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Building Better Digital Badges: Pairing Completion Logic With Psychological Factors

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Abstract

Background. Digital **badges** are used in games and simulations for purposes such as **incentivizing** learning, identifying **progress**, increasing **time** on task, and **credentialing**. Designing effective badges is complicated by **psychological** factors mediating the processes of recognizing, orienting toward, and acquiring badges.

Aim. This article analyzes digital badges through **mechanics** and **psychology**. This approach involves understanding the underlying **logics** of badges as well as the **experiential** nature of badges-in-use. The proposed **model** provides additional insight about badges and recommends **design** strategies to complement existing scholarship.

Procedure. This article examines an existing model of **completion logic** for digital badges. This model is expanded upon by pairing these formal mechanics with relevant **psychological** theory, summarizing key **principles** that pertain to how people **interact** with badges. It then considers three **dimensions** of badges-in-use—social, cognitive, and affective—reviewing examples and analyzing the relationship of badging to debriefing.

Outcome. Understanding the relationships between **formal** completion logics and the psychological **experience** of badging allows designers to better design, deploy, and critique badging systems, leading to more **effective** implementations within simulation and gaming contexts. A **design matrix** and a series of design **recommendations** for badging are derived from the presented perspectives.

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Gamification was defined by Deterding, Dixon, Khaled, and Nacke (2011) as "the use of design elements characteristic for games in non-game contexts" (p. 13) and by Hamari, Huotari, and Tolvanen (2015) as "affording gameful experiences or using design reminiscent of games" (p. 139). Such work positions "*gamefulness* as a complement to *playfulness*" (Deterding et al., 2011, p. 13), arguing design goals taking into account user experiences and behaviors are critically important for understanding the implications of gamification for user engagement. We argue for design heuristics that incorporate game design elements in a manner affording gamefulness, or the "experiential and behavioral quality" of play (Deterding et al., 2011, p. 15), and acknowledges the importance of social and psychological forces acting upon both players and designers, an argument also made in prior literature (Lineham, Kirman, & Roche, 2015).

Work in gamification has recently been studied in relation to other areas of simulation and gaming (Dubbels, 2013; Hense et al., 2014; Kapp, Blair, & Mesch, 2014; Landers, 2014) as well as in specialized types of computer-based training such as surgery simulation (Kerfoot & Kissane, 2014; Lin, Park, Liebert, & Lau, 2015). Gamification can exist in a variety of contexts, such as the use of leaderboards (Landers & Landers, 2015), but digital badges are one of the most popular strategies. Badges are used for various purposes, such as for credentialing and reputation (Deterding et al., 2011), as alternatives to grades and degrees (Rughiniş & Matei, 2013), as incentives to promote additional user activity and effort (Hamari, in press), or as frameworks for helping to recognize learning accomplishments found in nontraditional learning situations such as employee reeducation or lifelong learning (Grant, 2014). The preponderance of trophies and achievements displayed on player profiles is evidence of digital badging's popularity within commercial video games (Abramovich, Schunn, & Higashi, 2013). In addition, along with elements such as narrative, characters, avatars, and multiplayer functionality, digital badges are important for the selection of appropriate technologies for educational games and simulations (Young et al., 2012). Composed of images, captions, and optional currencies (e.g., point values), digital badges can take on different configurations and layouts, depending upon the media in which they are implemented. Figure 1 shows two common variations.

Despite an abundance of research focusing on digital badges in recent years, guidelines for developing effective design strategies within the psychological context of user experience are scarce. We are beginning to see comprehensive reports of design recommendations based on specific pedagogical functions such as recognizing, assessing, motivating, or studying learning in digital badges (Hickey et al., 2014). However, such principles focus heavily on issues such as pedagogy, alignment, goal-setting, and

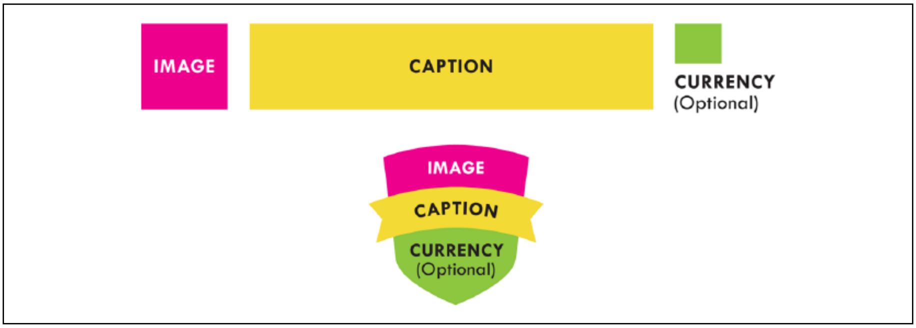

Figure 1. Two common designs for digital badges.

the materiality of badges, while the playful user experiences within specialized environments are not yet fully understood. Encouraging work is being done with video game achievement design (Blair, 2011a, 2011b) but such work is focused more on the world of commercial entertainment games. One complicating factor is that *gameful* design is somewhat nebulous as a strategy; it is difficult to identify concrete recommendations to follow when adopting an effective design strategy for building more effective badges for specific purposes. Nonetheless, literature focusing on gameful design helps to identify issues to consider when developing more effective badging systems for particular purposes.

In this article, we articulate such a model for digital badge design. This model enables us to make specific recommendations for badges in simulation and gaming systems by exploring three primary factors influencing the user experience of digital badges: affect, social interactions, and cognition. This approach combines both formal logic and user experience. To develop the model, we provide a detailed review of the mechanics of digital badges, extend these mechanics to consider their psychological implications for user experience, and discuss several specialized examples of badges interacting with other game elements and player experiences.

The first step in articulating a comprehensive model for badge design is to study the underlying mechanics of badges. To unpack and clarify this underlying structure and functionality, we review Hamari and Eranti's (2011) *completion logic* as a means of better understanding the rules underlying digital badges. The second step to defining such a model is to consider badges in use as experiential systems. To do this, we consider completion logic as it pertains to players' behaviors, thoughts, and emotions, particularly when badges are used as incentives. Specifically, this logic is considered within the context of affective, cognitive, and social factors; characteristics, we argue, that directly impact the user experience of badging. Such work broadens our understanding of digital badges.

After discussing the literature on completion logic and proposing an argument for important psychological factors to consider, we then present examples of completion logics as cases for considering learning within simulations and games. We also discuss the usefulness of digital badges as debriefing tools for complex learning exercises. The article concludes with a detailed discussion of three specific types of digital badges used in games, two from commercial entertainment games and one from an independently designed game created to teach players about brain function. From this discussion and our consideration of the relationship between badge design and player experiences, we propose eight design recommendations.

Background

Overview and Definitions

Badges have a long history in the physical world. Early badges date back to symbolic accoutrements worn by knights, religious voyagers, and politicians (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013). More modern examples include military medals, boy/girl scout patches, and classroom-based tokens earned in course-management systems. Modern digital badges are virtual markers of achievements. A digital badge is "a validated indicator of accomplishment, skill, quality, or interest" (HASTAC: Humanities, Arts, Science, and Technology Alliance and Collaboratory, n.d.), and a large body of recent research is beginning to explore the utility of digital badges in various scenarios and for various purposes (see Grant & Shawgo, 2013, for an annotated bibliography). Within video games, digital badges are referred to as achievements or trophies (Hamari & Eranti, 2011; Jakobsson, 2011) awarded to players for many types of behaviors and accomplishments. Montola, Nummenmaa, Lucero, Boberg, and Korhonen (2009) described such achievements as "secondary reward systems," where "players can complete optional sub-goals to earn achievement awards that are visible to other players" (p. 94). Montola and colleagues also outlined typical themes used to group achievements. These include categories such as completion, collection, loyalty, curiosity, luck, and fandom; each category includes badges distributed for playing games that reinforce those general themes. A digital badge can also be defined according to its use as a reputation-building tool, such as "an online image that tells people about a new skill that you've earned" (Masura, 2014, p. 9). Figure 2 shows some example digital badges.

The diverse categories and purposes for digital badges pose interesting questions for learning and the shaping of player interactions within virtual spaces. For example, how might players be encouraged to adopt particular play styles leading them through the information most relevant to the learning objectives? How can the less critical portions of a simulation be underemphasized in order to make room for the high-stress scenarios with which a learner needs more experience? How does the virtual environment support a player's acquisition of knowledge related to the learning objectives versus other extraneous knowledge necessary to play the game or move through the simulation? To answer questions such as these, we must consider not only the logic embedded within badges but also the relationships between formal logics and the psychological experiences of players.

Figure 2. Example digital badges.

Psychological Functions of Badge Acquisition

Individual and team-mediated interaction styles are psychologically complex, and a full treatment of these topics is outside the scope of this article. We can, however, make some general observations to guide us toward a model for better understanding how to design effective badges. For example, we know that the experience of play within video games is connected with individuals' experiences of self-esteem, satisfaction, emotion, motivation, catharsis, arousal, learning, competence, and many other complex cognitive, emotional, and behavioral phenomena (Juul, 2013). Similarly, we recognize that a multitude of psychological factors shape human behavior in human–computer interaction more broadly defined; as Newell and Card (1985) explained, a divide-and-conquer approach is necessary to make progress in understanding the complex relationship between human psychology and computational systems. Factors directly related to digital badging are summarized in our Analysis section in Table 1.

We can better understand the relationship between the formal logic of badging systems and the psychology of badge acquisition by broadly considering how human experience correlates with the typical functions of badge-based achievement systems. Gibson et al. (2013) noted that badges serve three primary purposes: providing incentives, promoting exploration/discovery, and credentialing. Each of these requires different design considerations, and each purpose will have psychological effects on players. For example, in their sociopsychological framework, Antin and Churchill (2011) articulated five primary psychological functions for achievements: goal setting, instruction, reputation, status/affirmation, and group identification. In this article, we argue that the functions that shape the user experience of badging are further mediated by cognitive, social, and affective forces.

Table 1. Core Psychological Concepts Relevant to Digital Badging.

Concept	Why Relevant to Badging	Key References
Autonomy	Humans have a psychological need to feel free and "in control."	See Self-Determination
Competence	Humans have a psychological need to be efficient and effective, mastering behaviors as necessary to attain competency.	See Self-Determination
Competition	Correlations have been identified between competition in games, motivation, and players' conceptualizations of self-efficacy.	Vorderer, Hartmann, and Klimmt (2003)
Curiosity	Curiosity, sometimes conceptualized as "exploratory behavior," finds that humans exhibit behaviors that indicate a preference for environmental variability. This preference is directly relevant to badges designed to encourage exploration.	Loewenstein (1994)
Feedback	Properly framed information provided at the appropriate time can enhance understanding of performance.	Hattie and Timperley (2007); Kluger and DeNisi (1996)
Goal Setting	Properly designed goals that are difficult to achieve, but still attainable, are highly motivating.	Fishbein and Ajzen (1975); Landers and Callan (2011); Locke and Latham (2002);
Motivation	Properly designed badges can motivate learners and change behaviors.	Abramovich, Schunn, and Higashi (2013); Cameron and Pierce (1994); Hakulinen, Auvinen, and Korhonen (2013);
Playfulness	Playfulness and learning are not mutually exclusive. In many regards, learning is achieved through play, and subject matter acquisition can be inherently playful.	Huizinga (1955); Rodriguez (2006)
Reinforcement / Recognition	Desirable behaviors can be made more prevalent through reinforcement or recognition.	Deterding (2014); Fogg (2009a, 2009b);
Relatedness	Humans have a psychological need to connect meaningfully with others.	See Self-Determination.
Reputation	Reputation is a form of social currency in an "informal economy" in which people must identify other people for various purposes, such as collaboration, without ever having met them. This need has significant implications for the credentialing function of badges.	Emler (1990)

(continued)

Table 1. (continued)

Concept	Why Relevant to Badging	Key References
Reward	Reward is often conceptualized along intrinsic (the reward is the act itself) and extrinsic (the reward is something outside of the act) dimensions. However, it is possible for extrinsic reward not to decrease intrinsic motivation if framed properly.	Deci (1972); Deci, Koestner, and Ryan (1999)
Scarcity	Exclusiveness can make virtual items more desirable.	Hamari and Lehdonvirta (2010)
Self-Determination	People engage in voluntary behaviors like play to feel competent, to have meaningful choices and experience freedom, and to connect to other individuals. These constructs speak to intrinsic motivation issues. See also autonomy, competence, and relatedness.	Deci and Ryan (1985); Ryan, Rigby, and Przybylski (2006); Sheldon and Filak (2008)
Self-Regulation	The process of pursuing goals is psychologically complex; how individuals behave when pursuing goals is shaped by a number of psychological constructs within self-regulation theory, including feedback, affect, input, attention, and focus.	Boekaerts, Pintrich, and Zeidner (2005)
Social Interaction	Social interactions and social feedback can influence motivation and change behaviors. See also relatedness.	Antin and Churchill (2011); Das and Lavoie (2014); Gibson, Ostashewski, Flintoff, Grant, and Knight (2013)

For example, goal setting necessitates prioritization, mental representations, problem solving, and other complex cognitive processes (Austin & Vancouver, 1996). Goal-setting theory has also been studied in relation to self-regulation theory (Landers, Bauer, Callan, & Armstrong, 2015), investigating how the ability to control oneself is a key driver of people's ability to direct their learning actively toward a chosen goal. Such theory helps us understand why players care about earning non-physical rewards such as badges. One extrapolation from the synthesis of these two theories would be that the psychological satisfaction from competently and determinedly achieving goals is sufficient cognitive reward in and of itself.

Antin and Churchill's (2011) other psychological functions of achievements, such as instruction, directly involve cognition but also social and affective factors. This connection is evident when we consider the impact of a learner's mood on receptivity to instruction or a learner's ability to demonstrate competency in a subject by explaining the content to another individual. Reputation, status/affirmation, and group identification all depend on one's standing in social circles, a standing often represented by one's ranked place within an achievement leaderboard posted inside specific communities. Further, we know that cognitive, social, and affective characteristics have been linked to complex psychological processes such as the regulation of emotion (Gross, 2002); this connection has also been hypothesized as a necessary dimension for considering better frameworks for achievement design (Hamari & Eranti, 2011).

As a starting point for what must ultimately be a more thorough treatment, we can begin a holistic investigation of the psychology of digital badging by focusing on these three areas: the cognitive, the affective, and the social. Each of these relates directly or indirectly to those *psychological functions* for badges as defined by Antin and Churchill (2011). The cognitive dimension is important for understanding phenomena such as learning, self-regulation, and goal orientation. The affective dimension is critical for evaluating players' feelings of motivation, arousal, and curiosity, feelings often targeted by badge designers. The social dimension is important because digital badges are mechanisms for reputation and credentialing. These dimensions have also been used in other studies, such as the identification of particular patterns of behavior in goal orientation and achievement (Dweck & Leggett, 1988). However, before reviewing these psychological constructs more closely, we must also be mindful of the *design functions* of badges—their reasons for use within games or simulations.

Design Functions of Badge Acquisition

As the diverse psychological functions already cited indicate, badges can be useful within games and simulations for a variety of purposes. For example, given the complexity of learning, technology, and instructional objectives present within educational games and simulations, measuring learning is often challenging. It is also difficult to redirect player behaviors meaningfully after levels have already been designed, coded, and distributed in playable formats. Digital badges are potentially useful in these types of scenarios.

Pedagogically speaking, learning outcomes can be divided into discrete criteria embedded by instructors or game designers into badges earnable by players. Since badges can be deployed after systems have been designed, they can also serve as useful post hoc behavior redirectors if data reveal less-than-optimal user strategies. For example, after reviewing gameplay data, designers might wish to use badges to encourage exploratory play patterns. If they wanted players to explore more of the nooks and crannies within an already designed level, these designers could deploy badges to reward players for collecting and reading every journal scattered throughout the level. If players were properly motivated to earn such a badge, this type of play behavior would cause them to explore and learn more about the virtual world.

In this fashion, badges catalyze different play styles. For example, Hamari (in press) found participants in a badged condition were more likely to interact with a resource-sharing website in a number of different ways. Similar effects have been found in learning domains (Denny, 2013). As an example, this strength of badges could be leveraged to increase trainee likelihood to engage more often with a training simulation in order to gain additional practice.

Although these examples speak to their potential utility as design interventions for games and simulations, the inclusion of badges does not guarantee improvement in learning or performance (Fanfarelli, 2014a). Effectively implementing digital badges is challenging (Grant, 2014; Hickey et al., 2014), so it is important to understand effective badge design principles at a more granular and detailed level.

In order to understand how badges function within the context of user experience, we need to understand, in detail, their underlying mechanics first. Such knowledge allows us to understand the mechanics of badges so we can recognize how particular components of badges might be adjusted to influence specific aspects of the user experience such as player motivation or focus. With this goal in mind, we will provide an overview of completion logic and then propose a model for badge design, taking into account this formal logic as it relates to cognition, affect, and social interaction.

An Overview of Completion Logic

The rules and logical procedures undergirding badge mechanics are known as completion logics (Hamari & Eranti, 2011). Completion logics are one of the three primary elements of badges, along with signifier and reward (Haaranen, Hakulinen, Ihantola, & Korhonen, 2014; Hamari & Eranti, 2011). We can conceptualize the structure of badges as shown in Figure 3. Here, the signifier is the *front-end,* or user view of a badge, while the completion logic is the *back-end,* or the hidden rules connecting user behaviors (gameplay) to system outcomes (badge awarding). When the conditions specified by the completion logic are met, some reward is provided to the player. The reward may or may not have an associated currency, such as points. This currency can be used to add to an overall score or position a player higher on a leaderboard. However, other types of out-of-game currency are also possible, such as the earning of participation points or course grades for the earning of specific badges in a course.

While signifiers show us how badges look and rewards tell us how badges compensate, completion logic tells us how and when badges react to player behaviors. These completion logics must consider both the state of the system and the rules for earning each badge. For example, an achievement might be offered within a simulation for flying an aircraft according to certain parameters, such as maintaining an altitude for a certain number of minutes. When this objective is performed correctly, a digital badge is provided to the player, marking the accomplishment.

Hamari and Eranti (2011) noted that a trigger is required to evaluate completion logic. Triggers can be activated by system events, such as particular conditions being met within the system, or player events, such as obtaining an item or completing an objective. Unlocking a digital badge happens when a trigger is activated, the completion logic is evaluated, and the logic's necessary conditions are met. Often, such conditions involve multiple levels of nested logic. For example, even a simple *collection* logic in a 2D platformer game might have requirements several levels deep. Such a system might provide a player with a badge upon earning 1,000 gold coins. One such logic for this badge is represented by the pseudocode below:

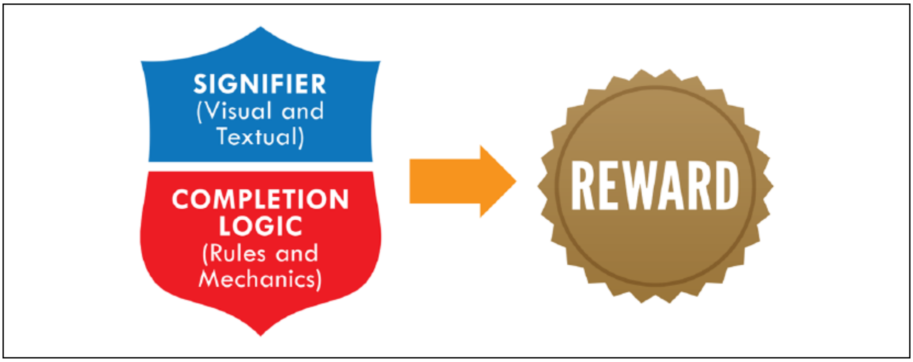

Figure 3. The mechanics of badges.

IF (CoinsAreBeingCollected) AND IF (CoinsCollected equals 1000) AND IF (CoinCollector Badge is not yet unlocked) THEN UnlockBadge(CoinCollector)

In the example above, the *CoinsAreBeingCollected* trigger fires every time a coin is collected by the player. The first level of the completion logic then evaluates the broadest condition—whether 1,000 coins have yet been collected. The logic is then further evaluated to determine whether the player has previously been awarded the badge. If not, the *CoinCollector* badge is awarded. If so, the trigger is ignored and the badge is not awarded. As the example illustrates, even seemingly simple badge mechanics are sometimes more complicated than they first appear. Further, the precise mechanics of badge triggers will vary depending on the programming language used to implement them.

Completion Logic in Detail

Hamari and Eranti (2011) deconstructed completion logics into four distinct components:

1. *triggering action or event*. As previously explained, the triggering action defines the requisite change required to the game state in order to unlock the badge. The trigger answers this question: What does a player have to do (e.g., correctly diagnose a patient) or what system-invoked event must take place (e.g., the round has ended due to time running out)?
2. *pre-requirements for the game setting*. Pre-requirements outline necessary conditions within the game state prior to a trigger being activated. Examples include the selection of correct game mode, difficulty, or player role. Pre-requirements disable triggers unless the pre-requirements are first satisfied.
3. *conditional requirements for the game state*. Conditional requirements specify how, when, where, in what time frame, and for which players the trigger takes place. These requirements refer to events or states necessary in the game session

before the trigger can unlock the badge. An example would be a conditional logic requiring the player to correctly diagnose a patient's illness without running any unnecessary tests.

4. *multiplier*. The multiplier specifies the number of instances necessary to satisfy the defined requirements. Examples of multipliers include diagnosing ten patients, saving 50 lives, or completing three scenarios.

As this four-component model suggests, the completion logic paradigm contains richness, even independent of player psychology. However, a number of questions can be further considered when linking completion logic to psychological factors. An extended model taking these factors into account is presented in the following section.

Analysis

Extending the Badging Model

To design effective badges, the completion logic model proposed by Hamari and Eranti (2011) must be considered in relation to the experiences of players. This broader model necessarily considers users' psychological relationships with badges and the social forces shaping those relationships. Reconciling the psychology of participants with the technology of a badging system and the social context surrounding them provides us with a fuller and more holistic understanding of badges as they are experienced by real individuals within specific games and simulations. This reconciliation is congruent with a player-centric design approach. Such an extended model suggests a number of additional factors to be considered in frameworks for effective digital badge design. For example, we can think about how badges function in games and simulations as tools for goal-setting, feedback, and debriefing (Figure 4). Understanding how badges function in these capacities requires a fuller understanding of how completion logics relate to player experience and psychology.

The multi-part model we propose retains the core elements of digital badges—signifier, rules, and rewards—but further considers the relationship of player psychology and sociality to each element. Extending this model to accommodate sociopsychological factors suggests a number of useful questions for designing and developing digital badging systems in games and simulations and opens up other areas of research within specific themes. For example, we might consider the optimal characteristics for inspiring competitive behaviors for earning badges, or the optimal symbolic constructions to improve players' motivation when playing a game or experiencing a simulation. Further, we can observe more granularly the interactions between specific badge acquisitions and psychological factors—for example, player cognition when following the rules leading to a badge's awarding or the affective outcome of earning a challenging badge.

This extended model, which conceptualizes a relationship between completion logic and three specific psychological dimensions, is the primary focus of this article. However, prior to this more focused analysis, we summarize a more general view of the psychology of digital badging.

Figure 4. Potential roles of digital badges in games and simulations.

Key Psychological Concepts Linked to Digital Badging

Table 1 considers a number of psychological areas of research and key ideas with implications for digital badges. While the table presented here is not intended to be comprehensive, it does capture a number of the major theories at work within badging systems.

Analyzing Badge Experiences Through Cognitive, Social, Affective, and Debriefing Heuristics

Using Table 1 as a guide, we propose analyzing badge experiences taking careful consideration of completion logic as it relates to the psychological context of acquiring badges. Following this line of thinking, we suggest developing a matrix of interactions wherein specific badge functions are listed in each row and psychological factors are

Table 2. A Matrix Model for Digital Badge Design.

	Cognitive Factors	Social Factors	Affective Factors
Incentivizing learning	Example 1: MEDULLA		
Credentialing players		Example 2: CS:GO	
Encouraging exploration			Example 3: GOAT SIMULATOR
Debriefing	Example 4: Badges for debriefing		

listed in each column. This approach is useful for more concretely identifying the role of digital badges in simulations and games and for building more effective digital badges for these purposes.

In our example matrix (Table 2) we focus on social, cognitive, and affective dimensions (for reasons explained in the Background section). However, this type of matrix can easily be extended in either direction by adding additional rows to indicate other purposes for badges or additional columns to indicate other psychological factors. Similarly, others might wish to develop more specific psychological criteria, such as self-regulation mechanisms used in cognitive tasks, for their own purposes. In this example, the cell containing the intersection of each pair suggests specific design recommendations or areas for critique useful within that context.

We note that design can be precision crafted for specific purposes, as examples 1-3 propose, or broadly considered as a holistic design pattern, as example 4 suggests. In other words, we do not mean to imply that badges function only within particular cells of this matrix (e.g., as tools that mediate player credentialing through social factors, as the middle cell considers). Rather, we propose this matrix as a useful design or critique tool when conceptualizing how digital badges might fit or are currently used within particular simulations and games. The matrix uses cognitive, social, and affective dimensions as significant aspects to consider.

We next consider examples from three interacting cells (Examples 1-3) to further discuss specific badge completion logics as they interact with user experience in specific video games. We then discuss an exercise where we consider each column in relation to a specific purpose, debriefing, following our overall approach to design (Example 4). In our discussion section, we then suggest specific design recommendations derived from these analyses.

Example 1: Cognitive Factors for Incentivizing Learning: MEDULLA

Cognition is a necessary consideration for any game or simulation where player learning is required. It includes a diverse assortment of constructs, including memory, information processing, choice, decision-making, creativity, and others (Runco & Chand, 1995). MEDULLA (Fanfarelli, 2014b) is one such example; its core game mechanics ask players to engage in the three stages of memory: encoding, storage, and retrieval (Poon, Fozard, Cermak, Arenberg, & Thompson, 1980), and the game uses

Figure 5. MEDULLA.

badges to provide players with an incentive to learn additional content. MEDULLA (Figure 5) was developed to teach brain structure and function to university psychology students. The player enters a virtual world in turmoil where the citizens (non-player agents) have had various regions of their brains incapacitated. The player must cure these citizens by understanding functions of the major parts of the brain.

At the beginning of each level, the player is provided learning content about a new portion of the brain (e.g., the occipital lobe is important for processing vision) through dialogue. This dialogue is presented in conjunction with narrative text used to enrich the game world. The player's first task is to process the information received and identify the learning content within the narrative to ensure that the correct information will be learned. The learning content must then be related to prior knowledge to make the content meaningful to the self (encoding). After understanding the information, the player must then place the information into semantic memory for later use (storage).

Later in the level, upon approaching an ill citizen, the player is greeted with a message providing a clue to the citizen's malady (e.g., "I can't see. Everything has gone dark. Is anyone there?"). In order to cure the citizen, the player must not only process the clue but also extract the relevant learning content from long-term memory (retrieval). Here, the player can finally cure the citizen by clicking the appropriate location on a two-dimensional brain representation.

The first badge's logic is satisfied by curing a single citizen—in essence, undergoing memory encoding, storage, and retrieval, and engaging in other forms of information processing. Players repeat this process as they continue through the game, receiving curing badges with multiplier-based logic (e.g., curing three citizens, five citizens, etc.) and conditional requirements (e.g., curing a citizen not along the level's primary path), and learning new content with each subsequent level. Without the relevant cognitive processes, these badges would be obtainable only by consistent strokes of luck. These logics thus draw upon cognition.

Figure 6. Badges in MEDULLA.

The badges in MEDULLA (Figure 6) can be described using Hamari and Eranti's (2011) four-component model. For example, if we consider the optional citizen badge, the logic can be completed only during the citizen-curing process (pre-requirements for the game setting). When the player successfully cures a citizen (triggering event) who is not along the main path (conditional requirements), the badge is awarded. This action needs to occur only once (multiplier).

While the processes of encoding, storage, and retrieval of memory in the described logics show their strong ties to cognition, most badges in some way contain a cognitive component. Constructs such as creativity, decision-making, and information processing are frequently integral to gameplay success and, as a result, are involved in the majority of non–luck-based badging logics. Considering cognition when designing badge logics facilitates a designer's quest to pair badging with the learning processes inherent in both educational and non-educational games and simulations.

Example 2: Social Factors and Credentialing: COUNTER-STRIKE: GLOBAL OFFENSIVE

In addition to the thinking that individual players must do when interacting with badges, social encounters also influence player experiences with badges in a number of ways. One major force shaping player behavior is found in multiplayer games with competitive or collaborative dynamics. These are frequently defined by completion logics requiring multiple player participation. COUNTER-STRIKE: GLOBAL OFFENSIVE (CS:GO) is one such game. While CS:GO, a first person shooter game, does contain a single-player game mode, the single-player mode takes a backseat to the popular multiplayer game modes. The high-stakes nature of such competitions further catalyzes the competitive social environment surrounding this game in multiplayer situations.

Figure 7. Badges in CS:GO.

Users who engage in competitive play within CS:GO attain a badge showing their current rank. In all, 18 badges are arranged in a hierarchical structure such that a person at a higher rank is presumed to be a better player than a person at a lower rank (Figure 7). The game's mechanics and strategies are highly complex, yet the game includes only a very basic tutorial. Instead of directly providing instruction, CS:GO incorporates a clever application of badges to motivate users' desires to improve and, consequently, to seek out external sources of instruction.

While the other badges described in this article are *permanent,* since they never disappear once earned and use clear completion logics, CS:GO incorporates a dual badging system, one fitting this model and another, more interesting impermanent system with vague and difficult-to-ascertain logics. For example, where completion logics are typically defined absolutely (e.g., complete an action five times, or achieve an accuracy rating of 75%), CS:GO's ranking badges use relative completion logics, based on social factors. A player's particular ranking badge takes into account the skill level of all other players who engage in online competitive play. As such, players' ranks may fluctuate from day to day, even on days they do not play the game.

Once a competitive game finishes, all players in the game can see the badges of all other players. In this way, the badge serves a credentialing role and becomes an indicator of social status (Antin & Churchill, 2011), a representation of where players stands amongst their peers in experience and capability. Players who take the game seriously and are interested in ranking up to increase social capital have motivation to work to improve their abilities.

It was previously stated that the logics of these badges are also vaguely communicated to players. The game's creator, Valve, has refused to release the algorithms driving these logics. While a game could simply position the top 10% of players as receiving the highest rank, 10-20% receiving the second highest rank, and so on, Valve's ranking system is more complex, expanding, in some unknown ways, upon the pre-existing Glicko-2 model. The Glicko-2 model uses several different metrics to generate a confidence interval based on an estimated rating, a calculated error or deviation, and a measure of expected fluctuation within a player's rating (Glickman, 2013). Expanding upon an already complex system in an undisclosed manner leaves players with little guidance on how to satisfy the completion logics of higher ranks, other than to become better than their peers in the most general sense.

In a game where hacking and exploiting the system is commonplace, this vagueness of logic reduces a player's ability to *game the system,* leading to interesting social outcomes. If, for example, players knew that the completion logic relied most heavily upon kills per game, players could do whatever it takes to get kills, potentially sacrificing their teammates for these kills. After all, social capital is important and difficult to come by. Thus, this vagueness of completion logic preserves the integrity of the game and the team-based mindsets underlying CS:GO's strategies.

Hamari and Eranti's (2011) four-component model is applicable here, too. In order to receive any ranking badge, the user must play in the competitive game mode. Playing in this mode is the pre-requirement for the game setting. Additionally, a conditional requirement for the game state requires the player to have recently played a competitive game. The exact time is unknown, but rank badges will disappear and will not respond to adjustments in the global ranking distribution if the player has not recently played a game. The triggering event occurs when the player's rank rises or falls some preset amount in the global ranking distribution in order for the player to receive a new rank badge. Finally, a few multipliers are involved. To achieve the first rank, players must win 10 competitive games. Afterwards, the multiplier becomes both variable and unknown.

This CS:GO analysis identifies the power of social completion logics within social environments. While we frequently think of completion logics as concrete objectives, with success relying on nothing more than our own abilities, logics can be of greater complexity, speaking to the relationships among people within a system. It is also important to note that depending on how they are implemented, collaborative digital badges can also be quite frustrating for players. For example, Bishop (2011) noted how the PORTAL 2 Professor Portal achievement frustrated players who were required to first finish the game on their own, then return to assist a second player who had not yet played enough to even see the opening co-op cinematic. Finding such a player is quite difficult, so a scarcity of resources (in this case, new players) limits opportunities for player enjoyment and motivation within this game's social infrastructure.

Example 3: Affect and Encouraging Exploration: GOAT SIMULATOR

An important element informing the construction of completion logic applied to many badges used to encourage exploration is the use of whimsy and humor. On a symbolic level, humor appeals to many gamers, and careful application of humor and the placement of culturally relevant signs and symbols often inspire players to be creative and playful when interacting with the game mechanics. For example, consider the achievement The Flapmaster from GOAT SIMULATOR, a tongue-in-cheek entertainment video game designed by Coffee Stain Studios in 2014.

As before, we can evaluate the requirements for this achievement using Hamari and Eranti's (2011) four-component model. While the description for this achievement sounds ridiculous, the logic behind its implementation is straightforward. Players earn The Flapmaster achievement by first navigating their goat character inside a virtual representation of the real Coffee Stain Studios office building. This is a pre-requirement. They must then navigate to one of the televisions and initiate a mini-game, FLAPPY GOAT, by pressing a button (Figure 8). This is the conditional requirement. The triggering event occurs when players have flown their player character, a flapping goat, through the requisite number of checkpoints within the mini-game. Thus, a multiplier is also at work here.

The Flapmaster achievement's completion logic is notable for its use of humor within both the symbolic representation of the achievement and within the completion logic itself. Here humor is characterized by a blatant application of silliness meant to be lighthearted, with an underlying style in line with the sensibilities of the parent game. Specifically, the humor in this logic is found in the conditions required to unlock the badge. These revolve around the manipulation of *flapping* a virtual goat through fence posts in order to pass through ten sets of vertically aligned fences of randomly varying heights. Players who discover this achievement will likely be aware of the direct comparison of this mechanic to FLAPPY BIRD (Hà Đông, 2013), a game infamous for both its unforgiving difficulty and its addictive qualities. The designers of GOAT SIMULATOR are relying on two assumptions here: first, that its players will be fairly sophisticated with their media usage and will recognize that the game is playing homage to a modern classic, and second, that gamers will appreciate the irreverent humor of such a game's being reskinned from a bird flying through pipes to a goat flapping through ladders.

Humor also extends to the completion logic itself. For example, even though the visually skinned goat provides a certain visceral flavor to the silliness, the logic itself connects the analogy to the earlier precursor game. Requiring the goat to proceed through *ten* of the ladders ensures the player will need to experience the mini-game multiple times. This point is key because it allows for player frustration and addiction, both of which are also cultivated within players in the original FLAPPY BIRD experience.

The second notable observation about The Flapmaster badge concerns the unique prerequisite conditions for earning the badge. The Flapmaster is a badge within a game, embedded within another game that purports to be a simulator. In order to earn The Flapmaster, players must guide their goat inside a virtual representation of Coffee

Figure 8. GOAT SIMULATOR mini-game.

House Studios, then control their goat to further control a second virtual controller to play the mini-game. Only after these various objectives have been completed does the completion logic for this badge become accessible. Even to initiate the possibilities for such a badge requires a level of dedication and a willingness to explore the virtual world in detail.

Achievements like this tell us that even seemingly lighthearted examples of badging in games often employ sophisticated cultural and operational logics to engage player attention and motivate players toward exploration and playful experimentation. While humor can be difficult to employ due to subjective differences and player preferences, audience analysis and playtesting can yield potential ideas for its use.

In our final example, we synthesize each of these design dimensions and consider how digital badges are useful for debriefing. We focus specifically on the role of completion logics in debriefing and discuss the relationship of these logics to feedback.

Example 4: A Holistic Analysis of Badges for Debriefing

Debriefing can be conceptualized as a process involving seven elements: "the guide/debriefer, the participants, the experience, the impact of that experience, the recollection of it, the mechanisms for the reporting out on the experience, and the time to process it" (Lederman, 1992, p. 149). Badges can serve a number of roles within this framework to facilitate debriefing. For example, digital badges are natural benchmarking tools for measuring performance and engagement, both indicators of different types of impact.

Badges are also useful for the *reporting out* function of debriefing. In terms of cognitive engagement, for example, badges can be quantitatively measured (i.e., counted) to determine the extent to which a player has engaged with a system in predetermined ways. Internal performance data tied to digital badge completion logics within a game or simulation might include measurements such as time on task, number of errors made, player deaths, percentage of environment explored, and player orientation toward goals. These data are critical for proper debriefing, an occasion for reflection on how the game experience has led to learning, and for sharing those insights with other people (Crookall, 2010).

The experiential nature of games and simulations also provides opportunities for the use of digital badges in debriefing. For instance, while performance and engagement data are useful and interesting, this content often provides less meaningful social information about a player's interactions with other players or team members in a virtual context. These virtual group dynamics are often similar to real-world group dynamics (Hermann, 2015) and can pose challenges for effective debriefing. Here digital badges can be useful for social purposes such as team-building. Pointing participants toward badges they did not earn, for instance, might highlight areas for improvement in future sessions. For example, consider a badge named *helpful hands.* This hypothetical badge has been constructed to encourage players to assist other players with completing objectives within a level. The badge is triggered when a number of system events and player events have been activated. Perhaps a predetermined number of assistive behaviors have been completed at a number of predetermined locations within the game level. If a player does not earn this badge, a discussion during the debriefing session can be used to redirect a player's behavior in desirable ways.

When these data are considered in isolation, performance data for a player engaging with the system in this fashion would probably indicate less-than-stellar performance. Helping other players will lengthen the total time taken to complete an objective. When framed within the context of the completion logic and player experience, however, this extra time turns out to have been important. This style of play enables a player to progress through the level satisfying the behavioral and performance conditions outlined by a designer. Further, the desired play style is reinforced through the completion logic of the digital badge. When collectively considered with other designed badges and compared against the performance of users in a post-task debriefing, digital badges leave us with a holistic impression of not only what player behaviors are valued by designers but also how players performed in enacting those desired behaviors.

The affective dimensions of badging are also potentially useful in debriefing scenarios, since emotion and feeling are often key to reflection after gaming activities (Thiagarajan, 1992). For example, similar to the types of questions asked by the debriefing games (or *d-games*) described in Thiagarajan's (1992) work, digital badges might be used to provide players with opportunities to talk about their feelings, emotions, and insights. Earned badges for participants could be used as discussion points; for example, a player who earned a competitive badge might be asked about feelings of pride or achievement, while a player who earned a badge based on exploration activities might be asked about feelings of curiosity.

Debriefing can also be facilitated more directly. Fundamentally, badges remind players of what they are doing correctly and incorrectly. They also serve as explicit design elements that provide player feedback. Depending on the badge's contents, badges can be used to draw attention to critical performance-based information. Additionally, badges earned during a level's play can be held in system memory until the end of the level. At that point, when gameplay has temporarily ceased, the badges can be displayed to the players, reminding them of their accomplishments and encouraging reflection (see Figure 4). These behaviors make players more successful during gameplay.

Linking desired learning behaviors with in-game success is a task all good learning games should already do. Further, most games featuring badges store them in a place where players can access them at any time. Thus, fulfilled completion logics contribute to a repository containing debriefing on-demand. Similarly, developers can make use of negative badges for post-operation debriefing. For example, if badges were distributed for *friendly fire*—injuring one's teammates in a particular mission—players who earned them could be targeted for additional coaching or discussions concerning why these events occurred.

Completion logic and sociopsychological factors might contribute to the debriefing process in numerous ways; the Appendix contains four examples. While this article and its Appendix describe a number of possibilities, future theoretical study and empirical research provide additional opportunities to investigate the use of badges for effective debriefing. This is an area in which more research is needed (Crookall, 2010).

Discussion

The surface simplicity of digital badges belies a deep depth of potential customization useful in simulation and learning scenarios. Badges enable us to develop focused interactions and define critical interactive moments within complex simulations and games. They also enable researchers to track performance, adjust player behaviors after levels have been designed, and build game elements for debriefing players using easy-to-digest units of information. Similarly, badges may elicit extra effort from players, encourage replayability, and provide dynamic objectives. Collectively, these factors are useful for shaping player behaviors in productive ways.

Moreover, badges can affect users on multiple levels, depending on how their completion logics are designed. We situated badge logics within cognitive, affective, and social frames, providing examples of how badges have already been designed to fit these purposes in both educational and entertainment applications. Reviewing these examples enables us to extrapolate specific design recommendations to guide those looking to design logics for cognitive, affective, or social purposes as well as those designers wishing to use badging specifically for debriefing.

Our analysis of MEDULLA suggests the following design recommendations for badges where cognition is incentivized:

- Consider how badge design logics will interact with specific cognitive phenomena, such as memory. For example, in MEDULLA, badges were constructed to reward players for successfully engaging in the three stages of memory:

encoding, storage, and retrieval. This design enabled badges to support the learning process directly—the explicit goal of educational systems and a useful process for all games.

- Consider the desired relationships between players' thinking and behaviors. Consider how logics require a user to implement creativity or decision-making. Badges are often developed for casual actions; identify the ways logics can require complex cognition to incentivize more meaningful behaviors.

Our analysis of CS:GO and PORTAL 2 leads to design recommendations for badges incorporating social elements for purposes such as credentialing:

- Before implementing specific collaborative or competitive logics, such as the variable ranking systems for player credentials in CS:GO, consider running a small pilot test with a group of players to map out how the various rules interact with social gameplay behaviors. Social behavior in games is difficult to predict.
- Develop a list of the destructive factors potentially emerging from collaborative digital badges, along with corresponding design solutions addressing these factors. For example, the resource scarcity problem in PORTAL 2 could be minimized by asking seasoned players to mentor rookies with five hours or fewer of play time, rather than no play time whatsoever.

Our analysis of GOAT SIMULATOR results in design questions for badges incorporating affective elements for purposes such as promoting exploration:

- Consider affect as a design tool to drive player behaviors in interesting directions. If appropriate, consider the use of logics leveraging humor and other affective factors (e.g., curiosity) to encourage players to explore.
- Be aware of the relationships between potential emotions in players and the specific elements of badging completion logic. For example, as discussed in The Flapmaster achievement, multipliers within completion logics often alter the affective properties of an achievement. While repetition as an element of completion logic can sometimes incentivize players' improved performance by appealing to their sense of pride, it can also breed frustration.

Our final analysis leads us to the following design recommendations for badges used as debriefing tools:

- Identify the completion logics for each badge and determine what those logics require of the player. Whenever possible, explicitly link logics to completion requirements within a game or simulation, allowing badges to be distributed for high or low performance, depending on purpose.
- Identify timestamps for meaningful actions (e.g., those representing success or failure). Identify the relevant logics not yet satisfied by that point to review a

trainee's performance. To ease the burden on a trainer, save these logics to a file and export them after training so the trainer can go over this list with the trainee.

Conclusion

Understanding how to design, deploy, and critique completion logics is an important skill for any game or simulation designer. Digital badge completion logic is analogous to game mechanics in games. It allows designers to customize the conditions for unlocking badges and specifies the number of times actions must be performed. A thorough understanding of completion logic paired with careful design that takes into account psychological factors allows designers to identify precisely the types of interactions to reward in order to encourage optimal player outcomes.

Future research should examine these design recommendations empirically, identifying their usefulness within the realm of simulation and gaming but also in broader education and training applications. Also, a number of areas in badge research still need to be understood in more detail. For instance, we need to understand not only the strengths and advantages of badges for simulation and gaming context but also their limitations and drawbacks. We need a better understanding of badge semiotics. We need to better understand how completion logic works within simpler badging systems, such as badging systems deployed within online course modules.

Further, while completion logic is useful for describing the mechanical operations of badges and how players respond to them, future investigations need also to analyze additional purposes for badging. Many additional sociopsychological factors deserve consideration, such as the complex issues involved in trust networks (e.g., interoperability issues for exchanging badges between systems, methods to incentivize user adoption, and methods to ensure privacy and player trust).

Finally, new studies must continue to investigate psychological factors at work in the design of completion logics. While motivational aspects have arguably received the most attention, identifying other psychological aspects will allow badge designers to leverage existing understandings of human behavior and the brain in their designs for more effective and versatile completion logics. Understanding the psychology of players in tandem with the components of badges—signifiers, completion logics, and rewards—allows us to consider specific design affordances in more detail and to build better digital badges.

Appendix

Examples of Digital Badging for Debriefing

Example 1: Team-Based Debriefing—Scout Sniper Team Virtual Training Simulation

A military scout sniper team typically comprises two people who alternate roles as sniper and spotter (Plaster, 2006). In this configuration, the sniper neutralizes targets with a rifle.

The spotter supports the sniper by estimating wind direction and speed, timing the sniper's shot, calling for fire, and then relaying information about the shot's accuracy and how the sniper should adjust. Both team members must be successful to land the shot, but it can be difficult for team members to identify which member needs calibration.

Here, a trainer may monitor the simulation and assess each team member, awarding digital badges for meeting preset milestones (e.g., correctly assessing wind speed in 100% of the shots). Moreover, the trainer may award badges for maintaining productive affective states (e.g., remaining calm after a missed shot) and for producing effective communication (e.g., exchanging useful information in pursuit of better accuracy).

Such badges are valuable for debriefing. A debriefing session can be organized by identifying which badges were earned or not earned by each team member and discussing the implications of each member's performance. By maintaining this list of badges, earned and unearned, the trainer and team can assess the team's cooperative and individual progress, identifying demonstrated proficiencies and future goals.

Example 2: Self-Regulated Debriefing—Training the Trainer in a Live Simulation

To be effective, a novice trainer often requires instruction to train others properly. Consider a live simulation in which a novice trainer is paired with an actor playing the role of the student. A senior trainer observes the exercise and awards badges to the novice trainer. Badges may be awarded for demonstrating skills or for supporting them in the trainee. For example, badges designed to improve affective training factors, similar to some of the "d-games" in Thiagarajan's (1992) work, may be awarded for remaining calm with a trainee or for managing a trainee's stress. Badges to address cognitive performance factors may be awarded for figuring out why a trainee is having trouble learning a concept or for helping a trainee engage in problem solving. Badges to improve performance or communication in social contexts may be awarded for feats demonstrated by the trainer or encouraged in the trainee.

The awarding or non-awarding of each badge transmits information through completion logic and badge text. Such information would normally be communicated by the senior trainer, but this person may have limited time to provide extensive feedback. Information packaged into badge form can help the novice trainer self-debrief. For example, novices who realize that they did not earn the badge for providing good feedback may pay closer attention to how they provided feedback—and, thus, work out how they could have done better—when they watch a video playback of their performance.

Example 3: Targeted Feedback and Debriefing in an Emergency Response Game

Given the rapid delivery of feedback possible in game environments, it is possible that digital badges may be used both for targeted feedback and as debriefing data even before a player finishes playing a game. This scenario seems counterintuitive, given the need for reflection and time to process experiential data, but it is possible for such data to be used for dual purposes, both to adjust behaviors in real time and to provide a more comprehensive and reflective debriefing component at the end of the game (Crookall, 2010).

One such scenario could unfold in a real-time strategy game in which players learn how to allocate critical resources such as emergency personnel (e.g., police, fire response teams, hazmat teams) during a crisis. While the prior examples described in this appendix have focused on the earning of badges for positive behaviors within a game, another model would be to award badges for making mistakes, an approach often used to humorous effect in commercial entertainment games. For example, the hypothetical game here might award *negative* badges such as *Overcommitted* for attempting to direct more resources than were available or *Stretched Thin* for moving too many police and fire responders to one area of the city while leaving other areas under-provisioned. Earning such badges would provide an opportunity for the game to provide direct, immediate feedback (perhaps through a supervisor's chastising the player through a virtual radio transceiver), while also generating data useful for a more comprehensive postmortem debriefing session that takes into account how players adjusted their performance (i.e., how they adapted) upon receiving feedback.

Example 4: Goal-Setting and Debriefing in a Medical Diagnosis Game

When goals are clear, a confounding factor is removed from debriefing—whether or not trainees have a clear understanding of their objectives. When trainees understand their goals, trainers can determine whether progress was made deliberately rather than as a result of chance. Consider a game in which a player interacts with a virtual agent who is displaying symptoms of some unknown condition. The player should work to diagnose the illness, based on the symptoms described and any evidence from physical examination or laboratory tests. The player then marks the evidence used to make the diagnosis. After each diagnosis, a new patient arrives, and the process repeats. Here, the goal becomes unclear. How important is accuracy? How important is speed?

If a list of badges is shown to the player prior to the start of a medical diagnosis game and one of the badges can be earned for a 100% accuracy rating on diagnoses, the player knows that accuracy is desirable and should be a focus of gameplay. If the player is unsuccessful in earning that badge, the game can provide tips toward improving accuracy, taking into account the incorrect diagnoses and the evidence presented to make them. Here, debriefing is more focused by homing in on the problem areas.

Author Contributions

All authors contributed to this article, both substantively and formally. RM wrote the initial draft, developed the matrix and the review of psychological literature, organized the creation of the supporting graphics (excluding MEDULLA), wrote about GOAT SIMULATOR and contributed Example 3 in the Appendix, and edited the final manuscript. He also drafted all reviewer responses as requested by the journal submission guidelines. JF contributed content dealing with completion logic and psychology, provided the examples for CS:GO and MEDULLA, edited the document during earlier drafts, and wrote three of the four debriefing examples for the Appendix. Both authors worked collaboratively throughout the process to revise the manuscript based on editorial and reviewer feedback.

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