Gamification: A cognitive–emotional view

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Abstract

Successful gamified systems engage players by eliciting their positive and negative emotions. However, prior literature provides little guidance on how to create emotional experiences through gamified design. This paper reviews work in psychology and neuroscience to examine the interactive processes of cognition and emotion and connect them to gamification. More specifically, it draws upon a model of the cognitive structure of emotions and the mechanics–dynamics–emotions framework for gamification to advance a cognitive–emotional view of gamification.

Keywords: Cognition, Emotion, Gamification, Mechanics, Neuroscience.

Gamification: A cognitive–emotional view

> *"The importance of emotion to the variety of human experience is evident in that what we notice and remember is not the mundane but events that evoke feelings of joy, sorrow, pleasure, and pain. Emotion provides the principal currency in human relationships as well as the motivational force for what is best and worst in human behavior. Emotion exerts a powerful influence on reason and, in ways neither understood nor systematically researched, contributes to the fixation of belief"* (Dolan, 2002, p. 1991).

1. Introduction[1]

We read books we cannot put down, watch movies from which we cannot look away, and play games we cannot turn off. We experience a rollercoaster of emotions through these media: interest in an unfolding story, fear in dire situations, anger at antagonists, and satisfaction in eventual triumph. Emotions are central to engaging in literature (Oatley, 1995), movies (Smith, 2003) and, more recently, games (Mekler et al., 2016).

The most engaging games, like great works of fiction, evoke emotions in the player that vary in their nature, valence, and intensity. Despite practitioners long recognizing the importance of emotions in games (Kane, 2003), scholars have only recently started studying the complex flow of positive and negative emotions in game design (Bopp et al., 2018; Mekler et al., 2016).

> "Video games lead the way as interactive products that create emotion. More emotional than software and more interactive than films, games manipulate player affect to create poignant experiences" (Lazzaro, 2009, p. 156).

This need for emotional depth also applies to the interrelated notions of a serious game (Marsh & Costello, 2012), i.e., a full-fledged game designed for non-entertainment purposes (Walz & Deterding, 2015), and *gamification*, i.e., the process of enhancing services through gameful experiences to support value creation (Huotari & Hamari, 2017). A gameful experience involves the subject perceiving that she is playing a game, whether or not the activity is normally

[1] We use acronyms to refer to two frameworks throughout the paper: MDE = mechanics–dynamics–emotions; OCC = Ortony, Clore, and Collins. We describe them further when first mentioned in the text.

associated with games (McGonigal, 2011). The target outcomes of gamification vary with the task(s) being gamified, and include increasing attention and engagement (Dale, 2014), enhancing service encounters (Larivière et al., 2017), and improving decisions (Hamari & Koivisto, 2013).

Prior work on gamification has examined both psychological and behavioral outcomes, but predominantly views psychological outcomes as cognitive motivational processes (Hamari et al., 2014) such that outcomes depend on triggering the desired cognitions. *Cognition* refers to mental activities pertaining to acquisition and application of knowledge, including processes such as attention, learning, language processing, problem solving, and memory (Anderson, 1990). Emotional processes, when studied in gamification, focus primarily on positive affect (e.g., enjoyment) in a general sense (e.g., Cardador et al., 2017), or on aesthetic experience as a more holistic phenomenon (e.g., Suh et al., 2017). While acknowledging multiple perspectives of emotion, we view *emotions* as mental states of varying intensity representing evaluative (i.e., positive or negative) reactions to environmental stimuli (Ortony et al., 1990). Both practitioner and academic literature on gamification assume positive affect as "good" and negative affect as "bad" (e.g., McGonigal, 2011; Mollick & Rothbard, 2014). While it is important to ensure that most gamified experiences are generally enjoyable, there is a need to understand how both positive and negative emotions may help achieve desired goals.

Advances in cognitive neuroscience have led to the view that "emotion and cognition are only minimally decomposable," with behaviors determined by complex and blurred interactions along multiple affective and cognitive dimensions (Pessoa, 2013, p. 155). Thus, gamification research should complement the current focus on cognitive processes with a deeper understanding of relevant emotional processes. Gamified experiences should evoke specific positive and negative emotions, such that those emotions interact with cognitions to influence behavior and enable desired outcomes. Based on this premise, this paper seeks to *develop an integrative perspective for gamification design, incorporating emotions and cognitions related to desired outcomes*.

We pursue this objective by drawing upon conceptually compatible principles of gamification, emotion, and cognition, including: the mechanics–dynamics–emotions (MDE) framework (Robson et al., 2015), which is the only gamification framework to explicitly position emotion as a key factor; the cognitive structure of emotions developed by Ortony, Clore, and Collins (OCC; 1990) for understanding sources of emotions; and the BrainMap taxonomy of cognitive functions (http://brainmap.org/taxonomy/behaviors.html#Cognition), which is derived from a meta-analytic database of functional brain imaging experiments (Fox & Lancaster, 2002). Figure 1 presents a high-level view of the proposed interactions of emotion and cognition in terms of perceptions and valenced reactions of individuals to three facets of the world: consequences of events, actions of agents, and aspects of objects (Ortony et al., 1990).

---*Insert Figure 1 here*---

Next, we discuss the relevant key concepts in gamification, emotion, and cognition, before illustrating how cognition and emotion may interact in a gameful experience. We subsequently integrate MDE and OCC frameworks to develop a cognitive–emotional view of gamification, including propositions for designing gamified systems. We conclude with a research agenda.

2. Gamification

Gamification is an emerging research area in business and information systems (Colbert et al., 2016; Liu et al., 2017). We adopt its definition as the "process of enhancing a service with affordances for gameful experiences" to support value creation (Huotari & Hamari, 2017, p. 25), where affordances refer to aspects of the system that contribute to a gameful experience. Affordances may take the form of implicit cues or more concrete design aspects—for simplicity, we refer to these affordances as game design elements. Illustrative game design elements include points, leaderboards, levels, badges, and challenges (Deterding et al., 2011). Game design elements may, individually or together, elicit in the user specific emotions and cognitions that promote desired outcomes from the gamified experience. However, little research has focused on the specific emotional outcomes of gamified experiences—beyond the general premise that enjoyment and satisfaction are desirable, while distress and dissatisfaction are undesirable.

Gamification generally leads to positive outcomes (Hamari et al., 2014), but some findings are mixed (e.g., de-Marcos et al., 2014) or show a negative influence of gamification (e.g., Hanus & Fox, 2015). Failed efforts to gamify, estimated to be about 80 percent (Gartner, 2012), result from poor game design (Burke, 2014). It is through elements of game design that gameful experiences manifest, and these elements should interact to evoke emotional engagement in the player.

The MDE framework of gamification, illustrated in Figure 2, incorporates mechanics, dynamics, and emotions as interdependent aspects (Robson et al., 2015). It was adapted from a game design approach focusing on mechanics, dynamics, and aesthetics (Hunicke et al., 2004), with the intention to better distinguish emotional aspects of engagement outcomes related to gamified experiences. Mechanics comprise the "designed" aspects of the gamified system, including: setup mechanics, i.e., the context of the experience (e.g., single- or multi-player, available objects in the game); rule mechanics, i.e., goals, allowable actions, and constraints (e.g., time limits, achievement criteria); and progression mechanics, i.e., the rewards and reinforcements used to influence player behavior (e.g., points, badges, and leaderboards).

---*Insert Figure 2 here*---

Dynamics relate to the players' actions and are not under the designers' control. Characteristics of the players influence how they interact with the gamified system, such that players may approach a game with different strategies and react to game mechanics in different ways (Bui et al., 2015). Game mechanics then respond to player inputs, creating a cycle of emergent run-time behavior characterizing the experience of "playing." Dynamics are difficult to predict, and it is through dynamics that unintended consequences of gamification arise.

MDE highlights the importance of emotional experiences in motivating human behavior. Consistent with prior work on gamification, this framework proposes that enjoyment is the most important player engagement goal, and it may come from a variety of positive emotions such as excitement, surprise, and triumph over adversity. Extending this premise, MDE acknowledges the importance of mixed emotions such as disappointment or sadness resulting from failures within the game. However, MDE does not provide guidance for designing such experiences.

While MDE suggests that designers should focus first on controlling the experience through mechanics, then on dynamics, and lastly on players' emotions, it inversely suggests that, for players, emotions are "more important than the rules that make them possible" (Robson et al., 2015, p. 416). Returning to the three facets of the world perceived by individuals, we suggest that game mechanics can control aspects of objects, regulate consequences of events, and enable or constrain actions of agents to generate desired emotions and cognitions.

3. Emotion

We view emotion as a mental state of varying intensity representing evaluative reactions to environmental stimuli (Ortony et al., 1990). Research on emotion has achieved little consensus regarding core tenets such as sources, frameworks, or definitions of emotion. Various theories, illustrated in Table 1, examine emotions. Despite being based on distinct premises, they all recognize emotions as adaptive, and as not inherently desirable or undesirable. Further, most theories account for three common dimensions that are relevant in the design of gamified systems: *arousal* (or intensity), i.e., a subjective feeling of activation or deactivation (Barrett, 1998); *valence*, i.e., a subjective feeling of pleasantness or unpleasantness (Barrett, 1998); and *feeling state*, i.e., a subjective cognitive representation of the specific mental and bodily changes experienced when confronted with a particular event (Scherer, 2005).

---*Insert Table 1 here*---

Research widely acknowledges the existence of a relationship between cognition and emotion, but the primacy of one over the other has been a topic of fundamental disputes in psychology (Lazarus, 1982; Zajonc, 1980). The OCC framework acknowledges the essential role of cognition in the structure of emotions and suggests that emotions result from a valenced reaction (positive or negative) to the consequences of events, actions of agents, or aspects of objects (Ortony et al., 1990). Each source triggers different emotions. For example, in considering conditions of other vs. self and desirable vs. undesirable events, an event that is undesirable for some other may result in gloating (positive valence) or pity (negative valence). A revised version of OCC (Steunebrink et al., 2009) resolves several ambiguities in the original model. We will return to this model later as an avenue for design guidance in gamification.

4. Cognition

The information processing view (Lachman et al., 2003; Simon, 1979) has long dominated the research on cognition. Rooted in the work of Newell and Simon (1972), this view likens the human brain to a computer that can conduct rapid serial processing of stimuli to achieve cognitive goals. Functions such as attention, memory, and decision making are generally associated with cognition. Recent work in cognitive neuroscience has produced a classification of cognitive functions via the BrainMap Project (http://www.brainmap.org), which aggregates published neuroimaging experiments to enable meta-analytical studies of human brain function and structure (Fox & Lancaster, 2002). The cognitive functions listed in the BrainMap taxonomy include attention, language (orthography, phonology, semantics, speech, and syntax), memory (explicit, implicit, and working), music, reasoning, social, somatic, spatial, and temporal.[2]

Neuroscience research integrates emotion and cognition as inseparable influences in the neural processes that lead to behavior (Dolan, 2002; Pessoa, 2013; Phelps, 2006). One of the most basic of these processes is the relationship between emotion and attention via the amygdala, a brain region that has been primarily associated with emotion but is receiving increasing attention as a critical hub that regulates flow and integration of information between brain regions in cognitive–emotional interactions (Pessoa, 2008). The amygdala is central to fear processing, and modulates sensory processing via evolutionary mechanisms of self-preservation by focusing attention (a cognitive process) on potential threats (Phelps, 2006). Other processes involving a complex interplay of cognition and emotion include emotional learning, processing of social stimuli, changing emotional responses, and decision making (Pessoa, 2013; Phelps, 2006). We suggest that such interactions are common in games and gamification, and seek to inform theory and practice in gamification through greater attention to how these processes operate. Appendix A provides examples of how emotions may interact with each cognitive function in the BrainMap taxonomy.

5. Gamification, cognition, and emotion

Current approaches to studying gamification adopt psychological perspectives based on traits, behavioral learning, cognition, self-determination, interest, or emotion (Sailer et al., 2013). We suggest that integrating cognitions and emotions offers greater opportunities for research and

[2] BrainMap also offers a classification for the neuroimaging study of emotions. We do not use it as it aggregates valence and intensity into one element and provides insufficient detail on feeling states.

practice. Drawing on the relevant neuroscience literature, we introduce such a view with three areas of inquiry[3] that may help in studying gamified systems. We then adapt the theory of the cognitive structure of emotions (Ortony et al., 1990; Steunebrink et al., 2009) to gamification and describe how mechanics can engender specific emotions.

5.1 Emotion and memory

The amygdala supports the encoding, consolidation, and recollection of memories linked to emotional stimuli (Phelps, 2006). As part of the encoding process, the amygdala modulates the neural signal by imbuing it with additional import and information related to the emotional experience, facilitating later episodic recall of emotional material (Pessoa, 2013). Memory relates closely to learning, with learning typically resulting from effort over time, and a memory representing a mentally stored representation of a specific occurrence at one point in time (Kazdin, 2000). Emotional arousal enhances the consolidation process through which memories become stable over time (Phelps, 2006). In the context of video games, the view of games as “controlled training regimens” is supported by growing evidence that performance improvements from video games are “paralleled by enduring and functional neurological remodeling” (Bavelier et al., 1990, p. 763). Thus, we underscore learning as an important outcome of gamification in the proposed cognitive–emotional view.

Gamification can influence both working memory (Ninaus et al., 2015) and episodic memory (Kapp, 2012). Gamified working memory training increases motivation to train near maximum levels as compared to traditional training (Ninaus et al., 2015). Episodic memories typically have strong associations to a particular time or place, so the potential for creating them through immersive games is high. To the extent that elements of game design can improve

[3] These areas are illustrations, not an exhaustive list or the most important ones (because importance depends on the context).

motivation and provide an immersive and memorable environment through emotional experiences, designers can harness cognitive–emotional processes to help achieve memory and learning goals (Kapp, 2012). For example, one study positions rewards as antecedents of episodic memory, with reward value and reward uncertainty proposed as factors in a reward signal (Mason et al., 2017). In that study, the value of the reward played a major role in modulating episodic memory, but the uncertainty did not. If there is a need for a player to clearly remember a piece of information, the association of a valued reward with an immersive experience may be an effective mechanism. Such effects may be contingent on the context of the person, task, and technology.

5.2 Emotion and attention

Attentional resources are valuable but increasingly scarce. In situations involving limited attentional resources, stimuli that evoke emotional responses are more likely to capture attention (Dolan, 2002; Phelps, 2006). Automatic processing occurs for emotional stimuli (Zajonc, 1980), particularly in response to fear or threat conditions. More specifically, activity in the amygdala relates to activity in the visual cortex such that increasing emotional arousal via the amygdala results in a physiological state consistent with that of increased attention (Pessoa, 2008). Emotion may also be "preattentive," such that subliminal emotional stimuli result in expected physiological responses (Dolan, 2002). Additionally, emotion may prevent "inattentional blindness," i.e., the tendency to miss a second stimulus after detecting an initial visual stimulus (Dolan, 2002).

Immersive first-person shooter games enable faster and more accurate attention allocation (Granic et al., 2014). Focused attention is key to achieving cognitive absorption or "flow" (Agarwal & Karahanna, 2000; Csikszentmihalyi, 2000). One framework in the literature on games suggests three levels of flow: engagement (e.g., attraction and investment), engrossment (e.g., narrowed focus and increased emotional involvement), and total immersion (e.g., experience of presence and empathy) (Brown & Cairns, 2004). In a state of total immersion in a game, players experience greater anxiety and other negative emotions, which sustain and increase engagement (Jennett et al., 2008). To the extent that game design elements can evoke emotions that facilitate a deeper state of flow, gamification may harness this cognitive–emotional process to create engaging and enjoyable experiences for players. Designers should exercise caution when promoting deeper engagement, as greater levels of emotional and subjective attachment in game-based science learning can produce less reliable learning (Cheng et al., 2015).

For example, challenge (a design element representing a difficult in-game task) increases engagement, immersion, and perceived learning in a game-based learning context, and engagement (but not immersion) subsequently increases perceived learning (Hamari et al., 2016). A challenge presents players with a difficult task and may evoke negative emotions such as frustration and anxiety during attempts to meet the challenge. This type of emotional involvement, within a certain range of intensity, promotes immersion (Jennett et al., 2008) and the associated state of sustained attention. While an immersive experience may lead to greater enjoyment, designers should promote "just enough" emotion to maximize meaningful engagement so that neither user engagement nor instrumental outcomes are compromised.

5.3 Emotion and decision making

Cognitive and emotional processes together influence decision making. Judgment improves through enhanced bodily states stemming from emotional arousal, such that the recollection of prior feeling states can bias decision making through anticipation of reward or punishment

(Dolan, 2002). The amygdala plays a central role here, interacting with the pre-frontal cortex to compute expected rewards from decision options (Pessoa, 2013). Emotion also plays an important role in processing social stimuli, such as the recognition of emotions in the faces and actions of others, during decision making (Phelps, 2006).

The negative emotions triggered by games include frustration, anger, anxiety, and sadness, and the "pretend context of video games may be real enough to make the accomplishment of goals matter but also safe enough to practice controlling, or modulating, negative emotions in the services of those goals" (Granic et al., 2014, p. 72). This balance of an imaginary context and real emotions enables adaptive regulation strategies such as problem solving and reappraisal as players learn to deal with negative emotions in productive ways (Granic et al., 2014). Strategy games, typically implemented as simulations of complex processes such as civilization building or warfare, create cognitive scaffolding to support decision making (Morris et al., 2013) and improve self-reported problem-solving skills (Adachi & Willoughby, 2013).

Consider the design element of limited resources, in which the player must prioritize goals and make decisions under constrained conditions. Such a constraint may lead to fear of making suboptimal decisions, and relief when the decision works out (or disappointment when it does not). In the perceived context of a game, however, the player will have the opportunity to work through the variety of emotions and cognitions in a "safe" place within the gamified system.

6. Designing for emotion

To offer initial guidance on the process of designing game mechanics to elicit specific emotions, we draw on the OCC framework (Ortony et al., 1990; Steunebrink et al., 2009). The OCC framework focuses on the structure of emotions and the associated causal chains, assuming three major facets of the world that are subject to changes from the perspective of a given individual: consequences of events, actions of agents, and aspects of objects. With a change to any facet, an individual may experience a valenced reaction of a certain type and of variable intensity, depending on the context. To illustrate, a reaction to a consequence of some event (e.g., earning a badge) may be a coarse-grained sense of pleasure (positive valence) or displeasure (negative valence). If the focus is on a referent other (e.g., another player earning the badge), the experienced emotion becomes more specific, such as resentment or happiness for the other individual.

Figure 3 presents the revised OCC model (Steunebrink et al., 2009). Terms within boxes in the figure represent emotions resulting from the conditions indicated above each, with emotions listed lower in the figure being more specific to conditions indicated earlier in the chain. Each box contains example emotion terms for a positive (top) and negative (bottom) valenced response. The dotted lines (added) represent the scope of propositions (P1–P3) which we develop in the following sections. Since a key design goal for this model is to provide a computationally tractable system that can be used to support artificial intelligence applications (Ortony et al., 1990), we suggest that it provides a useful starting point for determining how to evoke particular emotions through gamified design. For example, if fear modulates the desired cognitive process, based on this structure it would be advisable to create some event that portends a negative prospective consequence for the player.

---*Insert Figure 3 here*---

The MDE framework proposes three categories of game mechanics (setup, rule, and progression) that are present in all games and gamified experiences (Robson et al., 2015). In developing the propositions, we directly relate these mechanics to the OCC model. The second aspect of the MDE framework, dynamics, relates to both actions of agents and consequences of events, representing the "emergent" aspect of games. It is the interaction of the player with the mechanics—their reactions to events, objects, and other agents—and the subsequent reactions of the system that generate the dynamics. We address emotions, proposed as the final consideration for designers but the most important aspect for the player, in greater detail in the sections below. Given the established role of emotions in modulating cognitive processes, we develop propositions below based on desired emotional outcomes. While some consideration of mechanics is necessary in the early stages of any gamified design, we suggest that designers *first consider the desired emotional outcomes, and that those considerations should play a role in the mechanics (i.e., setup, rule, and progression) and target dynamics of the gamified experience.*

6.1 Consequences of events

To evoke pleasure or displeasure in a player, there must be some mechanics to generate an event with a relevant consequence. Setup mechanics can evoke emotions through consequences of events, for example via random generation of the player's in-game character's attributes. If those attributes are desirable but of no actual consequence in future interactions (e.g., a character's virtual appearance), they are unlikely to elicit emotions at a deeper level than general pleasure or displeasure. But if those attributes offer prospective future consequences (e.g., a limited number of virtual "lives"), the underlying setup mechanics may generate hope or fear. When those consequences occur (e.g., gaining or losing a life), this may shift to joy or distress. Thus, if the goal is to evoke joy, game mechanics should instantiate an event with a desirable consequence in the gamified environment.

Rule mechanics can also evoke emotions through consequences of events. In mobile applications, rule mechanics may involve consequences of geolocation or physiological monitoring, such as earning badges for checking in or accumulating points for physical activity. For example, the "activity rings" on the popular Apple Watch product involve a set of rule mechanics for making progress toward daily fitness goals. As a wearer exercises, she may develop fear that the current exercise routine will not be enough to meet the daily objective. Thus, if the goal is to evoke fear, game mechanics should create conditions with prospective negative consequences (implicit or explicit).

Progression mechanics, representing the rewards and incentives tied to players' actions in a gamified experience, can also evoke emotions through consequences of events. Rewards may include points, badges, social status, etc. Awarding a badge, for example, is only likely to lead to satisfaction if the actual consequence of earning that badge confirms some prior hope felt by the player. If the player did not have prior hope to earn the badge, the emotional outcome may be a more general sense of pleasure. Thus, to evoke satisfaction, it is necessary to first create awareness of the consequence and ensure that the consequence has relevance to the player.

> Proposition 1: Game mechanics should align with the desired emotional outcome, such that prospective and actual consequences of an event, and the confirmation of such consequences, are consistent with the revised OCC model.

6.2 Actions of agents

Actions of agents represent a potentially difficult set of conditions through which to elicit emotions in a player. Because the dynamics of player choices and behaviors are unpredictable, design of gamified mechanics should focus on either 1) probabilistic player responses to setup, rule, and progression mechanics; or 2) more scripted and controlled behaviors of simulated agents. In the case of the former, especially in multi-player environments, game mechanics should encourage or discourage certain types of actions to maximize the probability of eliciting the desired emotions. In the case of the latter, the ability of designers to control the behavior of the “other agent” affords more opportunity to evoke specific emotions, but the intensity experienced may be lower when the player knows that she is interacting with a machine.

Setup mechanics may establish how many agents are involved and the nature of those agents, and may assign initial conditions to those agents such as locations or roles. For example, consider a scenario in which an organization gamifies its software development function, and that one of the “players” assumes the role of a “spy.” By conducting covert code reviews, the spy may experience pride in the role, while others may react to the actions of the spy (uncovering bugs in their code) with either gratitude or anger. Thus, to elicit gratitude, game design mechanics must be in place to support and encourage the interactions necessary to identify agents, observe their actions, and favorably evaluate the consequences of those actions.

Rule mechanics are instrumental in enabling and encouraging certain types of interactions among players, but the dynamics of the experience cannot guarantee attainment of the desired emotional state. Returning to the example of the software spy, some type of rule mechanic may be in place to initially protect the spy from detection, and another to eventually uncover the spy’s identity through the actions of other agents or after a period of time. Rule mechanics inform the actions of agents, and other agents may perceive and respond to those actions on the basis of conditions consistent with the revised OCC model.

Progression mechanics will relate indirectly to the actions of agents, as they typically provide a signal of progression as a consequence of an event, which may have occurred as a result of the action of an agent. Returning to the example of the software spy, if the spy completes a mission to identify a certain number of bugs in a given time period, and the goal is achieved, this could result in gratification on the part of the spy, or a deeper sense of relief if the mission was accomplished without the undesirable consequence of being detected. These emotions relate to both the actual consequences of events and the associated consequences of agent actions in the OCC model.

> Proposition 2: Game mechanics should align with the desired emotional outcome, such that mechanics enable and constrain the actions of human agents to encourage the desired emotional states through the ability to identify agents, observe their actions, and recognize the consequences of those actions consistent with the revised OCC model.

6.3 Aspects of objects

Aspects of objects provide opportunities to elicit a more limited but very important set of emotions to achieve player engagement. Beyond general like or dislike, the primary condition in differentiating emotions resulting from the aspects of objects is the aspect's familiarity, with familiar aspects resulting in love or hate, and unfamiliar aspects resulting in interest or disgust.

Setup mechanics play the strongest role in eliciting this set of emotions, as it is the setup mechanics which dictate what objects (and aspects of objects) will be available in the gamified experience. The setup mechanic of progressively advanced levels, for example, draws on unfamiliar aspects of the game to spark and maintain the interest of the player. Setup mechanics can also affect the intensity of experienced emotions. For example, a sensory environment with high-resolution graphics, realistic audio, and haptic feedback enables a rich and immersive gameful experience which should increase the intensity of emotions experienced.

Rule mechanics may support emotional experiences in gamification to the extent that they alter and highlight aspects of objects (although setup mechanics constrain the availability and composition of these objects in the gamified environment). A rule mechanic may, for example, unlock a new level, based on some achievement in the game. While the new level (a setup mechanic) may evoke interest, and the achievement (a progression mechanic) may lead to joy, the actions of the player in accordance with rule mechanics in achieving the goal are integral in generating emotions such as pride, gratification, and relief.

Progression mechanics may directly or indirectly impact emotions that result from evaluating the aspects of objects in the gamified environment. For example, challenges (a progression mechanic) issued by a mobile fitness app may involve familiar aspects that a player likes or dislikes. A challenge to complete a five-kilometer run may be appealing to one player, while a challenge to complete fifty push-ups in a day may be unappealing to the same player. Setup mechanics determine the existence of the challenge and its possible aspects, while the progression mechanics instantiate the challenge.

Proposition 3: Game mechanics should align with the desired emotional outcomes, such that the player's familiarity with objects and their aspects is consistent with the revised OCC model.

Taken together, we propose the cognitive–emotional view of gamification, summarized in Figure 4. The circles in Figure 4 represent the components of the original MDE framework, with the emotions component extended to include cognitions via overlapping circles representing their interactions. The original framework directly connects each component to the others via bidirectional arrows that represent reciprocal influences among the components. We unpack these influences by incorporating facets of the world through which these relationships manifest.

---*Insert Figure 4 here*---

Three elongated ovals in Figure 4 represent the facets of the world proposed in the OCC model, and bidirectional arrows represent interactions among these facets. Weighted arrows indicate the ability of these facets to influence (while also depending on) emotions and cognitions, as well as their interactions with mechanics and dynamics. Aspects of objects relate to mechanics primarily through the design of the gamified experience. Actions of agents relate primarily to the dynamics of interactions with the gamified system, and are not under the direct influence of designers. Consequences of events relate to both the design of the mechanics and the dynamic interactions, as it is through the "rules of the game" that interactions occur and consequences are realized. Table 2 provides a more comprehensive assessment of each relationship, including the source framework(s), implications for gamification design, and an illustrative game-based example of each relationship.

---*Insert Table 2 here*---

7. Research agenda and discussion

We propose a future research agenda that focuses on the evaluation, enrichment, and expansion of the above cognitive–emotional view of gamification. Below, we discuss these aspects, with illustrative opportunities in each.

First, we suggest empirical evaluation of the cognitive–emotional view of gamification. Specifically, experimental research can begin to isolate the effects and interactions of specific emotions and cognitions in gamified experiences. This work should extend the literature in psychology and neuroscience to the context of gamification to establish a baseline for applying this view to gamification design. How do certain elements of game design influence specific cognitions and emotions? How do these elements operate in isolation, and in conjunction with others? Field studies should investigate these questions in a more natural context. Where field experiments are possible, designs should replicate and extend prior experimental work. Such inquiry should go beyond questions of "does this gamification treatment improve performance?" to questions such as "do negative emotions generated via competition through a leaderboard improve problem-solving performance?" and "do positive emotions generated through outperforming competitors lead to inattention to non-game activities?"

To illustrate this complexity and provide an integrated example of a single aspect of one mechanic, Table 3 suggests potential emotional and cognitive outcomes of the consequence of a change in leaderboard standings. We do not propose that the relationships specified here are deterministic, only that certain outcomes are probable given the intention of the designers, context of the task, and disposition of the player. As a result of moving up the leaderboard, a player may experience a sense of joy.[4] This sense of joy may increase working memory by more deeply engaging the player but may also reduce awareness of the external environment (Gray, 2001). Conversely, moving down a leaderboard may result in a feeling of distress. Ideally, the player will respond by reappraising the situation and applying problem-solving skills (Granic et al., 2014). However, this may also reduce working memory as the player experiences increased off-task and self-relevant thoughts (Forster et al., 2015).

---*Insert Table 3 here*---

We suggest methodological pluralism in empirical testing. Controlled laboratory experiments offer a compelling case for identifying isolated effects. However, a more comprehensive view of gamification (or other complex phenomena) requires multiple perspectives and research methods. In addition to experimental and survey data, neurological and physiological methods for measuring emotion and cognition can improve our understanding. Researchers should use such measures with caution, as physiological correlates of emotions may overlap. For example, when playing computer games, emotional arousal and attentional engagement, which are both indicators of engagement (Ravaja et al., 2006), may raise and lower the heart rate, respectively. Pairing physiological measures with self-report or observational data,

[4] We do not suggest that this is the only emotion experienced when moving up a leaderboard; for example, a player may simultaneously experience a feeling of pride if she feels that the move up the leaderboard is a positive consequence of her own actions (i.e., action of agent).

and triangulating between multiple physiological and neurological measures (e.g., heart rate + face recognition), can help to avoid measurement risks while assessing dynamic emotional profiles (e.g., Nacke & Lindley, 2008).

Second, we suggest further enrichment of the proposed cognitive–emotional view of gamification, including the development of finer-grained theoretical models with testable hypotheses. This work can go deeper into the OCC hierarchy, investigating specific emotions and cognitions to explicate the processes mediating the effects of gamified design on target outcomes. Moreover, scholars can draw upon established theories from complementary domains for logic and insights. For example, 25–30 percent of studies on gamification are in education (Hamari et al., 2014; Seaborn & Fels, 2015). Research can extend cognitive load theory (Paas et al., 2010), which is often used in the education literature, by incorporating the effects of emotion and gamified design on different types of cognitive load.

Future research can build on the cognitive–emotional view of gamification by considering potential moderating effects such as individual differences. For example, individuals oriented toward performance goals seek recognition of positive performance, while those oriented toward mastery goals seek the opportunity to improve their abilities (Pintrich, 2000). Providing poor performance feedback may have a detrimental effect for an individual with a strong performance orientation but a positive effect for an individual with a strong mastery orientation. While both individuals may experience an ostensibly “negative” emotion, disappointment may cause persistence in learning when paired with mastery orientation, or frustration with the gamified experience when paired with performance orientation.

Third, we suggest expansion of the proposed cognitive–emotional view of gamification into emerging domains, across multiple levels of analysis, and through a temporal lens. Technology is fundamentally changing how we work and play, and research should explore opportunities to integrate (e.g., gamify) these experiences in the context of emerging phenomena such as mixed reality (e.g., Holopainen et al., 2018), artificial intelligence (e.g., Harley et al., 2017), smart interactive services (Wünderlich et al., 2013), and distributed ledger technology (e.g., Synnes & Bai, 2017). Emerging frameworks and growing interest around gamification in the information systems field (e.g., Liu et al., 2017) will help to drive inquiry on these technological advances.

Levels of analysis deserve attention in future research. Gamification holds promise for improving outcomes at individual, team, organizational, and societal levels. Much of the present work is at the individual level, where neuroscience can offer substantial insights on emotion and cognition. Another emerging research area concerns team-level cognitions and emotions (e.g., Menges & Kilduff, 2015; Wildman et al. 2014). Such research can evaluate how gamified systems support team-level outcomes by influencing team cognitions and emotions. The streams of research on organizational cognition (Walsh, 1995) and the role of emotions in organizations (Fineman, 2007) can provide insights into the alignment of gamified approaches with organizational culture (emotional) and decision-making (cognitive) processes.

Gamified experiences are inherently processual, making it critical to study the role of time in these experiences. Their design can influence perceptions of time, sequences of events, and cycles of regularity that control cognitive and emotional flow. Recent work acknowledges the need for more complex emotional experiences in achieving deeper engagement and persuasion. A call for "serious experience" in serious games illustrates this need (Marsh & Costello, 2012), as does a call for similar consideration in the design of everyday objects (Fokkinga & Desmet, 2012). In healthcare, persuasive health narratives can manage the "emotional flow" of real-world experiences to improve well-being (McColl-Kennedy et al., 2017; Nabi, 2015). By identifying effective patterns of cognitive and emotional arousal in existing games and gamified systems, researchers and designers can develop templates for creating desired experiences. Future gamified experiences could become carefully engineered encounters that evoke specific emotions at desired levels of intensity, in the appropriate sequence, and match the targeted cognitions to achieve the desired outcome.

8. Conclusion

Emotion represents a significant uncharted territory in gamification, which is somewhat surprising considering the role of emotional engagement in gameful experiences. We offer a fresh theoretical lens—the cognitive–emotional view of gamification—that integrates literature in psychology and neuroscience to better understand the alignment of desired cognitions, emotions, and game mechanics. This proposed view of gamification contributes by answering calls for greater theorizing around gamification (e.g., Liu et al., 2017), and informing gamification research by explaining how elements of game design can interact with both emotion and cognition to produce desired outcomes. Moreover, it provides guidance to the designers of gamified systems, who can draw upon it for insights to enhance the likelihood of a successful gamified design, such as by integrating a “map” of the structure of emotions with the types of game mechanics that can elicit various emotions. This cognitive–emotional view may also be applicable to the broader domain of game design, as designers seek ways to enrich player experiences.

Gamified experiences, like games, should be enjoyable. However, the enjoyment of a gameful experience, like the enjoyment of literature or film, involves both positive and negative emotions. To support desired instrumental outcomes while also engaging the player, we must simultaneously consider cognition and emotion in the design of gamified systems. The cognitive–emotional view of gamification offers one potential avenue for pursuing this goal.

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Figure 1. Facets of the world, emotion, and cognition.

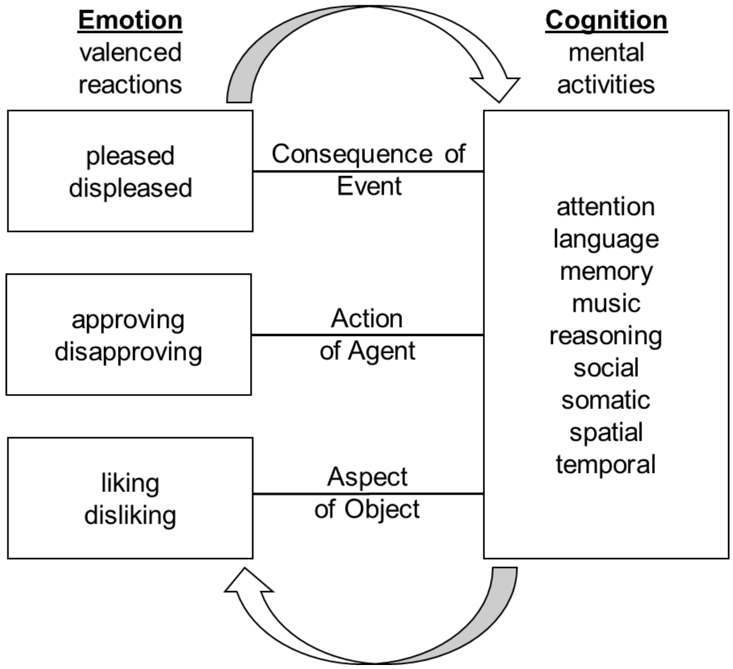

Figure 2. MDE framework (adapted from Robson et al., 2015).

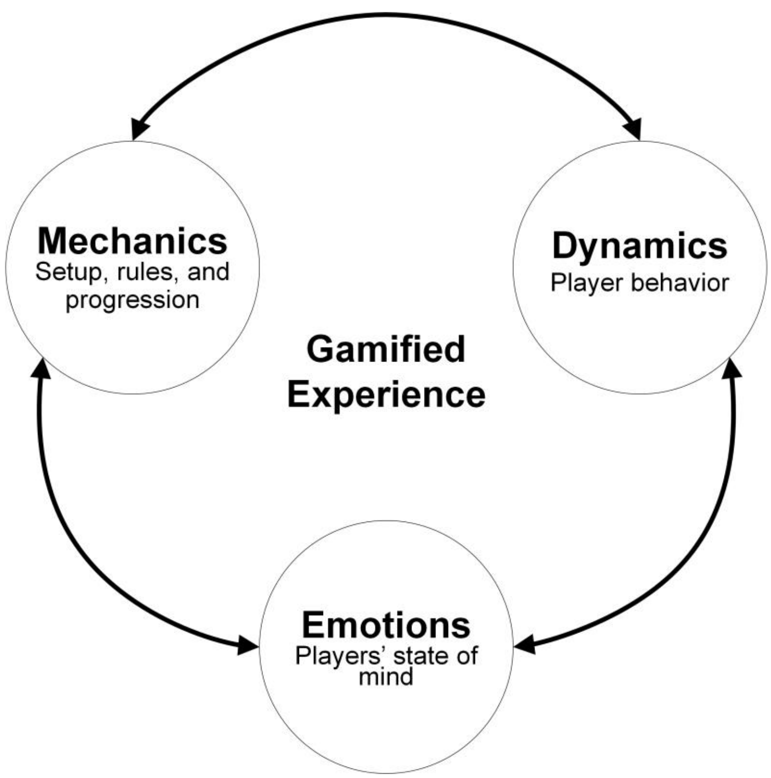

Figure 3. Revised OCC framework (Steunebrink et al., 2009).

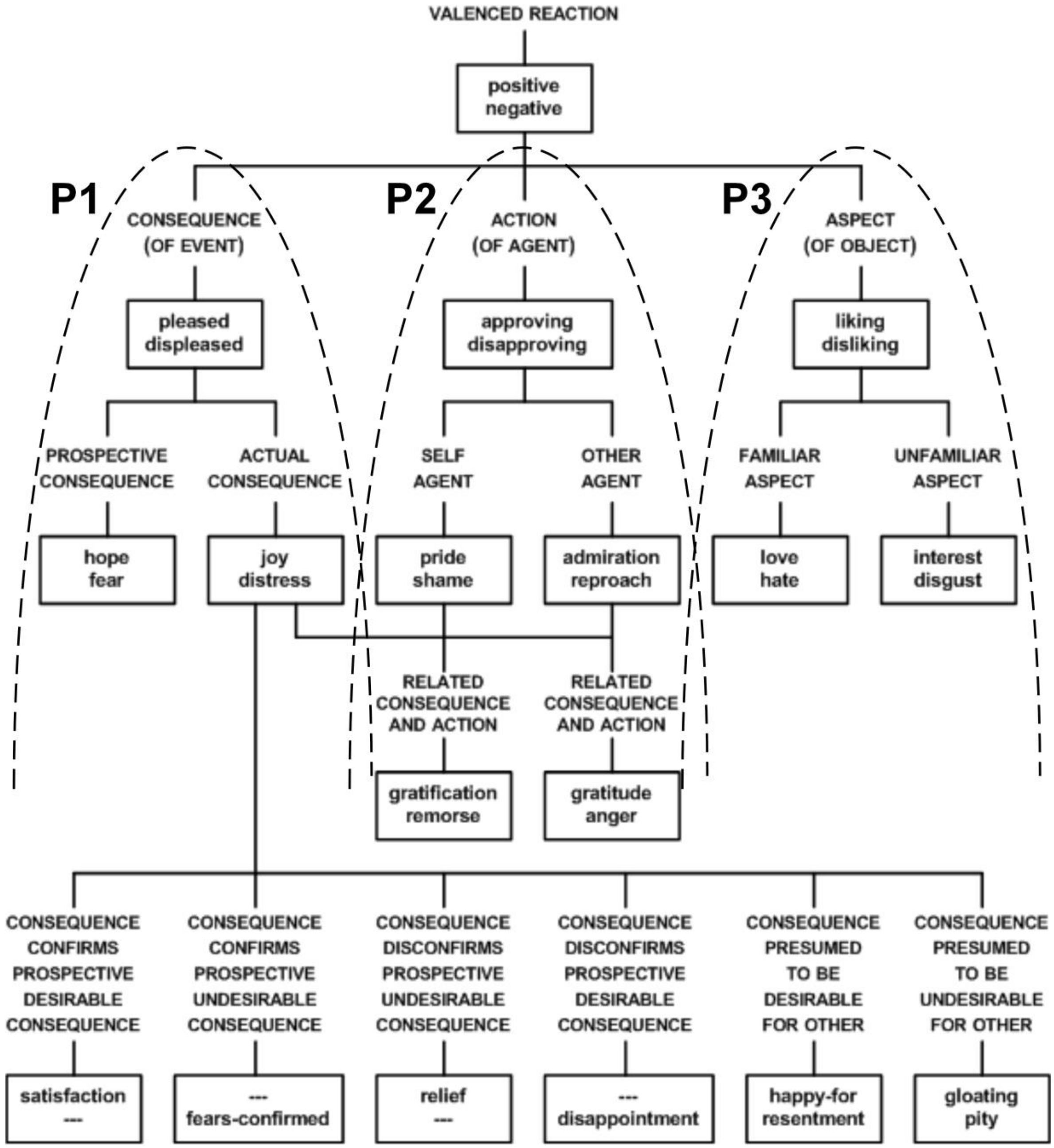

Figure 4. Cognitive–emotional view of gamification.

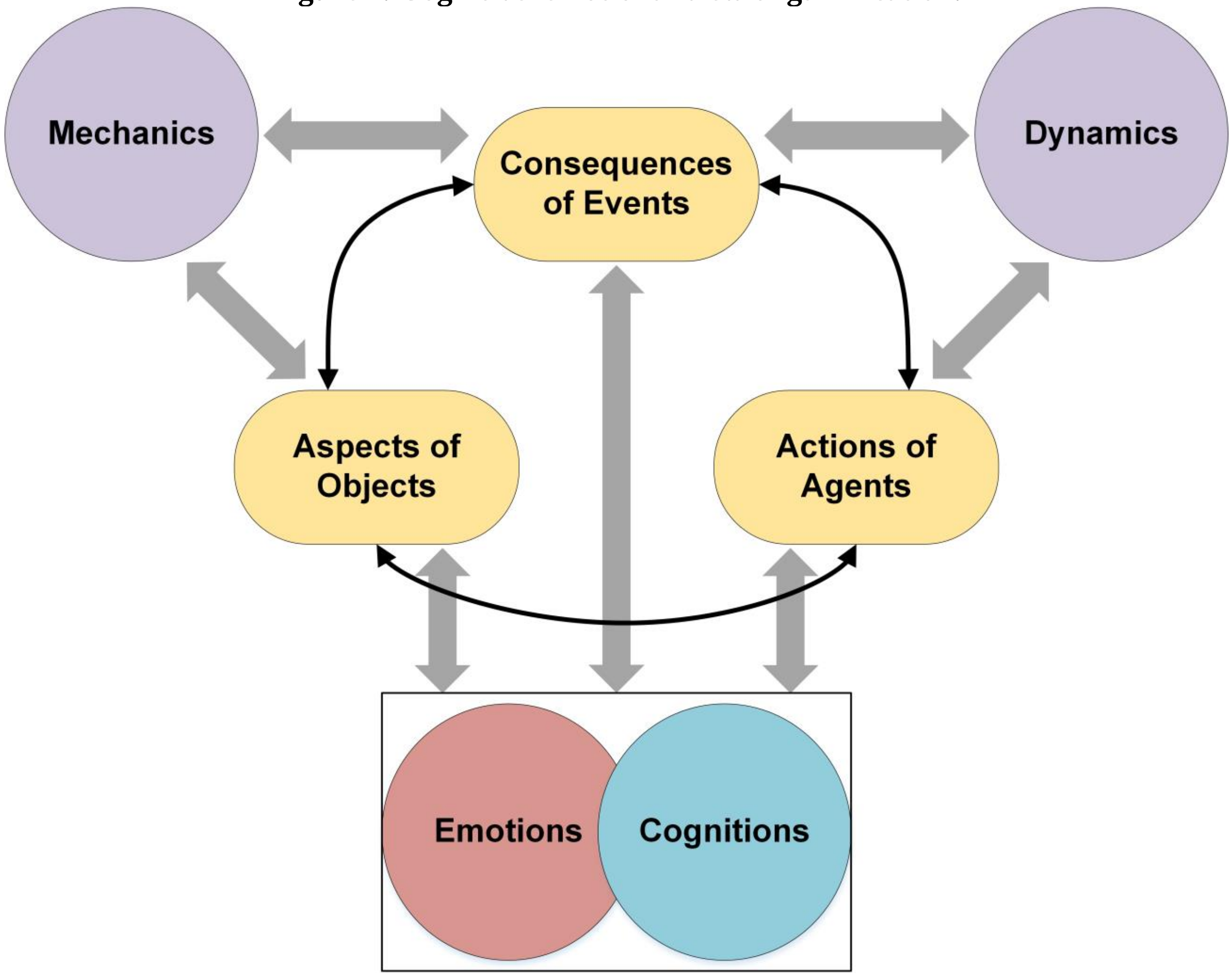

Table 1. Summary of major emotion theories.

Emotion theory	**Premise**
Differential Emotions Theory (Izard, 1992)	Innate (non-cognitive) emotions develop early; learned (social–cognitive) emotions develop later
Cognitive Emotion Theory (Lazarus & Folkman, 1984)	All emotions result from cognitive appraisal, whether automatic or volitional
Appraisal Theory (Scherer, 1999)	Emotions result from unconscious strategies for coping with particular types of situations

Table 2. Integrating MDE, OCC, and BrainMap for gamification.

Relationship	Framework	Implications	Illustration
Mechanics–Dynamics	MDE	Mechanics enable and constrain dynamics. They are the rules (mechanics) of play (dynamics).	In chess, the initial board configuration and capabilities of each piece enable and constrain the progression of the game.
Actions of Agents–Aspects of Objects	OCC	Agents take actions to change or preserve aspects of objects.	To preserve the safety of an important piece, a chess player may surround that piece with others.
Actions of Agents–Consequences of Events	OCC	Agents take actions in response to consequences of events, and those actions in turn become events with consequences.	A player may react to a chess move by capturing an opponent's piece, but in turn may be exposing her piece to capture.
Aspects of Objects–Consequences of Events	OCC	Aspects of objects may change as a consequence of an event, and may trigger other events as a consequence of those changes.	A previously captured piece may be restored to active play as a consequence of a pawn reaching the opponent's end of the chess board, and also results in the pawn's removal from active play.
Mechanics–Aspects of Objects	MDE, OCC	Mechanics dictate the aspects of objects and consequences of events in a gameful experience.	"Virtual lives" may be an aspect of the player's avatar, and the game ends as a consequence of losing the last life.
Mechanics–Consequences of Events	MDE, OCC		
Dynamics–Consequences of Events	MDE, OCC	Dynamic play emerges from actions of agents as they respond to consequences of events.	A player may respond to losing a life by adjusting strategy or tactics.
Dynamics-Actions of Agents	MDE, OCC		

Mechanics–Cognition/Emotion	MDE, OCC, BrainMap	Design of mechanics influences whether gamification leads to desired or undesired emotions and cognitions.	In a cooperative first-person shooter (FPS) game, a mechanic to display helpful team member actions may encourage gratitude or admiration, while a mechanic that allows team members to harm each other may encourage reproach or resentment.
Dynamics–Cognition/Emotion	MDE, OCC, BrainMap	Emergent aspects of the gameful experience result in cognitive immersion and emotional "flow."	Immersion in FPS games leads to faster and more accurate attention allocation (Green & Bavelier, 2012).
Aspects of Objects–Cognition/Emotion	MDE, OCC, BrainMap	Proposition 1	Realistic sensory environments (such as in a FPS game) can increase the intensity of experienced emotions, impacting the extent to which cognitions are modulated.
Actions of Agents–Cognition/Emotion	MDE, OCC, BrainMap	Proposition 2	Being killed by another player in a FPS game can evoke feelings of anger and frustration, but may also lead to adaptive strategies via reappraisal and problem solving (Granic et al., 2014).
Consequences of Events–Cognition/Emotion	MDE, OCC, BrainMap	Proposition 3	A limited number of "lives" in a FPS game may evoke fear, and enhance memory of events when that sense is heightened.

Table 3. Example map of mechanic-emotion-cognition effects

Mechanic	**Aspect of the world**	**Potential emotion activated**	**Potential impacts on cognition**		**Relevant literature**
			Positive	**Negative**	
Leaderboard	Consequence of Event: Standing Increases	Joy	Increased working memory	Decreased spatial cognition	Gray, 2001
	Consequence of Event: Standing Decreases	Distress	Reappraisal and problem solving	Reduced working memory	Forster et al., 2015; Granic et al., 2014

Appendix A. Cognitions and interactions with emotions

Cognitive process	Definition (quoted from BrainMap[5])	Example relationship with emotion
Attention	"The act or state of attending by applying the mind to any object of sense or thought."	Activity in the amygdala is highly correlated with activity in the visual cortex, such that increasing affective significance (*intensity*) results in increased attention (Pessoa, 2008), particularly for *fear* or threat stimuli.
Language	"The mental faculty associated with knowledge of a system of objects or symbols, such as sounds or character sequences, that can be combined in various ways following a set of rules, especially to communicate thoughts, feelings, or instructions."	*Valence* and arousal (*intensity)* exert independent effects on word recognition such that people recognize positive words more quickly than negative words, and calming words more quickly than arousing words (Kuperman et al., 2014).
Memory	"The mental faculty of retaining and reviving facts, events, or impressions, or of recalling or recognizing previous experiences."	The amygdala supports encoding, consolidation, and recollection of memories linked to emotional stimuli (Phelps, 2006), and negative *valence* emotion enhances memory accuracy (Kensinger, 2007).
Music	"The mental faculty associated with the art of sound in time that expresses ideas and emotions in significant forms through the elements of rhythm, melody, harmony, and color."	Composers and performers cognitively structure music (via tempo, dynamics, etc.) to express and elicit specific *emotional states* (Krumhansl, 2002).
Reasoning	"The mental faculty of forming conclusions, judgments, or inferences from facts or premises."	Prior *emotional states* bias decision-making processes toward or away from a particular option (Dolan, 2002).
Social Cognition	"The mental faculty associated with how people process social information, especially its encoding, storage, retrieval, and application to social situations."	Emotion plays an important role in processing social stimuli, such as the recognition of *emotional states* in the faces and actions of others (Phelps, 2006).
Somatic	"The mental faculty associated with knowledge of one's body."	*Fear*-related health information can cause cognitive–emotional sensitization (bias) and somatic health complaints (Brosschot, 2002).
Spatial	"The mental faculty associated with awareness of the three-dimensional expanse in which all material objects are located and all events occur."	Spatial cognition is enhanced by a withdrawal (negative *valence*) state and impaired by an approach (positive *valence*) state, whereas working memory is subject to the opposite effects (Gray, 2001).
Temporal	"The mental faculty associated with the system of sequential relations that any event has to any other as past, present, or future."	Perceptions of time are distorted by *emotional states* such that "time flies when you're having fun" and slows down as a result of boredom (Droit-Volet and Meck, 2007).

Notes. Words in *italics* represent one of the three dimensions of emotion (valence, intensity, or subjective emotional feeling).

[5] http://brainmap.org/taxonomy/behaviors.html#Cognition (Fox & Lancaster, 2002).

Appendix References

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