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A SERIOUS GAME USING PHYSIOLOGICAL INTERFACES FOR EMOTION REGULATION TRAINING IN THE CONTEXT OF FINANCIAL DECISION-MAKING

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Abstract

Research on financial decision-making shows that traders and investors with high emotion regulation capabilities perform better in trading. But how can the others learn to regulate their emotions? 'Learning by doing' sounds like a straightforward approach. But how can one perform 'learning by doing' when there is no feedback? This problem particularly applies to learning emotion regulation, because learners can get practically no feedback on their level of emotion regulation. Our research aims at providing a learning environment that can help decision-makers to improve their emotion regulation. The approach is based on a serious game with real-time biofeedback. The game is settled in a financial context and the decision scenario is directly linked to the individual biofeedback of the learner's heart rate data. More specifically, depending on the learner's ability to regulate emotions, the decision scenario of the game continuously adjusts and thereby becomes more (or less) difficult. The learner wears an electrocardiogram sensor that transfers the data via Bluetooth to the game. The game itself is evaluated at several levels.

Keywords: Serious Games, Emotion Regulation, Biofeedback.

1 Introduction

Serious games are (digital) games used for purposes other than mere entertainment (Susi, 2007). Corti (2006) points out an obvious advantage of serious games in allowing learners to experience situations that are impossible in the real world for reasons of safety, cost, time or logistics. Serious games can have positive impact on the development of a number of different skills (ELSPA, 2006; Mitchell & Savill-Smith, 2004; Corti, 2006; Squire & Jenkins, 2003; van Eck, 2006; see also Rieber, 1996) Having those different skills as defined learned outcomes, one can clearly see why serious games are considered as Game-based Learning (GBL) applications (e.g., Corti, 2006). To achieve the development of new knowledge and skills, game-based learning/serious games need to captivate and engage the end-users for a specific purpose (Corti, 2006). Corti further states that GBL has the potential of improving training activities and initiatives by virtue of, e.g., its engagement, motivation, role playing, and repeatability (failed strategies etc. can be modified and tried again); thus, lead to a more productive workforce.

Currently, there have been serious games created with the goal of teaching how to better manage financial decisions. These games may simulate real life financial situations players will eventually find themselves in, such as Massively Multiplayer Online Role Playing Game where the player has to make various financial decisions to gather enough money so they can retire and "win" (Jones, 2011) and "Darwin: Survival of the Fittest" where the player is thought options trading in the trading pit (Michael & Chen, 2006, p.151).; or simulating business and stock market trading, such as a computer-based simulation business game where teams of players make various decisions regarding the product manufacture operations of a plant(s) and play the stock market trading company shares, where the team with the highest number of assets is declared the winner after the final period (Hartman, 2000). Also noteworthy to mention are the games of "Bankloan" and "Supra" where six players take the roles of representatives of three banks/companies seeking to trade loans and three supermarket buyers/ sales-men each trading three products respectively (Abt, 2002, p.101). These articles report students playing these games with enthusiasm as they were used in the curriculum; on the other hand, no measurable quantitative data has been reported on meeting GBL objectives.

Classical economic theories and models are usually based on the assumption of market actors being fully rational and favor utility maximization when confronted with economic decisions (cf. Rasmusen, 2007). This way of considering economic decision-making has not only dominated economic literature for decades but has also shaped how humans perceive their economic decisions. In particular, professional investors and traders are considered to behave perfectly rational. However, the emerging field of *behavioral finance* gives broad evidence that not only financial amateurs, but also financial professional traders and investors suffer from strong decision-making biases (Shefrin and Statman, 1985). Especially periods of high stress and high market volatility can impair economic decision-making and hence trading performance (Lo et al., 2005).

There is broad evidence that emotions are one key factor that critically influences human decision-making (e.g. Loewenstein, 2000; Adam et al. 2011a). As will be shown in the next section, emotions do not always impair decision making. They can also have a positive influence and facilitate decisions. Gross (1998) argues that emotions act as response tendencies and subjects may follow these response tendencies or not. Recent research shows that, the ability of detecting or *being aware* of one's emotions and the skills to down-regulate levels of high emotional arousal improves human decision-making (cf. Fenton-O'Creevy et al., 2010).

Following this conjecture, the international project xDelia (Xcellence in Decision-making through Enhanced Learning in Immersive Applications, www.xdelia.org) has developed a serious game that aims at improving the player's emotional awareness and training of his/her ability to down-regulate levels of high emotional arousal by the means of online information system displaying biofeedback

based on *psychophysiological* measurements. As an advantage this system measures reliable emotional arousal in a stressful environment and is not biased by self-perception.

Based on the game, future experimental research can shed more light on the connection of training of emotion regulation and decision-making. Moreover, a bank with high expertise in the *private investors* sector will test the game as a training tool for real traders and investors in day trading centers.

The remainder of the paper is structured as follows. In Section 2, we will first describe the theoretical background on emotions and decision-making upon which the development of the game is based. Section 3 describes how emotional arousal can be measured externally with the use of psychophysiological measurement technology. We then describe the design of our game approach – which we titled *Auction Game* – and present and discuss evaluation results in terms of game functionality and usability/playability.

2 Emotions, Emotion Regulation and Decision-Making

Drawing from economic research there is broad evidence that economic decision making can be biased to a considerable extent by levels of high emotionality and arousal (Loewenstein, 2000; Adam et al., 2011b). In the context of economic decision making, emotions are usually perceived as inappropriate interfering with the rational best decision and impairing the decision-maker's ability to take "good" decisions. For instance, the disposition effect, i.e. the tendency for cashing in winning stocks quickly while holding on to losing stocks for too long, is often explained by subjects' emotional imbalance of how to cope with gains and losses (Shefrin and Statman, 1985). However, Seo et al. (2007) discovered in an empirical investigation with traders that emotions may also have positive effects on their stock trading performance. There is hence a bilateral effect of emotions: on the one hand they are bias-inducing and hence malicious to the decision maker, but on the other hand they also provide valuable knowledge in representing for example experiences one has gained in the past (cf. Bechara and Damasio, 2005; Astor et al. 2011). Emotions can help evaluating situations instantly or processing informational overload, when one has to come to quick decisions.

As mentioned above, emotions also affect decision making in professional settings, such as trading, which originally was believed to be a purely rational act. Several studies give evidence that professional traders are tremendously influences by their emotions. Fenton-O'Creevy et al. (2010) interviewed a set of traders in detail and reported that periods of losses were often accompanied by very risk-averse behavior and cautiousness. However, major gains often resulted in high confidence and headless behavior. These emotional states are often accompanied by high emotional arousal.

Russell (1980) generally classified emotions by their independent components arousal and valence. Thereby, arousal represents the level of excitement whereas valence defines whether the current emotional state is positive or negative (visualized on Figure 1). Following this notion when measuring emotions, one is actually measuring a combination of valence and arousal. A reliable measure which shows different kinds of variation depending on the kind of emotional stimulus is the heart rate (e.g. Anttonen and Surakka, 2005; Vrana et al., 1986; Leng et al., 2007). Furthermore, since levels of high arousal can be accompanied by positive as well as negative emotions, arousal remains as the primary attribute of interest in our study. In the scope of our game approach we use heart rate as a proxy for emotional arousal, which will be described later. The continuous measurement of heart rate helps to improve the understanding of the emotional processing in economic decision making.

Fenton-O'Creevy et al. (2010) further detected a strong link between traders' ability to regulate their emotions and their financial performance. The authors found that high performing traders have a better perception and awareness of their emotional state. Most interestingly, these traders are also more advanced in regulating their emotions. While less experienced traders usually try to avoid aversive emotions, the more experienced traders had actually learnt to cope with their emotions. Consequently, the more experienced traders were able to identify and discriminate their emotions in a more

sophisticated way. Thus, there are interpersonal differences considering the experience, the awareness, and the ability to regulate emotions, which in turn inhibit or facilitate decision making performance.

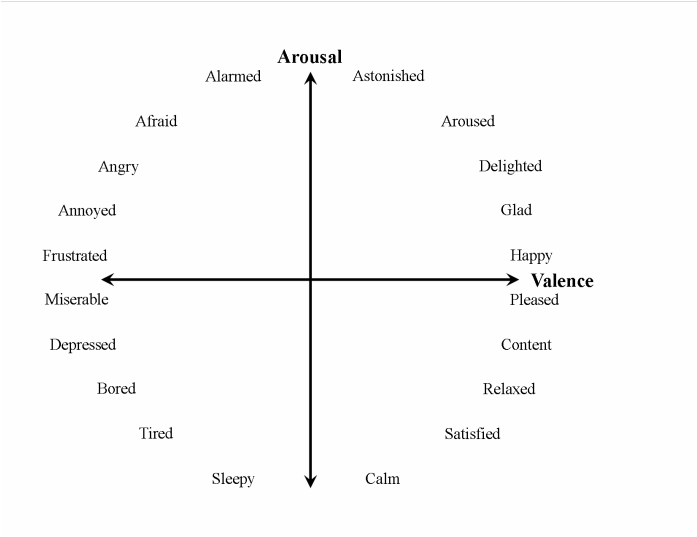

Figure 1: Emotions in the valence-arousal space

Emotion regulation can be described by the process model of Gross (1998) which is widely known and acknowledged in the field of emotion regulation strategies. It relies on the assumption that emotions are generated in an emotion generative process. A broad distinction which the author draws is the one between antecedent-focused and response-focused emotion regulation strategies. Antecedent emotion regulation strategies apply while the emotion is still unfolding and has not reached its peak. An example for emotional *reappraisal* would be a shy student in a class. Now, emotional reappraisal could result therein that s/he considers the school class as a good opportunity to train raising his/her hand and answering questions. Hence s/he constructs a potentially emotion-eliciting situation in nonemotional terms. Response-focused emotion regulation on the other hand tries to aim at altering and controlling the experiential, behavioral and physiological response to the fully established emotion. An example for such behavior could be the shy person in a school class which might try inhibiting ongoing emotion-expressive behavior and disguise them with e.g. insubordination.

People tend to use one of two main, broadly defined, strategies to deal with emotions emerging when facing difficult and stressful tasks (Wallace et al., 2009). These strategies are reappraisal and suppression. In line with the description in the previous paragraph, suppressors tend to constantly push down emotions, ignoring the fact that they exist and are continuously affecting them. On the other hand, reappraisers tend to positively re-evaluate situations. Both emotion regulation strategies take up cognitive resources (Wallace et al., 2009). However, the authors also state that suppressing emotions generally takes up more cognitive resources in comparison to the reappraisal strategy when encountering undesired emotions. Hence, emotional suppression can eventually take up so much cognitive resources that it can reduce one's performance in decision tasks compared to the strategy of emotional reappraisal.

Gross et al. (2003) designed a questionnaire – the Emotion Regulation Questionnaire (ERQ) – in order to identify suppression/reappraisal strategy tendencies used by individuals. It makes specific statements with respect to the emotion regulatory process intended to be measured, such as "I control my emotions by changing the way I think about the situation I'm in."

This section has shown that emotions in the context of financial decisions can be both, bias-inducing, and performance boosting. Better emotion regulation strategies result in better financial performance, whereby the awareness of the emotional state seems to be critical for appropriate evaluation of the

decision situation. The developed serious game for our study thus aims at improving emotion regulation, but also to improve the players' emotional awareness.

3 Psychophysiological Measurement of Emotions

In order to make players aware and give sufficient feedback on emotional arousal, it is crucial to apply a method to reliably detect emotional arousal. While subjective measures, such as self-evaluation, always also incorporate potential self-deception, we make use of psychophysiological correlates of emotions. Moreover, psychophysiological signals can be seen as an objective measure of the emotional state as it is hard to manipulate them intentionally. Iancovici (2011) gives an up-to-date overview on (serious) games using biofeedback, where we can see various usage ranging from educational support (Conati et al., 2003; Kato, 2010) to stress/relaxation/concentration training (Dupire et al., 2011; Sharry et al., 2003, Wang et al., 2011). There are a number of serious games in the field of healthcare and well-being using biofeedback (Kato, 2010), they are mostly concerned with hyperactivity disorder, autism, substance abuse (Wang, 2010) and more specific targets as pain, astma, bladder control, medical education on cancer. These games use various psychophysiology sensors to make the user aware of his/her medical state and provide a clear goal on how to improve it using feedback (Dunwell, 2010). This last point gives the motivation for the game presented in this paper; even more so if we consider that this overview describes the field of finance and financial decision-making as lagging behind in using serious games with biofeedback, in contrast to the healthcare field.

For computation of heart rate (HR), we used the ekgMove sensor developed by Movisens[1] which records electrocardiographic (ECG) signals with high accuracy. In contrast to most other commercially available ECG devices, the sensor is attached to the chest using a flexible belt with dry electrodes. Therefore, it is less obtrusive than other devices and offers a higher wearing comfort. The ECG signal is transmitted via Bluetooth to the xAffect software environment (Schaaff et al., 2011). The software offers a modular framework which allows to process data from various input devices and to transfer the derived values via TCP/IP to other applications like the Auction Game. To get information about the current arousal level of a person, the heart rate is computed from the raw ECG signal. An algorithm to derive the current arousal level from heart rate information is implemented in the xAffect framework. The arousal levels are computed in relation to a baseline period which is recorded before the game starts.

4 Game description

4.1 Underlying principle

The developed game serves two major goals:

- Improvement of *introspection*, the examination or observation of one's own mental and emotional processes, and self-monitoring of physiological arousal and hence personal emotional state.
- Improvement of skills in *emotion regulation* by elements that reward good emotion regulation and punish poor emotion regulation strategies.

In order to achieve these goals, the game uses a *physiological interface* detecting online physiologically measured levels of arousal, as a basis for providing emotional feedback (biofeedback); furthermore, the game difficulty is connected to the measured level of arousal. The better the player is able to control and adapt his/her level of arousal, the easier the decision environment is.

[1] http://www.movisens.com

The core motivation for the Auction Game is that there is a link between maladaptive financial behavior and poor emotion regulation abilities. Therefore the Auction Game can be considered as an emotion regulation training game in the context of financial decisions.

4.2 Game concept and gameplay

The narrative in the Auction Game is purposely simple, since it has to be easy to use the game for students, as well as for investors in day trading centers. The theme of the game is an abstract one depicting sky and clouds, as a supporting environment for down regulating levels of high emotional arousal.

The player is set in the position of a trader where s/he continuously can buy or sell goods, in each round one at a time. The game starts with the introductory screen where the player is presented with the instructions on how to play the game. Here it is also possible to go through the tutorial or just start the game, after which the player's baseline HR data is recorded. Every further arousal level measure in the game is calculated against this baseline. A previous tutorial explains the principle of the game and slowly guides the player. The tutorial should be played the first time the player gets in contact with the game, but it can be skipped if the player already knows the Auction Game.

Before the start of each round, an offer price and price estimations are calculated with respect to the level of arousal the player is currently at. A round (see Figure 2) consists of three price estimations presented to a player sequentially, from the three trusted simulated consultants. The clouds are individually presented on screen for a certain amount of time, from one second at starting easy levels and shorter as levels progress. To make the player attentive, clouds appear at random places on the screen. They estimate the goods price in the next round; thus, by calculating the mean of the three prices in the clouds, the player knows the true price of the good/stock in the following round.

After the indication of three price estimations, the player gets the chance to buy or sell the good for the offered price. S/he has to make a decision in a certain amount of time, from two seconds at easy starting levels and shorter as levels progress. To make a decision, the player has to click on the buy or sell button; following this, an audio and video feedback is presented conveying the outcome of the decision.

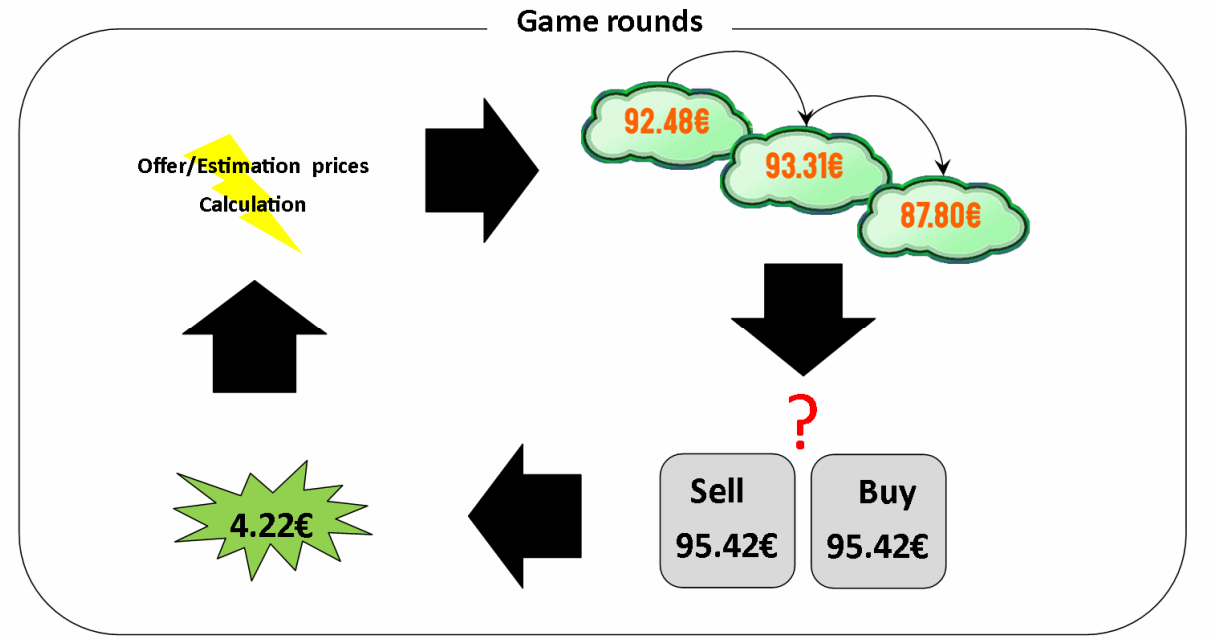

Figure 2. Example sketch of game rounds

Depending on his/her decision the player realizes a gain or a loss. In order to gain money the player has to take the right buy/sell decisions. Every profitable decision will reward the player with a certain amount of money, while a non-profitable one will reduce the player's earnings and take him further away from the current level's profit goal. Not taking a decision is the most expensive action, taking a large sum of profits (5 Euros) away from the player. Too many money losses will lead to the end of the game. This limit has been set to 10 Euros below the current level starting point. If the player is quick in calculating the three price estimations, s/he can easily reach a correct decision. After that, the total money earnings are updated and if the player has reached the current level's profit goal, a new round begins.

Consider the example in Figure 2. Assume that the price estimations are 92.48€, 93.31€ and 87.80€ and that the offered price is 95.42€. By calculating the mean the player realizes that the mean is close to 91€. In fact, it is 91.20€. Since the mean price of the estimations is lower than the offered price, the player should select the Sell button and realize a gain of 4.22€. This task continues until the player has reached an upper bound to move to the next level or the player loses the game due to running out of time or due to bankruptcy.

The player's level of physiologically measured arousal affects the game difficulty. Before the start of each level, player is informed on how his/her level of arousal will influence the game difficulty. For example, the goal within a round could be to keep the level of emotional arousal as low as possible. As long as the player is able to keep arousal low the game will remain in the relatively easy mode. However, as soon as s/he becomes more aroused due to, for example, anger of an incorrect decision, the arousal bar will move up and the decision task will become more difficult. The level of difficulty increases by increasing the variance on the price estimation signals. While the price signals would normally (without arousal) be 92.48€, 93.31€ and 87.80€ they could be then 68.22€, 79.21€ and 126.17€ when the player is unable to keep his/her arousal down, making it more difficult to calculate (or estimate) the mean. The variance of the estimations will get larger the higher the emotional arousal is.

The player's goal in the Auction Game is to reach the highest level possible. To advance from one level to the next, the player has to make profitable decisions and earn enough money to reach that level's profit goal. Moreover, s/he has to reach the next level in a limited period of time otherwise the game ends; this time limit is currently set to 4 minutes. In every level the profit goal increases by 30 Euros. As soon as the player earns this amount, a button pops up and s/he can proceed to the next level.

Players who can achieve targeted the emotional arousal level will be rewarded with larger profit/lesser loss money values. On the other hand, undesired emotional arousal values will yield lesser profit and larger loss. While in the first levels the constraint for physiological arousal is to simply down-regulate arousal, in later levels the players have to aim at a specific level of arousal. As the game progresses, as well as arousal gets higher, the game difficulty will change, making it more difficult to take a profitable decision. Moreover, from level to level the tasks to regulate emotions will become more and more difficult as step by step new distracting elements are included. Among those are additional irrelevant clouds carrying false information, time, distracting images, auditory, and visual constraints (will be described later in detail).

The game is conceptualized such that it has no predetermined ending level, but after level 10 the game becomes extremely hard entering what is called "The Death Mode." Hence, the ending time of the single levels and the game can vary, depending on the player's skills. Optimally the game should run for approximately 25 minutes where players should earn around 200 Euros profit in the game. The player's skills to earn money in the game are related obviously to (1) his/her abilities to perform calculations under stress, and (2) to the player's skills to regulate his/her overall emotional arousal state. Independently from the player's calculation skills, good emotion regulation will help to improve his/her individual game performance.

After the game has ended, the player is presented with the level s/he has reached. Better players earn a higher place on the high score list where they are given a chance to compare money earned result to their previous ones.

The objective of the Auction Game is to train players in performing emotion regulation strategies. By showing the level of arousal the player can gain an awareness of his/her emotional state and the influence of emotions and emotion regulation on decision making. In other words, guide the player towards mindfulness of emotions. By displaying the player's emotional state as an indicator indicating arousal levels ranging from relaxed to highly aroused, a player has to regulate his/her arousal to minimize the deviation of the estimations and thereby have a better chance to accomplish a higher profit. Indicator levels are dependent on a player's level of arousal.

4.3 Game Mechanics

The Auction Game has been developed in a Unity 3d pro game engine which supports integration of third party APIs. As can be seen in the Figure 3, the Auction Game is played in a 2D environment where price estimations are presented inside of the colored cloud drawings. To depict a sense of progress through the game, every level has a different background picture of the sky. The player can see his/her individual arousal level indicated on the meter in the top right corner, as well as by the color of the clouds (green, yellow and red). The profit goal and total money earned are presented on the meter at the bottom right side of the screen. Decisions can be made by clicking on one of the Buy/Sell buttons presented at the bottom of the screen using a mouse.

Figure 3. Screenshot from the Auction Game

4.3.1 Game Difficulty

The game must engage in play all types of players, ranging from experienced gamers to completely inexperienced players since the target group for a serious game may not necessarily be experienced game players. Thus, the game starts slowly introducing distracting elements step by step throughout the levels; moreover, the clouds appearance time (mean calculation) and decision time decreases.

In the Auction Game, different game elements are affected by the player's arousal level, which will make the game harder. In order to train emotion regulation during the game, it is important that the

game is sufficiently challenging in the aspect of emotional arousal control. The arousal affected elements described below are the different ways in which arousal influences gameplay, and are meant to make the game more difficult in different aspects. The further away the player's current level of arousal is from the target level, the bigger each of the effects will be.

Thus there are two dimensions of variety of difficulty in Auction Game respectively:

- **Game elements not affected by arousal**
  - As soon as the player reaches half of the level goal, the tempo of the background music will be slightly increased. Moreover, one quarter away from the goal music noticeably speeds up to distract the player and thereby suborn him/her to make quick decisions.
  - The speed of cloud appearance increases while the time for decision decreases. As the player progresses through a level, the cloud estimations slightly increase their movement speed; moreover appearance time and decision time slightly decrease to distract the player into making quick decisions in an attempt to make him commit errors.
- **Game elements affected by arousal**
  - Distribution of price signals is dependent on the arousal level of the player. The further s/he is away from the target arousal, the larger will be the spread of estimations. This will make it more difficult to calculate the true price.
  - Distribution of true price in the next period is dependent on the arousal level of the player. Every round a good shifts its true price on the market. The further s/he is away from the desired level of arousal, the larger deviation of the next true price is. This will make true price shift more unexpectedly.
  - Speed of cloud movement is directly linked to arousal. As the game progresses clouds start moving. The further s/he is away from the desired level of arousal, the faster the movement of clouds becomes. This makes it harder to visually observe the price estimation.

To keep the game interesting, piecewise elements varying cloud estimations are presented through the levels (Table 1). Note that every element adds to all the active ones from previous levels.

Level	Elements varying cloud estimations
1st	Player's arousal level is presented but it has no effect on the game at all
2nd	Player's arousal level affects the game
3rd	Estimation clouds move simulating the wind
4th	Estimation clouds become bigger and smaller in sizes
5th	Estimation clouds are same sized, but fake clouds with text start to appear
6th	Fake clouds with numbers start to appear
7th	Estimation clouds become bigger and smaller in sizes again
8th	Player has to achieve targeted arousal, but fake clouds do not appear in this level
9th	Fake clouds with numbers start to appear again
10th	Estimation clouds' speed and appearance time of the clouds are random
11th	Entering Death Mode, game speeds up impossibly

Table 1. Game level elements varying cloud estimations

5 Evaluation

The Auction Game has been thoroughly tested using functionality, heuristics and play testing.

5.1 Functionality and Heuristic Evaluation

The functionality evaluation consists of three categories: validation, verification, and future support. The validation was done in collaboration between the partners from *xDelia* at several face-to-face

meeting where the product was demonstrated. By letting the product owner test it before it was finalized much of the rather abstract discussions became concrete as feedback was communicated.

The verification was done by the development team throughout the development process. By working in an incremental development style the product was constantly tested for errors when new things were added, thus minimizing latent errors.

The future support is achieved by designing the game around a modular and dynamic architecture, making it easy to adjust for future studies; moreover, a xAffect as separate component is used for measurement of the arousal allowing for other sensors to be used within the same game.

Development of the Auction Game was followed by a heuristic evaluation (Isbister & Schaffer, 2008) aiming at qualitatively identifying design errors and suggest improvements. A group of expert evaluators reviewed the game using heuristics divided into a set of categories, looking for potential usability and gameplay problems in the prototype. Heuristic evaluation pinpointed several important design issues and reinforced the robustness of the game.

5.2 Playtesting Evaluation Method

A total of six students volunteered to participate in the Playtesting Evaluation. They were all students of *Blekinge Institute of Technology* aged between 20 and 32 years old with four of them being male and two female. They reported varying gaming experience.

Before the game, the students were fitted with the Movisens ecgMove HR sensor and given a tutorial session. In order to objectively determine which game elements the players were paying attention to, the game was played through the Tobii T60 eyetracker logging data on different Areas of Interest (AOI) and recording the whole gaming session on video. The purpose was to be able to tell how important different visual objects (AOIs) on screen are to a player. At the end of each game, each participant was given: an Emotion Regulation Questionnaire (Gross et al. ,2003) in order to identify suppression and reappraisal tendencies of individuals; a modified System Usability Scale (Nacke, 2010; Brooke, 1996) questionnaire measuring game usability. The questionnaire contained 10 questions whose score was summed up in a single number representing a composite measure of the overall usability of the game being studied; an interview session where participants could openly discuss perceived game speed and difficulty, as well as visual cue elements and any issue they wanted to note.

5.3 Playtesting Evaluation Results

The Auction Game scored a mean value of 67.92 in a range from 0 to 100 on modified SUS questionnaire. Thus according to Tullis (2008) where a score of 60 presents a border between poor and average usability, we can conclude that the game fulfills the average game usability.

The game was successfully played up to a hard 8th level by two participants, both of which are high reappraisers, while one had low and the other normal suppression tendencies. They both evaluated the game as manageable and in the interview session reported that they were practicing emotion regulation techniques themselves without being instructed at all. This provides evidence for a good game design of the Auction Game.

Five out of six participants reported that they were not paying attention at all to the arousal meter indicator present at the top-right of the screen. We evaluated this claim on how informed the participants were about their arousal level. They have an option of keeping track of it on the arousal meter indicator during rounds in the whole gaming session. A paired-samples t-test was concluded on the eyetracker data to evaluate the difference in number of gaze observations on marked indicator arousal meter AOI compared to number of rounds taken for each participant. There was a statistical significant difference found with number of rounds (M=110.17, SD=95.26) to number of arousal

meter observations (M=16.33, SD=24.5, $t(5)=2.94$, $p<.05$). Thus we can say that participants paid little or no attention on the arousal meter indicator during the whole playing session. Participants reported that the reason for paying little or no attention on the arousal meter indicator was lack of time during fast paced decisions. Most of the participants reported that they were paying attention to the arousal indicated by the color of the cloud estimations, especially when it turned red. This gave evidence to concentrate on making the color of the cloud estimations more distinct, since players are focusing their concentration on them. Further studies should identify how to optimally present the arousal information to the cognitively engaged player during fast paced decisions.

A one-way between-groups analysis of variances was conducted to explore the impact of arousal level on profit in each round. Total number rounds played, 661 rounds, were divided into 5 groups according to the arousal level while decision was made (Group 1: 1[relaxed], Group 2: 2 … Group 5: 5[highly aroused]). There was a statistically significant difference at the $p<.05$ level in profit made each round for the five arousal groups [$F(4, 656)=3.566$, $p<.01$]. The effect size, calculated using eta squared was .02. Post-hoc comparison using Turkey HSD test indicated that the mean score for Group 1 (M=.6328, SD=2.95) was significantly different from Group 5 (M=-1.369, SD=3.3). Other groups did not differ significantly. Same has been conducted for the time needed to reach a decision in seconds and there was a statistically significant difference the $p<.05$ level [$F(4, 656)=5.753$, $p<.001$] between Group 5 (M=1.55, SD=.45) and rest of the groups. The effect size, calculated using eta squared was .03. This gives strong evidence supporting a good design of the Auction Game to present a hard challenge and punishment to a player in an undesirable high arousal emotional state.

6 Discussion and Conclusion

Evidence shows that emotions impact our decisions, especially in the field of finance. Thus it makes sense to develop a tool to get people aware of this implication as well as to help them in regulating their emotions to reach better financial decisions. A serious game emerged as an appropriate tool in which players get feedback on their emotional arousal, according to their psychophysiological state. This on screen feedback helps subjects to get aware of and to learn how to control their emotional state. The Auction Game is a serious game where a player buys or sells stocks with the objective to train emotion regulation; but also to get them aware of the arising emotions. To support this, achieving a target arousal level will reward the player accordingly, increasing his/her earned profit.

Data from successful participants gives first evidence that the Auction Game is indeed overwhelming and puts players at a highly aroused state where they need to practice emotion regulation techniques to succeed in the game.

We have demonstrated in the Auction Game how one can reward a player achieving a desired arousal level, while at the same time presenting a hard challenge and punishment to a player in an undesirable high arousal emotional state. Through this experience emotion regulation can be learned and practiced using this tool.

For future work it is planned to use the Auction Game in varying contexts: it will be interesting to detect which strategies players apply (e.g. breathing) in order to regulate their level of emotional arousal; Related to this question, we want to examine how effective certain strategies will prove, measured either by self-perception and/or by physiological measures (e.g. phasic heart rate response, heart rate variability), in order to perform well in the game. Moreover we want to find out whether certain emotion regulation strategies (suppression versus reappraisal) result in systematic differences in game performance. Our last and most prominent goal is to evaluate the Auction Game as a learning tool for enhanced emotion regulation, i.e. examining whether extensive playing of the Auction Game (or another tool following the same paradigm) can systematically improve subjects skills to get aware and control their emotions and whether these skills are transferable to other (financial) tasks, leading to a long lasting shift in decision performance. This future research has to be conducted in order to investigate how successful our approach is in teaching emotion regulation and how well it can be

transferred to real life trading. Up to now, we have demonstrated that the Auction Game was successful at reaching its goals as a study tool, as well as a usable game. If we can systematically succeed in this, we can make learning emotion regulation in the context of financial decision making more fun and more effective.

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