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AFFECTIVE GAMES: ADAPTATION AND DESIGN

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ABSTRACT
Biofeedback applications, including games, implement affect recognition and adaptation modules. The adaptation mechanism in affective games associate the extracted emotion or affect variables with in-game features and events; mainly with game mechanics. This is used to procedurally create new content or modify existing content or game characters. Explicit or implicit feedback and control offer different interaction experiences through visible indicators of affect or back-scene subtle changes in gameplay. Several experiments in the literature attempted to formalise the adaption mechanism by deriving mathematical relations between game feature and user satisfactions or exploit machine learning to predict adjustment parameters and playstyles. Others propose affective game design patterns.

A game designer’s main role is to create engaging mechanics that provide players with an immersive experience. Affective game design requires a thorough understanding of the role of emotions in games and the expertise of an interdisciplinary design team from computer science, psychology and physiology. It seems that research is approaching affective game design with over-simplified definitions, and mainly from an implementation perspective, rather than a psychophysiological one. Generally, a deep understanding of the affective quality of certain game features is lacking and there is rising need to study such association and investigate ways to guide game designers on the selection and operation features.

1. INTRODUCTION

Human Computer Interaction (HCI) has evolved from classical interfaces with mouse and keypads, through touchpads and haptics, into more advanced hands-free input devices and wearable technology. Computer games benefit from such advancements as users usually enjoy the “exploration” phase of a new controller, and the promised enhanced usability and maximum experience. Relevantly recently, another form of interaction came to focus; biofeedback applications. Such applications react to users’ psychophysiological states with the aim of learning how to modulate their physiological activities to improve performance. Overall, HCI applications require a level of adaption (system features alteration) to maintain interaction, and hence the biofeedback versions ideally adapt according to the predicted user emotions in an affective loop. There are two types of affective feedback; direct body-activation measures (e.g. heart rate) obtained from biometric sensors, and indirect where emotions are inferred from indirect features (button pressure or body posture). The former suffers usability and measurements issues, while the later may be difficult and time-consuming to tune.

Affective feedback systems were often coupled with adaptive task automation and health improvement applications. However, this recently shifted to a broad range of other applications, including games. The inevitable fusion of biofeedback and games initially lead to games designed to encourage users towards some target to improve performance. This is often through decision-making, attention and arousal validation, supported by the game score (Jerčić and Sundstedt 2019). The literature shows such bio-serious games focusing on emotion regulation and game-based learning. Nevertheless, affective feedback design is now being used for both serious and entertainments games creating adaptive gameplay for increased immersion.

With respect to ludology frameworks and game design, mechanics, dynamics, and aesthetics are the sources of players’ emotional reactions that produce gameplay and engagement. Mechanics construct the rules by which the player interacts with the game and how the game responses, and involve elements like gravity, jumping, dialog, timing, weapons, etc. In biofeedback games, mechanics activations can be tied to direct or indirect physiological inputs. (Nogueira et al. 2016) argue to additionally consider player perception of the mechanics and whether they should be aware of the resulting adaptation. Consequently, a direct/explicit feedback approach conveys to players their emotional/physiological state using visual indicators, while an indirect/implicit approach presents physiological information indirectly through subtle changes in gameplay (Kuikkaneni et al. 2010). Regardless of categorisation, an affective game (AG), where certain elements dynamically change based on player’s emotions, includes adaptation capabilities that varies (or should vary) according to different design parameters. In an affective loop, the output of the classification module is the player predicted emotion and a mapping is required to link this to the game context by finding a game state suitable for the recognised emotional state (Yannakakis et al. 2016). This process can alter game content through adaptive changes to different game elements and mechanics.
This paper discusses the internal part of the AG loop as a design task and reviews the different adaptation mechanisms and design requirements suited for affective play experiences. In section 2, a number of dynamic adaptation elements are discussed along with examples from the literature that employ these in games. Section 3 analyses these sources of interaction in the overall design process and highlights relevant design issues. A generic framework for affective game design is presented. Conclusions are presented in section 4. In Figure 1, we propose a basic framework for affective games design that incorporates biofeedback and adaptive mechanics. The adaptation module is addressed in this paper. The affect recognition module was investigated in (Handy and King 2018).

2. DYNAMIC ADAPTATION

Several categories emerge of game components that adaptively change during gameplay (Bontchev 2016, De Byl 2015) but dynamic difficulty adjustment (DDA) seems to be the most exploited in the literature as it can be tied to several mechanics at once and most of the other components can be designed within this category. Using player performance, the difficulty of any game task can be controlled through positive/negative feedback and hence the overall game difficulty is adjusted automatically.

2.1 Adaptation Targets

Three main directions for affective adaptation in games can be identified:

Content generation is typically applied to platform games and uses methods like procedural content generation to automatically generate textual and multimedia game content algorithmically. A taxonomy of level generators in (Togelius and Yannakakis 2016) suggested a first-order player-centric approach where interaction with the level elicits affective responses (partly caused by design) that are used as input to a model to predict emotions. A second-order designer-centric approach highlights the affective goals of the designer and aspects of the internal player model captured to predict the emotions. Interaction patterns are analysed to infer the player’s/designer’s emotional state which is associated with level context variables. Furthermore, in a direct generator, the evaluation function of the level generation mechanism is built on a computational model of the player’s affect as opposed to considering other aspects of the player experience beyond affect and emotion, such as behavioral traits and cognitive processes, in an indirect generator.

Content adjustment dynamically adapts elements or level of interaction of specific context/items according to player’s skill acquisition. Content collectively falls under game narrative which consists of different descriptors that create the overall impression of “story” to the player. These include most visual elements of the game (text, cut-scenes, interface, world, audio-visual, plot, sounds, music, atmosphere, dialogues, player choices and gameplay etc.). Unlike other forms of entertainment, game narrative is not just the plot. It entails interactivity and player participation. (De Byl 2015) realise this in their concept model as interface and point out how game interfaces can be exploited to provide “seamless” interaction mechanisms with the game environment that encourage emotional behaviour. Adapting audio-visual content was first used in multimedia applications like music recommendation. One of the early attempts in games directly mapped physiological player responses to changes in game properties (Dekker and Champion 2007).

Character adaptation involves the design of adaptive intelligent agents to create emotionally believable behaviour, or to perform “proper” decision making based on their current emotional state. These include NPCs that react to players affect, use their emotional state to decide their next behaviour, or forge a long-term companionship with players. Either way, the affective gameplay experience is improved through the player’s emotional attachment to the NPC adaptability. This extend to the player’s avatar whether central (emotionally embodied as themselves) or acentral (emotionally seen as a third person) that require a gradual bond to establish. Affective game characters and believability design was addressed comprehensively in (Handy and King, 2017).

Overall, most literature in adaptation focusses on game world, level or character. Despite research signifying that changes in musical expressions and sound effects can be reliably identified by electrodermal activity (EDA) levels (Garner 2016), a very limited number of studies addressed procedural music or game sounds that reflects, or changes to, the player’s emotional state, and were mostly horror games targeting fear. Next, we present selected examples from the literature that adaptively exploit game mechanics within the
above categories for both serious and entertainment affective scenarios.

2.2 Related Work

(Zafar et al. 2018) implemented three “casual” biofeedback games incorporating explicit and implicit features and providing visual feedback for players to control stress levels and regulate their breathing. Four components were dynamically altered: game environment, game-controlled elements, player-controlled elements, and object manipulation. Players showed better breathing control during gameplay and improved attentional-cognitive performance in subsequent tasks. The study concluded that game adaptation is more suitable for skill acquisition and transfer than visual biofeedback. However, evidence from other work suggests that combining both is more effective.

Another relaxation game in (Chittaro and Sioni 2014) used a multi-modal affective input to control the behaviour of a character inside a realistic virtual environment. Level progression was subject to avoiding stress sources and relaxing, allowing the character to complete a task. The study carried out three experiments for single EDA input, multi-modal, and a placebo condition. Interestingly, the multi-sensor technique did not show noticeable difference from the EDA-only one, which performed significantly better than the placebo condition. This can simplify an effective model if a single input is enough to gauge a change in the emotional state. Moreover, authors highlight the importance of a control condition in experiments design as comparing two non-placebo conditions may not reflect authentic results.

(Negini et al. 2014) developed a FPS zombie survival game where Galvanic skin response (GSR) controlled the difficulty by altering three mechanics: player (avatar speed and rate of grenade respawns), NPC (speed and number of zombies) and environment (density of fog and rate of health packs respawns). Authors suggest a formula for updating the game elements based on constants and the arousal variable inferred from the GSR. However, these constants, and the threshold resembling a normalised GSR, are adjusted manually based on design experience and play testing prior to the experiment. Although the experiments were limited to a small number of participants, result indicated that GSR was higher for the affective version of the game. They also reported that adapting the NPC resulted in less enjoyment and that player adaptations were the most noticed by participants.

(Nogueira et al. 2016) implemented biofeedback modulation through a horror game with four mechanics that could be influenced by players emotional state: character sanity (sane, scare, terrified, insane), creature AI (passive, passive-aggressive, and aggressive), character ability (sprint velocity, stamina and orientation) and evasion tunnels (spawned in strategic positions to reward quick-thinking). The game supports VR with Oculus Rift and is suitable for emotion regulation tasks as it records skin conductance (SC), heart rate (HR) and facial electromyography (EMG). Both the game’s level layout and events can be generated at runtime. Results perceived the biofeedback to increase the gameplay depth. However, different participants had significantly different interpretations of some gameplay features, highlighting the need for design guidelines based on player type.

(Gilleade and Allanson 2003) incorporated three genres in their experiments with a hybrid action-sport-puzzle game. This paper concluded that a complex analysis of the physiological signals is not possible and opted to a class-based assessment; board, tired, content, excited and ecstatic. The tempo and environment elements changes according to player positive/negative response through HR. However, experiments were conducted on a very small sample with the electrocardiograph (ECG) employed to map a range of physiological state expected from the player. Also, the study assumed decreased and increased heart rates are always associated with negative and positive responses, respectively, which may not be a valid assumption.

(Nacke et al. 2011) used a standard controller in Xbox360 2D side-scrolling shooter game in addition to physiological input processed separately. The study addressed direct physiological signals (gaze, EMG, and respiration) and indirect ones (EDA, ECG, and temperature). The latter was implemented by blowing hot air on the sensor. These inputs were linked to variables that altered five mechanics in different ways: enemy target size, flamethrower length, speed/jump height, final boss speed and weather conditions, and Medusa’s gaze to freeze enemies and platforms. The study tabulates the measured signals and what pre-processing applied to it from each sensor, which could be useful in deciding which mechanics suit which sensor, and how the variables are augmented into the game after pre-processing. Results showed the majority of participants preferring direct control as indirect ones are difficult to control separately and may not be suitable for fast-paced action games. Also, controls were perceived as best when they matched natural input (melting snow by blowing and freezing by gazing), a guideline observation for associating mechanics design with sensors and vice versa.

Authors is (Yannakakis and Hallam 2009) derived differentiable relations between game features (response time, pressure on tile, number of interactions) and entertainment value, quantified as a variable, in a physical Bug Smasher AR game. Machine learning models were used to predict entertainment preferences and gradient descent was applied to suggest direction/magnitude of parameter adjustments. Two mechanics were altered: challenge (speed with which bugs appear/disappear) changed adaptively by a simple set of rules, and curiosity (spatial diversity of the opponents appearing in the game space) adjusted through the partial derivative. Results reveal a preference for the adaptive Bug Smasher version over the static one. Although reported a few limitations and maladjustments, the study shows the possibility of quantifying fun, and that even simple methods can reasonably adjust game features to maximise player satisfaction.

(Baldacci et al. 2017) introduced a set of formal design guidelines based on RPG features to describe two levels: boredom and flow. A support vector machine is used to classify five emotions detected by a wireless electroencephalography (EEG) headset recording brainwaves. Both levels implemented simple/dubbed/riddle dialog, single/group fight, chest open, skills upgrade, and stealing task mechanics. Event logs were crossed to match in-
game data and external data from the headset and reported high accuracy for both game levels confirming the goodness of design and development method. Dialogs were classified best for both boredom and flow proving to be effective in manipulating player emotions positively and negatively in RPGs. Quantitative results show the boredom level being perceived as repetitive and tedious with almost similar accuracy across tasks, while rating varied for the flow level with gradual increase confirming progressive player engagement due to adaptation.

The study in (Nacke et al. 2014) investigated the accuracy of automatic in-game recognition of four playing styles based on facial expressions. A simple linear regression model was constructed from structured interviews with domain experts and applied to infer the styles. The game adapted shooting, discovering, puzzle solving and planning tasks to both player's skills and emotions. Machine learning was used to implicitly recognise playing style at run time and results were cross-matched to self-reported data to record an in-game recognition accuracy of around 71%. However, the experiments only used still facial expressions on a small number of participants and is based on certain learning theory and styles.

(Li et al. 2015) suggested a systematic model of designing affective VR games based on a dynamic graph structure and a closed-loop affective computing system. Skin conductance and heart rate variability are mapped to discrete emotional states. The graph-based approach includes different sub-graphs scenarios that induce different emotions (neutral, positive and negative). The system keeps track of the path a user takes to complete the game, including the order of nodes visited and each transition between subgraphs. Authors proposed parameter-based formulas to measure the effectiveness of emotions (based on nodes in the subgraph), interaction (based on the transition between subgraphs) and game design (based on successful trials of completing the game). Although limited to the specific experiment, this seems a promising trial to quantify a qualitative experience and can be extended to other scenarios.

(Plass et al. 2019) investigated the effect of choosing design features for game characters. They altered four visual attributes: shape, colour, expression and size of the character. The study associated round shapes and warm colours with positive arousal, and used happy, sad and neutral expressions of a 3D game character to elicit positive/negative responses. Participants perceived expression and dimensionality with the strongest effect, while colour had a medium effect, and shape a small-medium effect. Of course, not all characters can be round, orange and smiley, but the above observations lend themselves to affective NPC design and help form some guidelines for creating appealing agents in certain situations.

(Lara-Cabrera and Camacho 2019) provides a taxonomy of affective games based on type of feedback, with a tabulated review of games that employs direct/indirect affective feedback. Reader may also refer to (Novak et al. 2012) for more examples on research-induced affective games.

It is undisputed that including a biofeedback mechanism in the system have positive impact on user engagement and overall experience. However, as appealing as it sounds, affective adaptations are difficult to implement, and it is often unclear whether the expected user state has been achieved can be reached more efficiently. The next section analyses affective games from a design perspective and points out issues that game designers are encouraged to consider early in the design process.

3. AFFECTIVE GAME DESIGN

3.1 Biofeedback System

An adaptation mechanism can be a system with no explicit data fusion where a variable is directly proportional to the physiological signal, a classifier followed by a simple decision-making with a pre-defined action for each recognised emotion class, or an emerging system that gradually adapts to users as they gain experience. Either way, the module is preceded by pre-processing the physiological inputs for noise removal and feature separation. The extracted components are then either used to identify the player's emotional state or streamed directly into the adaptation mechanism to adjust mechanics. (Novak et al. 2012) recommend using classification over estimation because discrete classes are easier to validate using questionnaires or independent observers than continuous values. However, for games, it seems that estimating values is sufficient when the system is designed for continuous physiological inputs, while a classifier is used when the adaptation operates on discrete values, typically the arousal and valence (Bontchev 2016). This is also believed to vary depending on the game requirements and mechanics to be adapted. As mentioned in section 1, quantifying player satisfaction and elicited emotions helps evaluate the overall experience on a parameter-based model. Finding a mathematical mapping between the extracted physiological variables and desired game features facilities the game design and implementation processes and offers more generic approaches to be followed.

Rather than explicitly identifying players' emotions, most experimental affective games tie the sensing device output(s) to a general emotion and employ variations of interaction-feedback mechanisms. Direct-explicit feedback is best for easy mechanics and simple gameplay and should be intuitively mapped to actions and mechanics of the game. Indirect feedback allows for more subtle adaptation and is more suited for slow-changing game world variables that do not directly influence the mechanics. It was also found that combining negative and positive feedback types contributes essentially for a higher player satisfaction (Bontchev 2016). Player's immersion is strongly increased by using direct control, but this can be exploited if players learn to intentionally manipulate physiological inputs to cheat (Nacke et al. 2011). Overall, it is best when control matches natural input (like flexing legs to jump) with more intuitive game interfaces, but it limits the flexibility and generality of the sensors.

Due to the diversity of emotions across people and events, it is important to find best suitable combinations of affective variables, to baseline the hardware. Most of the work in section 2 begin by normalising the collected physiological data though a neutral or a placebo scenario, where the game score and difficulty are independent of and
not influenced by the biofeedback. Otherwise, generalised conclusions cannot be drawn. This is to calibrate the affect detection/recognition module and eliminate the variation of first exposure (Li et al. 2015). The quality of the raw data will impact on the adaptive gameplay and hence preprocessing is often applied. Nevertheless, significant increases in recognition accuracy may not result in significant changes to user experience (Guillotel et al. 2015). The work in (McCrea et al. 2017) concluded that classification accuracies below 70% are unacceptable to end users while increasing accuracy above 90% has only small benefits. They suggest an acceptable accuracy of about 70–80% for affective games. Furthermore, adaptation frequency was not explicitly tested in the literature. Ideally, it should depend on the game and mechanics, but (Yannakakis and Hallam 2009) reported that adjustments at 45 seconds have, on average, a lower impact on the entertainment value. Again, this perhaps is a player-dependent parameter, and it is noted that most of the studies admit to the insufficient number of participants and short playing time impacting results reliability.

3.2 Game Genre
Affective adaptation should not change the nature of the gaming interaction irrespective of the game type, otherwise, the game loses its appeal and falls out of its designated genre(s). (Gilleade and Allanson 2003) argue that only game genres with high level of interaction are suitable for affective inputs. Hence, they suggest action-sport-puzzle games as they require full player attention, high physical responses and fast-paced interaction. Contradictorily, (Zafar et al. 2018) claim that action, adventure, sport and fighting games are inappropriate for affective adaptation as they lack common appeal, higher stimulation and may contain violent content. Alternatively, they point out what they refer to as “casual games” to be the best choice; defined as fast-paced games that are easy to play for a short duration and still deliver a good experience. Strategy, RPG and simulation games are excluded as they require less interaction levels, longer to execute actions, and do no elicit a wider range of emotions, while quiz-based and board games do not possess enough dynamic content for adaptive gameplay.

Possible mechanics that can adaptively incorporate or convey affective information vary greatly between genres, as each genre features different elements. Action and adventure games are all about exploring worlds and solving puzzles and will almost certainly feature NPC interaction. An inclined adaptation would involve dynamic generation of the NPC emotions, behaviour and adaptive social interactions. It can also include manipulating objects and interactions with other NPCs based on extracted emotions. Fighting and FPS games involve direct combat with another player or NPC, hence can include similar mechanics, although with different expressions of emotions. RPGs are based on adventures with complex missions that involve a wider range of social interaction and deeper connection to the NPCs. In addition to dynamic generation of emotions and adaptive level content, dialogue and quests can be adjusted to affective states of player or NPCs. It is worth noting that serious games are the fastest growing genre with respect to adapting affective inputs, where all the other types can be designed within for instructional, training or therapeutic purposes (Broekens et al. 2016).

3.3 Patterns
An interesting approach to affective game design that emerged recently is built on the assumption that player’s emotional reactions to in-game events can be associated with certain patterns early in the design phase. Originally, the well-known game design patterns by Holopainen and Björk, (2004) exploits the repetitive nature of mechanics across games and genres to provide a communication tool during the design process. The template includes pattern name, problem, solution and consequences, and used to express gameplay to designers, gamers and domain experts.

(Gizvcka and Nalepa 2018) highlighted the lack of such consistent methodology for affective games and implies that some game design patterns evoke emotional responses by nature and that detecting these responses is possible. Hence, an arbitrary set of affective design patterns can be distinguished, and a framework is needed to somehow formalise the design process with a catalogue of game design patterns including affective ones. It is assumed that a correlation exists between game events designed with affective patterns and the resulting players’ physiological responses patterns caused by these (those?) events.

One work in (Argasiński and Węgrzyn, 2019) suggested some design patterns for game-based learning and a list of mechanics that can be exploited. A novel framework is presented for the creation and evaluation of serious affective games. The model was tested with six design patterns in a hidden object puzzle adventure game designed for occupational safety and health. The study emphasised traditional game design frameworks “lacking insight on the role of affect in game systems” and concluded that some patterns do have a clear affective association that can be exploited to establish an affective loop within gameplay. Another in (Ngo et al. 2018) studied 21 affective game design components collected form the literature in an experiment that involved the puzzle game LittleBigPlanet 2. The participants group included designers as well, in an attempt to discover their thoughts and feelings on the game design as sometime, the designer’s intended emotions may not be experienced by the player. The study concluded with 15 recommendations for affect-user centred game design grouped under user diversity, challenging and creative gameplay, and impressive visuals, all of which server the flow in the game.

On a relevant note, in analogy to traditional game design/development tools and classical physics engines, (Hudlicka 2009) presented the notion of affective game engine; a system capable of dynamically instantiating game elements accordingly to specific emotions and affective factors. Authors suggest the engine containing both a modelling module to track player’s emotions and identify triggers leading to emotions, and provide real-time construction of an affective user model, and a manifestation module responsible for implementing emotional expression across modalities. The engine should be scalable to facilitate any necessary tuning and extendible to accommodate advances in affective sciences. This means the engine would minimally include features like type of emotion, intensity,
decay, triggering conditions, association between modalities and channels, and behavioural choices, and must be able to encode this knowledge and data as they emerge during gameplay. Similarly (Broekens et al. 2016) discussed an emotional appraisal engine as a specialised game engine to support modelling of emotions in NPCs, in a manner that does not require a commitment to a particular NPC architecture. Their system GAMYGDALA (Popescu et al. 2013) is a plug-in module that is capable of generating emotions and dynamic relationships among NPCs, and integrate emotional appraisal over time, intensity and decay. The designer can define NPCs goals and how they are affected by particular game events which governs their emotions generation. Furthermore, relationships among NPCs can be configured, which forms the basis for social emotions towards other agents. This work demonstrated the emotional appraisal engine independence from the NPC AI and integration with several known game engines and development tools.

Frameworks and Data

(De Bly 2015) suggested a conceptual framework to position adaptation categories on a layered emotional system to serve as general affective game design guideline. Also, the work in (Balducci et al. 2017) can be useful to improve the guidelines in traditional game design featuring different gameplay and interaction modalities. A model-driven engineering (MDE) approach was followed by (Tang et al. 2013) to propose a framework for serious game software independent of hardware or platform specifications. Whether this applicable for entertainment games given the diversity of requirements and design features is still to be explored.

It is no surprise that with the emerge of affective games, new types of data will start to play a role in game design and analytics, where the player’s actual bodily responses, not just game states, may need to be stored. Game telemetry databases are contentious with ethics and security concerns and having bio-data collected will certainly fuel the risk, especially if identifying features are included. These issues need to be addressed and resolved for affective games to commence on a production level. (Drachen et al. 2013) elaborates on game telemetry and lists useful gameplay metrics for different genres which can guide some decision in the design process.

4. CONCLUSION

According to how the adaptation module handles the physiological inputs, players are able to control the game either indirectly through content adaptation if their predicted emotion is coupled to a game element, like colour or sound, or directly if their affective variable is controlling events, like steering or shooting. Players often need to feel in control and having a direct adaptive system that keeps changing gameplay every time the player exhibits a spike in affect, may not always reflect a positive experience, especially for implicit feedback. Direct control is not suited for face-paced entertainments scenarios as it slows down the pace (Zafar et al. 2018) and is difficult to accustom to. It may be more suitable for emotion regulation and skill training (Nacke et al. 2011). Furthermore, the adaptation frequency and duration should be cautiously set to fit seamlessly within the game flow. Attributes could be adjusted on certain time windows, every new level or game, or set of critical actions (Yannakakis et al. 2016). Decision-making tasks (serious games) and quests/missions (entertainment) must be designed to ensure sufficient levels of arousal to avoid breaking the adaptation loop (Jerić and Sundstedt 2019). It might be more effective to combine the affective module with another “static” one, timed on other parameters like game state or player skill.

Overall, existing affective games operate on a predefined set of rules and lack the “ambitious” ability to create new reactions on their own (Lara-Cabrera and Canacho 2019). NPC adaptation rules are often based on OCC and PAD emotional models for their analytical and computational nature, while avatar and affective dialogs are not widely explored. Interactive narrative, specifically dialog, seems a promising venue for affective games. (O’Neill and Riedl 2016) explores the concept of dramatic; a computational model that calculates suspense levels over time allowing for increased emotional content. A narrative engine can provide an affective game with artificially generated stories and interactive narratives tailored to an individual player’s emotions.

Hybrid game genres are rarely investigated, and action, adventure and puzzle games were designed with the claim that an affective game has to be high-paced and casual. However, we believe it is not possible to categorise games with respect to experienced emotions. Players need a broad spectrum of options and mechanics per genre and playstyles are heavily influenced by certain design affordances. Recommendations can be made within each genre, but still players react differently to the same genre and their responses vary with experience and time spent on the game.

Currently, game designer should focus on available consoles and controllers and device “affective scenarios” and methods exploiting those within a demographic game design approach in mind (Bontchev and Georgieva 2018). Moreover, commercialisation is reliant on sensors accessibility and usability in dynamics conditions, hence the suggestions of augmenting existing controllers with affective technology.

Decisions!

The game designer may be faced here with several decisions that are somewhat out of their traditional role. This is why affective applications design is a multi-disciplinary task that requires fellow members from psychology and sociology, something that seems lacking in the experiments from the literature.

Existing designs are often built around distinguishing boredom and engagement, which is perhaps sufficient for monitor flow and immersion, or coupling mechanics with basic classes of emotions or physiological levels based on the OCC appraisal model. It is understandable that this facilitates implementation, but for actual gaming environments, even small-scale commercial level, more complex creative gameplay is owed, and the design team should thoroughly investigate the range and depth of experienced emotions in the designated genre.

This, consequently, should give an insight on the choice and number (unimodal vs multimodal) of physiological
inputs to harvest and how to include them in the game, what theory/model to adopt for modelling the predicted emotions, and what mechanics are best suited for each input and how these vary with respect to the changes in affective variables. It is difficult to say which impacts which, decision of mechanics or physiological inputs type; some experiments in the literature used existing games and hence adapted for existing gameplay, while others designed and created their own test games based on their choice of affective inputs. Also, with respect to hardware, either simple cheap devices, powerful multichannel commercial devices, or custom homemade ones were used approach in mind (Bontchev 2016).

This, again, is a design decision that has to be carefully consider as it reflects on the capabilities of the system and impacts subsequent features.

Collectively, the game designer needs to consider affective adaptation that incorporates regular user interface for explicit feedback, provides a suitable control mechanism, preferably direct; making the players feel they still have the upper hand, while still applying implicit changes to game elements to achieve the desired adjustments, maximising the affective experience. Some more solid designs would include a player-centric model to tailor gameplay with specific playing styles and skills. All of this must be in a timely manner that achieves the affective experience, without breaking immersion or causing boredom.

Choices for the above design parameters will certainly vary with different design aspects like genre, targeted audience, and mechanics implementation. Some intuition is required from the designer to associate available physiological signals to traditional game event or actions within an acceptable engaging narrative, and the possibilities are endless. However, the nature of biofeedback systems combined with the classical uncertainty of “good” game design, makes the task more of a constrained challenge. The more complex the game, the more creative the designer can be with affective inputs, going beyond the discussed categories, but this is likely be hindered by development and testing issues, in addition to usability and user satisfaction. After all, not all fabulously drafted ideas are produced well into computer games.

To conclude, the designer has to remember that the goal is improving players experience not necessarily their score, and it is better to think of the adaptation mechanics as an enhancement rather than fundamental. Furthermore, perfectionism limits creativity; even simple techniques, emotions, and mechanics can generate interesting gameplay with a clever enough design.

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