Challenging Interfaces are more fun!
Operant Conditioning for the Interaction Designer

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ABSTRACT
Since 2011, gamification of interfaces has been a growing trend in interaction design, creating fun and compelling interfaces that increase user motivation and involvement; in some cases even modifying user behavior. However, critics point out that gamification is not suited for all applications, and being a new interaction design method, there is probably a potential for improvement of the method. This review article provides an analysis of gamification in terms of operant conditioning, suggesting that gamification is based on mechanisms described by behaviorists as operant conditioning. It is proposed that a better understanding of the latter provides the interaction designer with tools to create better and more accurate gamified interactions, as well as motivating and compelling interfaces without the use of game design elements.


1. INTRODUCTION
In the mid 1980s, when industrial designers Verplanck and Moggridge coined the term “interaction design”, interaction designers’ efforts were focused on creating usable and useful interfaces, allowing untrained users to effortlessly interact with computers [1]. Since then, the field of interaction design has broadened and evolved, steadily improving human-machine interactions for a number of digital products [1]. Even though usability has retained its position as the essential component of good interaction design [1][2][3], user experience design has gained increasing attention in recent years [4][5]. It is not always enough that a system is easy to learn and efficient to use these days, it should also provide an enjoyable experience for the user.

A growing trend answering to such experience requirements is gamification [6][7][8][9][10]. Gamification is the application of game design elements in non-game contexts, and has repeatedly been shown to increase user motivation and involvement, even change user behavior, in many cases dramatically increasing companies’ revenues [11]. Although gamification is a relatively new term, adopted by the industry as late as 2010 [6][12], it has already received considerable attention. The application of gamification methods have increased exponentially since 2010; a growth that is expected to continue [6]. By 2015, the technology consultancy Gartner projects that 50% of corporate innovation will be gamified [8], and companies offering gamification platforms and services, such as Badgeville and Big Door Media [6][13][14], are flourishing. However, critics have identified potential shortcomings of
gamification [10], pointing out that not all users may respond to gamified interfaces, and that some interfaces should not be associated with games.

Simultaneously, the reinforcement-based learning method developed and described by behaviorist psychology, operant conditioning, is gaining popularity both in animal training, parenting, and behavior modification in schools and psychiatry [15][16][17]. The method has in numerous experiments and real world applications been shown to, inter alia, increase motivation [18]. This review article will propose an interpretation of games and gamification in terms of operant conditioning, and discuss whether interaction design methods based on the latter can increase the accuracy and effect of gamified interfaces, as well as provide an alternative to gamification for creating compelling and motivating interfaces without the use of game design elements.

In order to propose such an interpretation, and discuss the possible contribution of operant conditioning to interaction design methodology, this review article will review textbooks, articles, gamified interfaces and even game forum posts, dealing with gamification, games and operant conditioning. There will be a particular focus on exploring the reward mechanisms in games and operant conditioning respectively, and the effects on people in terms of motivation, enjoyment and involvement.

2. GAMIFICATION

Gamification is defined as “the use of game design elements in non-game contexts” by Deterding, S., et.al. [12]. This definition stresses that gamification is not about turning interfaces and activities into full-fledged games, but rather adding elements known from games in order to enhance user experience. Thus, to understand what a gamified activity is, it is useful to define a “full-fledged game”.

2.1 Gamification put in context

Games range from simple board games like Tic-tac-toe – involving a grid and two players taking turns to scribble down either an x or an o, hoping to get three in a row –, to advanced adventure games with thousands of players trading, fighting and creating cooperative guilds for survival, while acquiring valuable artifacts, gold and glory in detailed fantasy worlds, – such as in Blizzard’s very successful “World of Warcraft” video game. Though drastically different, these two examples still have a few shared traits that are widely accepted as the definition of games: games are designed to be entertaining, and they are certainly played; but in contrast to the mere play with toys, gaming involves rules and challenges (place the third cross in a row in your turn, or kill a monster within the boundaries of the fantasy world), and games have goals and objectives, with the most important goal being to win – or at least not to lose [12][19][20].

In addition, game designer Chris Crawford emphasizes the difference between puzzles and games, pointing out that games are interactive; either by several players interacting in the game, or the game reacting to a sole player’s actions [20].

To distinguish the act of playing a game from mere playing with toys, it has been argued that “playing” in the context of games should be referred to as “gaming”. This emphasizes that the play of a game is a rule governed, competitive activity, unlike the expressive, rule-free and impulse driven play of children [12][21].

With this in mind, “serious games”, e.g. training and simulation games, persuasive games and other “games with a purpose” [12], certainly sort within the concept of full-fledged games. Serious games have goals, rules and challenges, and are designed to be entertaining. But these games have a serious real-life side; such as persuading players to lead a healthier life and manage their economies better, learning how to solve algebra
problems or spelling “onomatopoeia”, - or even aiding scientists in their research [22].

Gamified activities are rule based, but in contrast to games they are generally not designed to be won or lost [12]. Instead, elements recognizable from games, e.g. leaderboards, avatars, game-like environments, unlockable events and trophies, are added to the activity to increase user motivation and customer loyalty [6]. Instead of the “win-or-lose” objective typical for games, the objective of gamification is to encourage users to completing non-game tasks that are otherwise perceived as boring or unattractive. Examples of such tasks can be filling out forms, reading through web sites, completing surveys, managing personal economy, or completing household chores. Figure 1 shows gamification put in context with games and play [12].

The boundaries of game design element definitions, however, are fuzzy; being defined as “elements characteristic for games” [12] leaves for personal judgment to determine exactly what is characteristic for games, and what is merely present in a few games. However, some phenomena are generally accepted as typical game design elements and often incorporated in gamified activities and interfaces. Among other elements, status, scores (points as well as real and virtual resources), trophies, leaderboards, achievements, badges, embedded casual games, progress visualizations, levels, avatars, time constraints, turns, and challenges are widely adopted examples [6][12][23].

Avatars, time constraints, turns and challenges are game mechanisms that does not directly deal with rewarding the gamer, and may be interpreted as gameful contexts, encouraging users to embark on gamified activities with a gameful mindset [23]. The screenshot in figure 2, from the gamified household chore organizer “Chorewars” [24], exemplifies the use of avatars, challenges, as well as rhetorics and aesthetics typically associated with games. Chorewars is a website for registering what chores have been completed by whom within a household. Though the game design elements are not essential to the interface’s function, the gameful context adds to the feeling of playing a game, seeking to motivate “gamers” to complete household chores.

Figure 1: Gamification put in context [12].

2.2 Gamification demystified

As mentioned above, gamification is not about turning an activity into a full-fledged game. Rather, user experience is enhanced by adding game design elements to a non-game context, in most cases by adding a “gameful layer” to the context. This means that the game design elements of a gamified interface are not essential for the function of the interface, but are added to increase user motivation and involvement [23].

Figure 2: Chorewars screenshot [24], displaying a gameful context with avatars, as well as game rhetorics and aesthetics.
Statues, scores, leaderboards, achievements, trophies, badges and embedded casual games, however, may be seen as reward systems; reinforcing desired user behavior and motivating for continued favorable behavior, – in the eyes of the interface provider. The interface of LinkedIn, as shown in figure 3, motivates users to complete their profiles in order to reach “100 % profile completeness”, rewarding every step towards this goal by visualizing the user’s efforts in the progress bar. In addition, “Profile Completion Tips” are provided for the users, describing which steps can be taken to easily complete their profiles, accompanied with the reward users will receive when completing these steps.

![Figure 3: LinkedIn progress bar and point earning system [25].](image)

In gamified interfaces, such reward systems reinforce users continually, instead of providing a reward when the user is finished with the interface; such as a short “thank you” at the end of completing a survey. In games and gamified interfaces, rewards are dealt out every time a user completes a step towards a greater goal.

The screenshot shown in figure 4 is taken from teamtreehouse.com [26], an online education website for web and iOS technology skills. When purchasing an education project, such as “Photoshop Foundations” displayed in figure 4, the student receives a pack with several stages that, upon completion, are rewarded with badges.

![Figure 4: Treehouse badge earning system [26].](image)

3. OPERANT CONDITIONING

Behaviorism, constructionism and cognitivism are considered the main branches within learning theory [18][27], a part of the field of psychology. Each theory gives a different perspective on how learning occurs; while constructionists and cognitivists analyze internal processes of the learner’s mind [15][18][27], behaviorists mainly study observable relations between stimuli and responses through experiments [16]. Though being the leading learning theory in the early 20th century, behaviorism has lost its superior position in education; these days being mostly used for modifying class room behavior and dynamics, as well as rewarding efforts and motivating continued learning [22].

Operant conditioning is a behavior modification method described by behavioristic learning theory, dealing with how a particular behavior’s likelihood is affected by the experienced consequences, and describing how this process can be controlled [16][18]. If a certain behavior leads to something perceived as positive for the subject, either by being presented with a rewarding stimuli, or relief from punishment or discomfort, it is likely that the occurrence of that particular behavior will increase – learning has taken place. However, if the consequences of a behavior are perceived as negative, either by the removal of benefits or application of punishment, the behavior is less likely to be repeated. Thus, the method does not rely on directly influencing
behavior, avoiding enforcing subjects to act desirably; rather, operant conditioning allows subjects to act on free will, subsequently reinforcing any desired behavior.

This section will provide an overview of the basics of operant conditioning, as well as presenting views and findings on its validity and effect on human subjects.

### 3.1 Concepts of operant conditioning

Using the vocabulary of operant conditioning, the probability of a given behavior can be increased by positive reinforcement (presenting desirable stimuli), or negative punishment (removing unpleasant stimuli). In addition, behavior can be decreased by negative reinforcement (removing desirable stimuli) or positive punishment (presenting unpleasant stimuli). These events are illustrated in figure 5, with + denoting adding stimuli and – denoting removal of stimuli.

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<th>Increase probability of repeated behavior</th>
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<th>Decrease probability of repeated behavior</th>
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<td>Positive punishment</td>
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*Figure 5: Reinforcement and punishment matrix of operant conditioning [17].*

A typical experiment illustrating positive reinforcement of behavior, involves learning a hunger-deprived rat in a box how to obtain food by pressing a switch. The box removes the rat from any influences from the surroundings, excluding the possibility that the rat is reinforced or punished by stimuli beyond the experimenter’s control. Set ups where the subject is removed from any influences from the environment, is popularly called a Skinner Box, named after one of the major behaviorism theorists, B. F. Skinner [16][27].

First, the rat in the Skinner Box will behave randomly, moving about the box and testing the walls and ceiling. At some point, the rat will accidently activate the switch, and a food pellet is presented. The acquisition of food is, naturally, a positive consequence for the food-deprived rat; therefore, it will try to reproduce the conditions that resulted in the food pellet being presented. After some trial and error, the rat will learn that it can obtain food by activating the switch. From this point on, the rat will push the switch whenever it is hungry [18][28]; it is in control of its environment [16].

### 3.2 The importance of contiguity

The above experiment illustrates a central finding in operant conditioning experiments, namely the importance of contiguity: stimuli should be removed or presented close to a response – both in terms of time and space [18]. In circumstances where reinforcers cannot be administered immediately after desired response, a secondary reinforcer (typically a visual or audible signal) is presented to signal that a reinforcement is on its way [16]; not unlike loyalty programs such as frequent flyer programs, where passengers are notified that they have earned discounts that can be used when purchasing tickets for a later flight [6].

### 3.3 Intermittent reinforcement

Continuous reinforcement, where every response within a desired class of responses is reinforced (e.g. “food pellet presented every time switch is activated”), is found to be the most efficient set up for establishing new behavior. However, when behavior is already established, intermittent reinforcement will increase the number of responses, as well as strengthening or even
perfecting the performance of responses [16][30][31]. In a schedule for intermittent reinforcement, reinforcers are presented either after a certain time interval since last reinforcement, or after a certain ratio of correct responses. In addition, the time interval or response ratio between reinforcers can be fixed or variable.

![Reinforcement schedules](image)

Figure 6: Reinforcement schedules [30][31].

As is evident from figure 6, variable ratio is the most effective reinforcement schedule. Reinforcement is presented for some responses, but the subject cannot predict when reinforcements will be earned, and thus will always do its best in case reinforcement will be presented this time [31].

Variable ratio reinforcement schedules are actually used in slot machines [30][31]. After a variable number of games have been played, a prize is won; some big, but mostly minor prizes. When the player puts money into the slot machine and starts playing, there is no knowing how often she will win, or how big the prize will be. However, the player knows that her odds for winning increase the more she plays, and many keep on playing hoping that the big prize will be won with the next coin. Or the next after that.

Experiments with rats has shown that when a rat has learned how to press the switch in order to obtain food pellets, a variable ratio schedule will cause the rat to activate the switch more often. Rats will even activate the switch without being hungry, leaving the food pellets when they “win”.

3.4 Validity of operant conditioning of human behavior

Though operant conditioning is widely accepted as the most efficient method for altering behavior in various animals [17][16], the operant conditioning of human behavior has been the subject of massive criticism [32][33].

Behaviorism has been criticized for excluding any cognitive effects such as thought processes and independent behavior typical to humans [18], ignoring how a subject’s feelings and thoughts will influence the subject’s actions [32]. Cognitivists have pointed out that humans are invariably influenced by what is previously learned in other settings, and even operant conditioning experiments have shown that what is first learned by operant conditioning, is not easily “un-learned” when conditions change. This is compared with the effect of advertisements, as consumers tend to choose those goods or candidates they have learned to associate with rewards; even though the consumer may never experience such rewards themselves [34].

This is highly related to another challenge for successful operant conditioning of human behavior, namely the influence of social norms. Humans have a complex social repertoire which in many cases are culture specific [18], making it difficult for researcher both to control the decision making process of a human subject, and to determine whether a stimuli is rewarding to the subject, reinforcing the intended behavior. By ruling out any intrinsic reinforcement, it is even more difficult to be in control of what influences human behavior.

Though the mentioned challenges limit the application of operant conditioning of human behavior, both laboratory experiments and documented experiences from real life situations, have demonstrated successful behavior
modification by operant conditioning [18][35][36][37]. However, the subjects in these cases have been unaware that they have been conditioned, and though behavior modification has been observed within the experiment settings, the effect outside these settings is uncertain in many experiments [35].

Still, operant conditioning is widely used in both education and psychiatry [18], and has particularly given good results in treating autism [39].

3.5 Motivation and feelings

Although behaviorists historically have ignored the impact of cognitive processes on human behavior, newer behavioristic research has studied the effect of operant conditioning on thoughts and feelings [16][18][28][35]. It has been shown that operant conditioning has a positive effect on motivation; experiments have repeatedly shown that when a behavior is established by rewarding correct responses, subjects choose to perform reinforced responses in order to earn reinforcers, even when given a choice between working for reinforcers or freeload [28].

A number of observations show that both humans and animals respond positively to being reinforced, an effect that was clearly illustrated in a 1967 experience conducted by John S. Watson [39]. Watson placed two months old infants in a playpen, with a movable toy hanging directly over their heads. One group of infants could set the toy in motion by turning their heads, because of a sensor in their pillows, while the other group was put in a similar situation, where the toy would move without the infants controlling it. Soon, the first group realized that they controlled the toy, and whenever they turned their heads setting the toy in motion, the infants gave clear signs that they were enjoying the situation. The other group, however, were at first fascinated by the moving toy, but soon lost interest. Clearly, it was not the movements of the toy alone that were amusing to the first group of infants, rather, it was their perceived control over the toy.

Control over the environment seems to be something humans enjoy. Studies show that even in uncontrollable situations, when presented with possibilities associated with control (e.g., choice), people tend to instinctively feel an enjoyable sense of empowerment [16].

4. GAMIFICATION AND OPERANT CONDITIONING

This section will give an overview of the application of operant conditioning in games; as well as theories prevalent in game communities about how the game context enhances the effects of operant conditioning. In addition, literature about the application of operant conditioning in interaction design will be discussed briefly.

4.1 Operant Conditioning in Games

Operant conditioning in games seems to be a somewhat disputed topic; some game design theorists deny behaviorism’s relevance to game mechanisms altogether [19], while others argue that reinforcement schedules is what makes games rewarding and addictive [30][40]. Some even warn that too extensive use of reinforcement schedules can make games both dangerous, due to game addictivity, and unappealing to certain gamers [30].

As discussed in chapter 2.2, games often provide reward systems, reinforcing “correct” gamer actions and punishing “faulty” behavior. By completing quests, killing monsters, placing crosses or moving game pieces as prescribed by the game, players are instantly rewarded with points, resources, tools and equipment – as well as new quests and possibilities. In addition, playing a video game “right” will in many cases reward players with equipment that makes tedious tasks less tedious, by providing faster vehicles or better weapons [40]. Whenever a gamer fails at their quests, makes a faulty move
or accidently kills a character that was not supposed to die, it may result in losing points, experience; even ending the game altogether.

Game designers and gamers both agree that the risk of failure is a powerful motivator in games; victory tastes sweeter in the face of danger, and having failed once makes succeeding more important – as long as succeeding is not too difficult [40][45][46]. Though punishment is not much described in operant conditioning, practical use have shown that subjects experience increased motivation to earn reinforcers when they have failed, and that success after failing leads to even mediocre reinforcers being perceived as of higher quality, and increases the subject’s ability to cope with failures [17][34].

4.2 The Virtual Skinner Box and Addictive Games

Over the past years, stories dealing with game addiction have received increasing attention by the media, and the reports about game addiction related deaths pile up [41][42][43]. Casual games, designed for casual gamers looking for everyday fun and diversion, typically have a predictable, continuous reinforcement schedule that steadily rewards all correct gamer behavior with badges, achievements and points. Highly addictive video games, however, are often characterized by loot based reward systems [44][45][46].

EverQuest, World of Warcraft and Diablo III are popular loot based video games [44][45][47]. When winning over their adversaries, gamers are rewarded with loot from the defeated foe. Loot is, in short, goods stolen from defeated adversaries, typically containing money, resources and, often more important to gamers, equipment, weapons and other items. For every successful encounter with an adversary, gamers are rewarded with loot; however, most loot winnings are not very valuable. Once in a while, though, gamers are rewarded with highly valued loot, such as rare, magical items with great powers, items that are necessary to progress in the game, or that can be sold at a high price within the game community. It is not uncommon for game companies to provide gamers with information of the chances to obtain a certain item from a given adversary [44].

This is comparable to a variable ratio schedule, where the subject knows that there is a change for a big winning; however, there is no knowing when this prize will be won – or how many times the adversary must be killed in order to obtain the desired loot.

Gamers themselves increasingly refer to this game mechanism as a “virtual skinner box”, arguing that the intermittent reinforcement schedule of addictive games is one of the main reasons for their game addiction [44][45]; a notion supported by, among others, game behavior researcher Nick Yee [47]. When playing an immersive video game, gamers report how they experience being removed from the real environment, almost exclusively focusing all their senses and activity on the virtual game world; nothing but the game matters when in such a state. The majority of reported game related deaths tell about gamers dying after several days of gaming without proper food or drink [42][43]; there has even been a report on game addicted parents neglecting their child while gaming, resulting in the child dying from starvation [41].

Though these are extreme examples, and the “virtual skinner box” of games cannot alone take the full blame of such tragedies, they all exemplify how powerful games are in terms of removing the gamer mentally from the surrounding environment. This effect is not unlike the original skinner box, which physically removes the subject from any stimuli from the surroundings. Thus, game contexts cause the effect of the variable ratio schedule to come to full effect, causing serious addictions and even contributing to deaths due to excessive gaming. Game companies, however, have so far avoided giving comments on the existence and conscious application of the virtual skinner box in games [43][44][45][47].
4.3 Operant Conditioning in Interaction Design

In spite of the present popularity of gamification of interactions, and though the evidence of gamification relying on reward schedules as describes by behaviorists seems convincing, operant conditioning does not appear to be a much discussed topic within the design community. Admittedly, techniques for influencing behavior is used in design; however, the concept of only rewarding or punishing subsequent to responses, without trying to influence users before they act, is not commonly adopted. Though there are some recent publications on the topic [31][48], the direct application of operant conditioning is not widely discussed in literature, and methods for exploring how to reinforce behavior as described by operant conditioning does not seem to be included in regular design processes.

5. DISCUSSION

When interpreting gamification in terms of operant conditioning, a classification of game design elements is useful, splitting game design elements into two groups; one containing elements contributing to gamelike reward systems, and the other containing elements contributing to gamelike contexts. It seems that reward systems used for gamification are based on the same reinforcement mechanisms described by behaviorists as operant conditioning, reinforcing desired user behavior as, or shortly after, the behavior occurs.

Though certain game designers and game producers reject this notion, it seems reasonable to presume that operant conditioning provides efficient methods for reinforcing behavior. While operant conditioning is a well developed and scientific method for reinforcing behavior, gamification is a less scientific tool for the practical application of these reinforcement techniques. While there is little doubt that gamification is a powerful tool for creating captivating and motivating interfaces, it is not unlikely that there is room for improvement.

Gamification provides, as mentioned, designers with a simple method for creating compelling reward-based interactions, by adding elements found in games. However, a better understanding of reward mechanisms could potentially increase the accuracy and width of possible applications for such interactions. Thus, a fundamental understanding of operant conditioning, or efficient design methods incorporating the basics of operant conditioning, is likely to make interaction designers capable to create better and more integrated gamified interfaces. In addition, such tools should also make it possible to design interactions increasing motivation, loyalty and even a sense of empowerment in the user, without availing elements known from the world of games.

As opposed to gamification, being by its definition limited to elements associated with games, operant conditioning invites the designer to explore reinforcers beyond the context of games. This might provide the designer with a larger repertoire of reinforcers, and the option to reinforce desired user behavior without the game association of gamification – in cases where such associations are unwanted. For example, it is possible to envisage meaningful reinforcers supporting and contributing to an increased sense of empowerment in users, in situations where game associations may not be well received by the users; e.g. in mourning processes, stressful situations, or other contexts where games are not readily accepted, and users expect a more professional interface.

In light of the findings from operant conditioning of human behavior, it may seem peculiar that gamification works altogether; as humans often oppose behavior modification when knowing that something or someone is attempting to influence them, while the reward systems of gamified interfaces are in generally quite obvious. Perhaps this is what makes gamified contexts important; creating a platform where users are primed for a gameful approach to the interface, accepting the reinforcers because they are expected, and desirable, in a game context.
However, critics have pointed out that some users dislike gamification, and reject the reward systems gamified interfaces provide. A tentative interpretation of this is that these users do not accept the game environment of gamified interfaces, precluding a situation of expectation and accept for reinforcement through game design elements. Rather, these users could actively resist influence from the interface, just as humans tend to resist influence when they are aware of attempts on behavior modification by operant conditioning.

Thus, it seems to be sensible to explore subtle reinforcers if operant conditioning is to be applied in interaction design beyond gamified contexts. Such reinforcers might make it possible to reinforce desired user responses, without users being disturbed by obvious and intrusive behavior modification. This may be solved with graphics that change or evolve, for example by becoming increasingly detailed, as the user completes steps in an interface, or by options and possibilities that are revealed when the user masters the basic tools, or leaving the user at trial and error in order to learn how navigation in an interface works – being reinforced with success when the interface is navigated in the intended way. As operant conditioning does not rely on giving hints or otherwise influencing the users, solely reinforcing desired actions spontaneously performed by users, it is likely that this method can enable designers to modify user behavior without users feeling that behavior is being imposed on them.

5. CONCLUSION

When gamifying interfaces without considering the effect of the rewards on the intended users in the given context, gamification may not always be successful. It is likely that methods for more directly applying the theory of operant conditioning can both improve gamification methods, and provide tools for creating motivating and even fun interfaces without the association of games.

Thus, it seems that practical interaction design methods incorporating the basics of operant conditioning, such as reinforcement and reinforcement schedules, are likely to increase the interaction designer’s ability to create more accurate and better integrated gamified interfaces; as well as recreating the effects of gamification without the use of game design elements. Though gamification has been shown to increase companies’ revenue as well as user motivation and customer loyalty, gamification might not be suited for all applications nor all user groups; calling for alternative tools to achieve similar effects.

6. FURTHER RESEARCH

According to the findings of this review article, there is potential for drawing on more knowledge from operant conditioning and reinforcement schedules, in particular in the context of achieving the effects of gamification without the use of game design elements. However, further research should be conducted in order to verify whether this is possible, without the use of game design elements. Research could also shed light on how the different reinforcement schedules affect user behavior, and possibly provide guidelines for how and when operant conditioning should be applied.

Furthermore, if operant conditioning is to be applied beyond gamification contexts, possible reinforcers, as well as punishments, should be explored, providing the interaction designer with the tools to reinforce user behavior.

Last but not least, design being a practical profession, further research should in particular focus on how to incorporate operant conditioning principles in practical design methods. The key is to empower the regular designer with tools to make good use of operant conditioning techniques.
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