A GAME BASED APPROACH TO IMPROVE TRADERS' DECISION-MAKING

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ABSTRACT

Purpose: The development of a game based approach to improving the decision-making capabilities of financial traders through attention to improving the regulation of emotions during trading.

Design/methodology/approach: The project used a design-based research approach to integrate the contributions of a highly inter-disciplinary team. The approach was underpinned by considerable stakeholder engagement to understand the 'ecology of practices' in which this learning approach should be embedded.

Findings: Taken together, our 35 laboratory, field and evaluation studies provide much support for the validity of our game based learning approach, the learning elements which make it up, and the value of designing game-based learning to fit within an ecology of existing practices.

Originality/value: The novelty of the work described in the paper comes from the focus in this research project of combining knowledge and skills from multiple disciplines informed by a deep understanding of the context of application to achieve the successful development of a Learning Pathway, which addresses the transfer of learning to the practice environment

Key words: Design-based research, emotion-regulation, disposition–effect, financial traders, serious games, sensor-based games

1. INTRODUCTION

This paper describes the xDelia project (http://www.xdelia.org), which was concerned with developing approaches to improving financial decision-making. The primary target group was investors who trade their portfolio regularly (typically via online trading platforms). This is a large and increasingly economically important group around the world. Such traders invest their own funds in investing and speculating in markets for financial assets. Most national (and trans-national) regulatory regimes are concerned with the need to ensure that citizens participating in such activities are well informed about risks including behavioural risks such as systematic biases.

1.1 The Problems of Previous 'De-biasing' Approaches

Many forms of de-biasing training, which seek to reduce propensity to systematic biases in decision-making, have been, at worst, counter-productive and at best had very limited impact even in laboratory settings (Bazerman, 2002; Fischhoff, 1982; Lilienfeld, Ammirati, & Landfield, 2009). A key problem with de-biasing training approaches has been the focus on shifting cognition from System 1 (fast intuitive pattern recognition mediated by the emotion system) to System 2 (conscious, reflective analysis) (Lilienfeld, Ammirati & Landfield, 2009). As Baumeister and colleagues (1998) have shown, human capacity for self-monitoring and effortful System 2 cognition is limited and is rapidly depleted.

Attempts to reduce biases by learning about biases and engaging in self-monitoring, rapidly come up against human cognitive limits.

1.2 Emotions and Emotion Regulation

There is an increasing body of research which shows many systematic biases in human decision-making to be shaped and mediated by emotional reactions (Fenton-O'Creevy et al, 2011). However, recent research on emotion regulation makes it clear that humans do not just experience emotions; we actively regulate them (Gross & Thompson, 2007). Recent empirical research has begun to address the role that emotion regulation processes play in individual susceptibility to biases. For example, a large-scale field study of investment bank traders showed important differences between novice and expert traders in emotion regulation strategies and showed many traders and their managers to be concerned with the regulation of emotion to avoid the biasing effect of strong emotions on trading decisions (Fenton-O'Creevy et al., 2011, 2012).

1.3 Developing an Alternative Approach

As we note above, prior approaches to de-biasing training have been especially ineffective in the transfer of learning into real-world settings. Our approach, to learning to avoid systematic biases in financial decision-making, does not rest primarily on shifting cognition from System 1 to System 2. Rather we recognise first, the importance of enhancing domain-specific task feedback and, second, the role of emotions in mediating System 1 decision-making. In particular a wide range of decision-biases can be shown to be underpinned by emotion processes (Loewenstein & Lerner, 2003) and a central proposition of the project is that such biases can be reduced through more effective regulation of emotions. We have a particular focus on biases in financial decision-making which have the following characteristics: i) the bias has been demonstrated to be significant in naturalistic settings as well as in the laboratory, ii) there is reason to believe that emotions play an important role in the operation of the bias and iii) the bias is tractable to detection at the level of the individual, for example, though the analysis of past trading decisions. Whilst there may be merit in embedding learning in the real trading context, this carries evident risks of, at least initially, harming performance. Thus we aimed to design a game based learning environment, for play based learning, with a structured process for transfer of learning into the context of application.

To develop and establish a 'proof of concept' for a game based approach to decision-bias reduction, we chose to focus initially on one particular bias which fits the above criteria: the disposition effect. The disposition effect is the tendency to hold assets that would sell at a loss for longer than assets that would sell at a gain (Shefrin & Statman, 1985). In colloquial terms an investor who suffers from the disposition effect cuts their wins and runs their losses. This bias arises out of the desire to avoid the emotional pain of realising a loss. So long as the investor does not convert a paper loss into a realised loss they can console themselves that 'it will probably increase in value again'.

2. METHODOLOGY

The methodology we adopted was Design-Based Research. Design-Based Research (DBR) has emerged in recent years as an approach for studying learning in context through systematic design and study of instructional strategies and tools (Brown, 1992). Barab (2006, p. 155) argues that the value of Design-Based Research (DBR) is that it offers a methodology for dealing with the complexity of real learning contexts by "iteratively changing the learning environment over time – collecting evidence of the effect of these variations and feeding it recursively into future designs" (citing Brown, 1992; Collins, 1992). DBR provided an appropriate methodology because it is agile, iterative and is useful when developing for and evaluating complex contexts. It also provided a broad framework within which the different methodological approaches and theoretical perspectives of a very interdisciplinary team could be integrated.

A first important underpinning for our DBR approach was very considerable stakeholder engagement to understand the 'ecology of practices' (Scanlon et al., 2013) in which this learning approach would need to be embedded. This involved working closely with a commercial partner, Saxo Bank, who provided in depth knowledge of the industry setting, trader profiles and behaviour and were also an active research partner. It also involved a series of exploratory observational and interview studies which looked in depth at the practices used by professional traders to effectively regulate their emotions; and the practices, including learning practices, of private traders and investors with which any learning approach would need to integrate. This led to our understanding the technological artefacts that we sought to produce as only one element in a technology enhanced learning 'complex' (Scanlon et al. 2013) of technology, software, learning design, learning practices and learning support which would need to successfully integrate with the existing practices of our target audience, including their, largely informal, and highly self-motivated learning practices.

The second key underpinning for the work was the highly cross-disciplinary team which included expertise in financial economics, the psychology of financial decision-making, neuro-economics, behavioural economics, serious games, technology enhanced learning, and physiological sensors.

We set out below an account of our learning design, with an account of the underpinning assumptions, theory, and data.

3. A LEARNING DESIGN FOR REDUCING INVESTOR SUSCEPTIBILITY TO BIAS

In designing a learning approach to reduce investors' vulnerability to bias we have framed learning objectives at four levels:

- Level 1: Propositional Knowledge. Understand the disposition effect and emotion regulation strategies and how they relate to investor trading.
- Level 2: Self-awareness. Improve awareness of own profile in relation to disposition effect, habitual emotion regulation strategies; and propensity to defensive emotion regulation.
- Level 3: Skill development. Develop skills in recognising and avoiding the disposition effect and in effective emotion regulation in a learning environment.
- Level 4: Transfer. Support the transfer of skills from the learning environment into the practice context.

To achieve these outcomes we needed to engage investors in the acquisition of propositional knowledge, provide opportunities for feedback, develop a learning environment for skill acquisition and practice, and develop a supported approach to transfer of skills into investors' real-world practice of trading.

3.1 Overview of the Learning Pathway

We developed a Learning Pathway which has multiple elements: didactic elements, diagnosis and feedback on behavioural biases (both game-based and based on real-world trading), learning and practicing emotion regulation strategies in a serious game environment, practicing emotion regulation strategies in the practice context, and support for reflective practice.

The learning approach can be broken down conceptually into three key aspects: diagnosis and feedback, skills development, and transfer (see Figure 1). While the diagram represents this as a linear pathway, we would emphasise that in practice it is iterative, with learners returning to earlier diagnostic and skill development phases as they work on transferring these skills into the trading context.

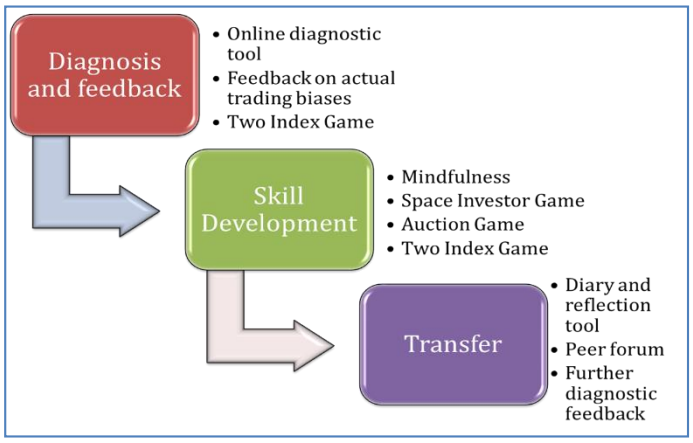

Figure 1 – The xDelia Learning Framework

We are clear that didactic, knowledge-focused learning approaches to de-biasing have largely failed in the past (Bazerman, 2002; Fischhoff, 1982; Lilienfeld et al., 2009). However, that does not mean that we entirely reject the utility of didactic approaches. First, some element of knowledge transmission is necessary to support the other approaches we espouse, namely diagnosis and feedback, and critical reflection. For example, feedback on susceptibility to a disposition effect or training in improving emotion regulation is unlikely to be effective without an understanding of the nature of the disposition effect and the meaning of emotion regulation. Second, the impact of didactic approaches on real-world practice should be significantly enhanced to the extent that the learning is brought alongside and placed in the context of the specific domain of practice (in this case investors trading on a trading platform). We describe below the three games which formed the core of the learning journey.

3.1 The Games

3.1.1 The Two Index Game

Figure 2: The Two Index Game

The Two Index Game is a fast paced serious game which challenges a single player to buy and sell assets in a set number of timed levels and perform as close as possible to playing perfectly relative to a benchmark. The game emulates decision making processes within investment and trading, in a non-specific manner, and can perform diagnostics about exhibited cognitive biases, including disposition effect, as well as incorporate feedback derived from these into game play in real-time. The game is available in both diagnostic and didactic modes. The first, to diagnose the extent to which a participant may be subject to the disposition effect, and provide post-gameplay feedback; the second provides in-game visual feedback on current disposition effect to the participant and enables them to use it as a training tool to reduce the extent to which they are affected by this bias.

When playing the game, the participant is presented with two indices: the Value Index, showing current asset prices, and the Predictor Index, which partially determines the tradable index value (with lag and some random component). The player's task is to buy and sell the assets using these indices at the best moment to maximise profit and perform as close as possible to a benchmark: their performance is presented as a percentage distance from optimum, changing during game play. The participant is taught the game through an initial tutorial which walks them through the game

demonstrating key features, and gives them the opportunity to practice before the real game starts. The game is structured so as the levels progress more options are made available, allowing for more possibilities for taking risk and ways of transacting. To begin with the player can only buy single assets, then they are able to buy multiple assets at a time, and finally they can short sell.

The game is available as an online version, or can be installed as a standalone local version for computers that are not connected to the internet. Both versions offer the same functionality.

3.1.2 Space Investor

Figure 3: Space Investor - showing arousal bar

Space Investor takes the form of an asteroid shooting game that helps to train a player's emotion regulation strategies. Two variants have been produced: a didactic version which provides live feedback to the player, and a diagnostic version (no live feedback).

The purpose of the game is to assist investors in becoming aware of their own arousal state as well as training them in regulating their arousal. This is important, as emotions and arousal are strongly linked phenomena. Space Investor provides participants with a game environment in which to practice awareness and regulation of arousal. The game both gathers biofeedback on the participant's arousal state and also requires participants to self-report their own perceived arousal level (from 0-4) at the end of every game play level. Playing the game supports development of emotion regulation skills in three ways. First, it provides an environment in which management of arousal levels can be practiced and rewarded. Second, by directing attention to the participant's own physiological state it encourages improved interoception (awareness of internal physiological state); there is empirical evidence for a link between interoception and perception and regulation of emotion state (Damasio, 2000). Third, it provides a context for the practice and consolidation of emotion regulation approaches developed in other contexts (for example mindfulness approaches, which require effective interoception).

Playing Space Investor, the participant has to shoot down asteroids, selectively, to avoid them hitting their space ship and avoid hitting other asteroids to collect resources to gain upgrades. The player wears an ECG sensor, which communicates with the game via Bluetooth and as the player becomes aroused, the game records the player's arousal levels (as measured by heart rate). In diagnostic mode, the game simply records how the player's arousal levels vary. In the didactic mode version of the game, the player is both presented with visual feedback displaying their arousal level, and the game increases in difficulty if the player does not manage their arousal level by down-and up-regulating their arousal level to within bounds indicated on the arousal bar; providing motivation to focus on bodily signals of arousal (interoception).

3.1.3 The Auction Game

Figure 4: The Auction Game

This is a simple financial decision making game simulating a stock exchange. The participant takes part in an auction, buying and selling stocks, aiming to achieve maximum profits by making the correct decisions when presented with options to either buy or sell at different prices. The game has the same fundamental learning design as the Space Investor Game but aims to train investors in emotion regulation in a more financial context. By observing their level of arousal the player can gain an awareness of his/her emotional state and the influence of emotion regulation on decision making. Additionally, in didactic mode, the arousal level will influence the game play. To be able to play successfully the player has to regulate his or her arousal. Players get feedback about their behavioural and physiological (galvanic skin response or heart-rate) responses to losses and missed gains. This provides important process feedback to aid understanding of the reactions which underpin the disposition effect. In particular the players can observe their asymmetric responses to the pain of losses and the pleasure of gains. The Auction Game provides participants with an environment in which management of arousal levels can be practiced and rewarded in the context of a fast-paced financial decision task, to become more aware of their own physiological state, and provide a context for the practice and consolidation of emotion regulation approaches developed in other contexts (for example, mindfulness approaches).

During game play, the participant is presented with three prices for a stock. The participant must quickly calculate the mean of these prices to understand the true price. Having been presented with these estimates, the participant is given the opportunity to buy or sell (or not trade) on an offered price against the true price of the stock. The decision has to be made within 3 seconds of the final estimate being shown or a financial penalty is imposed and the game continues to the next decision.

The participants are required to regulate their arousal to within bounds indicated by the on-screen dial. The more distant the participant's arousal level is from the ideal, the more the price estimates deviate from the true price with higher variance, while the closer the participants are able to regulate their arousal level to the ideal, the closer the stock price estimations approach the true price enabling buy or sell decisions to be more easily made. In diagnostic mode, the game continues for a set number of decisions, while in didactic mode the participant has to reach a financial total within a set amount of time to successfully complete a level and move on to the next; failing to do so finishes the game.

3.2 The Learning Pathway

1) The Learning Pathway starts with an opportunity to gain diagnostic information on propensity to disposition effect and own approach to emotion regulation. The aim here was to, first, develop the investor's self-awareness in relation to the disposition effect and emotion regulation approaches. Second, the diagnosis process provides a vehicle for delivery of propositional knowledge in relation to the disposition effect, the role of emotion in trading biases and emotion regulation strategies and how they relate to investor trading. This should increase investor engagement with the concepts by making them highly personally salient. Diagnosis was achieved through:
    a) Questionnaire measures on emotion regulation strategies
    b) For investors with existing trading history, diagnosis of level of disposition effect shown in past 'real world' trading behaviour

c) For investors without available trading history, playing the 'Two Index Game' to diagnose propensity to disposition effect. This game uses a simple trading task under time pressure to induce a disposition effect in players. Players varied in their susceptibility to the bias.

2) Alongside the feedback, the investor is given access to multimedia didactic materials on disposition effect and emotion regulation and the likely meaning of the feedback in relation to their own investment practices.

3) In the next stage the Two Index Game becomes a learning space where the investor can try out and get feedback on different strategies for avoiding the disposition effect. In a first iteration they can play the game multiple times and experiment with monitoring and modifying their own behaviour.

4) In this stage investors get the opportunity to engage with learning elements, which support the development of enhanced emotion regulation. Two approaches are involved here: a) mindfulness inductions; b) Space Investor, the first person shooting game incorporating physiological sensors in which effective management of physiological arousal is rewarded by in-game upgrades. This is followed by further opportunities to play trading task games (Two Index Game and Auction Game) but this time accompanied by physiological feedback on arousal and regulated responding (heart rate and high frequency heart rate variability).

5) An online diary tool integrated with the trading platform supports a structured approach to writing down and reviewing real-world trading strategies including reviewing emotion state and emotion regulation. .

6) The diary tool is linked to template-based structured reflection tasks. Output from these tasks is stored in the diary tool. This provides opportunities to review progress in a structured way, including additional feedback opportunities on disposition effect and emotion regulation.

7) Alongside such learning opportunities investors should have access to peer discussions in online forums with tools to support development of peer learning groups interested in discussion of their regulation of emotions and management of disposition effect.

4. THE EVALUATION OF THE LEARNING PATHWAY

We have evaluated individual elements of the xDelia Learning Pathway and, where possible, combinations of these elements in 35 laboratory, field, and evaluation studies involving 1,422 students and 793 traders and private investors. Space limits in this paper preclude the presentation of this full set of study and evaluation outcomes (we give example results below). The interested reader may find fuller documentation of these studies at www.xdelia.org. We have targeted two key themes with these evaluations: evaluating effects of the learning elements and evaluating user perceptions of the learning experience.

Data on user experience has been gathered through a combination of surveys and interviews with participants in trials of learning elements, and has included data on usability; user engagement and enjoyment; and on user perceptions of learning outcomes and learning potential. Data on effects has, where possible, been gathered through the use of randomised control design studies. In particular we have examined the effect of learning interventions on improved emotion regulation; improved mindfulness; improved interoception and body awareness; and financial decision-making behaviour (including susceptibility to the disposition effect.).

The outcomes: -

Taken together, our studies provide support for the validity of the learning approach and the learning elements which make it up.

1) There is evidence for the effects of the learning interventions in achieving proximal goals of improving emotion regulation, mindfulness and interoception. For example: -

a) In a student study (N=108) we conducted a three week course of emotion regulation training using the sensor games. Compared with a control group, participants showed a significant

improvement in emotion regulation. First they showed reduced (self-reported) use of emotion suppression strategies and greater use of (more effective) emotion reappraisal strategies. Second while resting HF-HRV (a physiological measure of base emotion regulation capacity) remained unchanged from week 1 to 3 (0.120 vs. 0.119, N= 47, t(45)=-0.52, p=.958) for the control group, subjects that received ER training had a significantly higher HF-HRV in week 3 compared to week 1 (0.09 vs. 0.12, N= 138, t(136)=-3.105, p=.002).

b) A study of day traders (N=58) in which participants played both Space Investor and Auction Game showed a significant improvement in interoception from before start of gameplay to after gameplay (F (time) = 6.44, sig=0.014). However, there was no effect of a condition which varied whether they received direct feedback on arousal levels in the game.

2) We have very positive feedback from investors. For example in the day trader study described above traders felt xDelia games could help them learn to manage their emotions (95%), and that they were engaging to play (84% Space Investor, 80% Auction Game, 69% Two Index Game)

3) Our studies support the value of our sensor-based games in diagnosing emotion regulation capabilities and the value of the Two Index Game in diagnosing a propensity to a disposition effect. E.g. : -

a) Both the Auction game and the Space Investor game showed a significant correlation between game performance and effective management of arousal (Auction game: N=104, Pearson's r=.38, p<.001; Space Investor(final game stage): N=32 r = .51; p < .01)

b) The Two Index game reliably induced a disposition effect (in studies with students (N= 100), trading platform clients (N=64) and day traders (N=58). The induced disposition effect showed a significant correlation (0.28, p<.05) with the disposition effect of platform clients measured across their history of real trading (N=64).

4) We show a significant impact of training on disposition effect as measured in real-world trading behaviour of trading platform clients (see Peffer et al., 2012, p11), although effects of sensor game based training on disposition effect in the Two Index Game for a student sample were non-significant.

a) In a test with trading platform clients of the initial diagnosis and feedback phase of the learning journey (N=222), participating clients showed a significant drop in their disposition effect from that in their prior trading history to date to that calculated from their trading in a 14 week follow up period. Compared with a matched group of non-participating clients, DE prior to the intervention was not significantly different at p<0.05) but was significantly lower post intervention (0.21 vs 0.49; p<0.05).

5) Key elements of the learning approach have been adopted by Saxo Bank and the work has influenced its development of a learning platform for client traders.

5. CONCLUSIONS

The novelty of the work described in the paper comes from the focus in this research project of combining knowledge from multiple disciplines informed by a deep understanding of the context of application to achieve the successful development of a Learning Pathway, which addresses the transfer of learning to the practice environment. In this project, work in the areas of cognitive psychology, physiological responses, behavioural and neuro-economics, games design, biosensors, and Technology Enhanced Learning combine to address the learning needs of groups involved in financial decision making. In this game-based learning pathway we have brought together a set of activities which support learning to manage emotions in a financial context, making use of physiological measures of arousal and emotion regulation. We believe this project provides an

interesting basis for further game-based learning designs that support effective human decision making in multiple domains and points to approaches which may be useful in ensuring such developments achieve take up by users.

6. REFERENCES

Barab, S. (2006). Design-Based Research - A methodological toolkit for the Learning Scientist. In *The Cambridge Handbook of the Learning Sciences*. Sawyer, R. K. (ed). Cambridge: Cambridge University Press: 153-169.

Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. 1998. Ego depletion: is the active self a limited resource? *Journal of Personality and Social Psychology*, 74(5): 1252-1265.

Bazerman, M. H. 2002. *Judgment in managerial decision making*: Wiley New York.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings . *The Journal of the Learning Sciences* 2(2): 141-178.

Damasio, A. R. 2000. *The feeling of what happens: Body and emotion in the making of consciousness*: Mariner Books.

Fenton-O'Creevy, M., Lins, J., Vohra, S., Richards, D., Davies, G., & Schaaff, K. 2012. Emotion regulation and trader expertise: heart rate variability on the trading floor. *Journal of Neuroscience, Psychology and Economics*, 5(4): 227-23.

Fenton-O'Creevy, M., Soane, E., Nicholson, N., & Willman, P. 2011. Thinking, feeling and deciding: The influence of emotions on the decision making and performance of traders. *Journal of Organizational Behavior,* 32(8): 1044-1061.

Fischhoff, B. 1982. Debiasing. In D. Kahnman & P. Slovic & A. Tversky. (Eds.), Judgement under uncertainty: Heuristics and biases. Cambridge: Cambridge University Press.

Gross, J. J. & Thompson, R. A. 2007. Emotion regulation: Conceptual foundations. In Gross, J. J. (Ed.), *Handbook of emotion regulation*. New York, NY: Guilford Press.

Lilienfeld, S. O., Ammirati, R., & Landfield, K. 2009. Giving debiasing away: Can psychological research on correcting cognitive errors promote human welfare? *Perspectives on Psychological Science*, 4(4): 390.

Loewenstein, G. & Lerner, J. 2003. The role of affect in decision making. *Handbook of Affective Science*: 619-642.

Peffer, G., Fenton-O'Creevy, M., Adam, M., Astor, P., Cederholm, H., Clough, G., Conole, G., Davies, G., Eriksson, J., & Gaved, M. 2012. *xDelia: emotion-centred financial decision making and learning. Final Report*. Milton Keynes: Open University, CIMNE.

Scanlon, E., Sharples, M., Fenton-O'Creevy, M., Fleck, J., Cooban, C., Ferguson, R., Cross, S. & Waterhouse, P. 2013. *Beyond prototypes: supporting effective research on technology-enhanced learning.* Milton Keynes, UK: Open University.

Shefrin, H., & Statman, M. (1985). The disposition to sell winners too early and ride losers too long: Theory and evidence. *The Journal of Finance*, 40(3), 777–790.

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