insights when they happened and why. Using this knowledge can significantly improve the way we develop communications around any kind of change or how we launch a new product or strategy.

2. Coaching, learning, and leadership initiatives

Like with general communication strategies, the purpose of coaching, learning, and leadership initiatives is to get people to take action, in addition to helping them grow and learn. This means people need to have new ideas but also the motivation to try new things. Given that the strength of insight correlates to the level of motivation people feel, measuring insight is like getting a direct line into the efficacy of an intervention. This can be done in real time or after any kind of intervention. It can help practitioners understand the key moments in an intervention, to make sure they are given quality attention, and perhaps remove content that hinders the strength of insight. The Eureka Scale can also be used to compare different approaches and interventions to see what works most effectively. For example, when looking to scale a leadership development experience, you might compare the strength of insight people have in a half-day classroom experience versus three one-hour online sessions, exploring both the intensity and the number of insights participants have during the event as well as in the month following.

3. Innovation strategies

Innovation and creativity are critical for organizational success. At the heart of creativity is the frequency and intensity of the insight moment, and organizations invest huge resources, both financial and human, into strategies designed to help employees be more creative. Yet until now, there has been no framework that can be used to measure, tweak, and improve these strategies, individually or across different approaches. This includes how we design leadership retreats and off-sites, which are intended in part to find breakthrough ideas. This is also relevant to the way offices are physically laid out. The Eureka Scale could be used to determine if people have more insights if they have quiet spaces to work or if they are all together in larger rooms and can interact more freely. Additionally, organizations could track the quality and quantity of insights across different types of working styles, comparing full time in the office, people working full time at home, or a mix of the two, to identify the best approach for creativity overall.

Consider the enormous costs and work involved in gathering top leadership teams every year. While part of the benefit of this experience is to build social capital and share knowledge, a key goal of this kind of event is to find new ideas and increase leaders' levels of motivation — two concepts that directly tie to the strength of insight. Here, different design approaches can be assessed through gathering Eureka Scale data across a leadership retreat and comparing this with previous years to identify the kinds of designs that increase insight. For example, are there more insights if a group stays together and shares their learning or if the group is broken into subgroups? Are insights stronger in groups of two, four, six, or eight leaders working together? What time of the day do people have the most insights? This kind of data can be extremely helpful for maximizing what is generally very expensive time spent together.

In summary, across communication strategies, learning interventions, and innovation initiatives, the Eureka Scale provides a consistent and somewhat objective framework for understanding the key messaging, moments, content, or activities that move people to action. Using this framework can help organizations be significantly more data-driven around their people strategies, whether this involves crafting a company-wide email, designing a learning experience, or deciding how much to let employees work from home.

Conclusion

Above, we described our Eureka Scale as it fits within current research and how it supports individual and organizational performance (Davis et al., 2015; Jung-Beeman et al., 2008). Stronger insights will not only boost intrinsic motivational circuitry but also promote better memory formation and solution awareness, all while supporting innovative problem-solving and idea generation. Better understanding of the scale, its components, and implications will spur more actionable applications and inform better decision-making toward viable, measurable solutions (Laukkonen et al., 2020). We often say that organizations should design for insight. What we now know is that the science tells us it's even more impactful to design for the highest insight possible.

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Glossary

Research-based techniques used to detect insight

Electroencephalography (EEG): This superficial measure of the brain's electrical activity is obtained by applying a set of surface electrodes to the scalp that will record cortical brain electrical potentials. This type of neural recording is analyzed by separating the waveforms via frequency. Commonly encountered frequency bands are: delta (<4 Hz), theta (4-7 Hz), alpha (8-12 Hz), beta (13-30 Hz), and gamma (>32Hz). Each of these has been associated with distinct physiological mechanisms. For purposes of eureka moments: The alpha frequency band is associated with restful activity or inhibitory control, as in to gate incoming visual stimuli; and the gamma frequency band has been associated with short-term memory and neural network formation that happens as a function of new synaptic connections.

Functional magnetic resonance imaging (fMRI): This type of imaging uses a powerful magnet to manipulate and measure the oxygenated blood flow throughout the brain. The idea is that the brain areas most active at any time will receive more of the oxygenated blood and areas less active receive less. So this technique results in an image of relative blood flow indicating areas more or less active during an activity or in response to a stimulus. One benefit of fMRI is that it can access deeper brain regions, and from multiple angles, so it can essentially examine the whole brain in relation to the environmental context.

Brain regions that underlie the eureka experience:

As they relate to the functions associated with the eureka experience. Keep in mind, there is a large amount of overlap between each and their co-functionality.

Amygdala: This small, almond-shaped region underlies the processes related to our emotional experience such as cognitive, reward, and learning. As emotional experiences can be both positive or negative in their valence, the amygdala is attentive to both. Its engagement helps us to learn about, form memories of, and develop behavioral actions in response to these emotional experiences, especially those related to insight.

Anterior cingulate cortex: This is a hub for a number of integrative functions, specifically in regards to the emotional experience after conflict. One major theory suggests its involvement in detecting and processing inconsistencies of new stimuli. This can lead to insight as it triggers an attentional shift toward the inconsistencies, and this may lead to insight-based solutions. Additionally, the processing of the emotional experience that occurs alongside an insight moment is thought to be due to activity in this area. Notably, this area is also associated with processing of pain and is discussed in other publications.

Brainstem releasing norepinephrine (NE): As the brainstem is the most evolutionarily conserved brain area, as a whole, it primarily supports the basic, unconscious functions that keep us alive and responsive to the environment. One nucleus here, the locus coeruleus (LC), is the main source of NE for the brain. NE is critical for modulating our state of arousal and attention toward novel things in our environment. It is also involved in the sympathetic arm of our autonomic nervous system, triggering our fight-or-flight response. As such, it directly controls our pupillary diameter, and this observable response occurs at the moment of insight, making it an ideal external indicator.

Dorsal anterior insula: This somewhat hidden cortical structure has been associated with several functions, including sensory and emotional processing. Specifically, it allows us to process a range of internal sensory information, from external to internal bodily sensations. Its involvement in our emotional experience stems from the impact of internal body sensations on our subjective experience of emotion. For instance, a wide range of emotional experiences, from disgust to pleasure, activate the insula.

Hippocampus: This deeper brain region plays a critical role in learning and memory. It is especially important for memories of events and spatial relationships (like remembering where you parked your car). It is also critical for filtering important information into long-term memory, which is determined in a large part by the emotional and rewarding nature of the experience. Thus, emotional and rewarding events, such as those that happen with higher levels of insight, are more likely consolidated into long-term memory.

Nucleus accumbens (NAcc): This area is involved in motivation, reward, and feelings of pleasure and is part of the reward-based mesocorticolimbic pathway. As it is also associated with the limbic system, it helps to mediate our emotional response, which is why activity here is linked to pleasure and motivation. It primarily uses the neurochemical dopamine to communicate with the prefrontal cortex, amygdala, and hippocampal regions.

Orbitofrontal cortex: This ventrally located frontal lobe structure plays a role in the conscious experience of pleasure and reward and is involved in reward-based and decision-making behavior. In relation to eureka moments, it becomes engaged in response to the emotional experience of insight and will impact the decisions that follow the insight and the formation of the memory related to the event.

Prefrontal cortex (PFC): This large brain region, which takes up about 30% of our cortical space, is involved in many of our higher level cognitive functions. While still in the early stages of understanding, it is generally thought of as our executive control driver. Specifically, it is critical for attentional modulation, working memory, and complex decision-making. As it relates to the moment of insight, its involvement seems to relate to the attentional focus toward the resulting solution and the learning that follows.

Right parietal-occipital area: This combination of cortical regions is highly involved in sensory and motor processing. Specifically, the occipital lobe underlies visual perception and processing. So when thinking about its involvement in solving problems via insight, the type of EEG signal recorded over this region indicates that the sensory input to the occipital region is being gated or suppressed. This can help to enable insight since it dampens new incoming, and possibly distracting, signals to allow for the current problem to be solved via insight.

Right temporal area: The temporal lobe is one of the major cortical regions of the brain. As a lobe, it has a number of functions associated with it, including sensory, language, memory, and emotion. Important here is its role in the formation of memory and emotional processing. Based on the type of EEG signal recorded here, specifically a burst of the gamma frequency band, which is associated with the formation of new neural connections, it suggests that its involvement is centered on the network formation at the moment of insight.

Superior temporal gyrus: This brain area has been associated with the integration of distantly related information when working to understand novel ideas or problems. Its engagement during an insight moment could be to combine this distant and quieter activity. It should be noted that this area is also highly linked to language perception.

Ventral tegmental area (VTA): This region is involved in generating feelings of reward and motivation and will impact learned reward-directed and motivational behavior. It is part of a larger reward-based mesocorticolimbic circuit. Most of the cells release dopamine and these are largely projected to areas like the prefrontal cortex so that the reward can impact executive control and ultimately decision-making behavior.

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