NEW PERSPECTIVES ON EMOTIONAL PROCESSES AND DECISION MAKING IN THE GAME OF POKER

WITH SPECIAL EMPHASIS ON THE TILTING PHENOMENON

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ABSTRACT

Poker, especially on-line poker, is a game of *skill* and *chance* that requires constant and rapid decision making under varying levels of risk and uncertainty. Poker playing skill encompasses both *technical* and *emotional* elements. In poker, it is possible to acquire enough experience and skill to win money *in the long run*. Yet every poker player, regardless of his/her skill, occasionally loses. Poor, "out-of-control" poker decision making due to negative emotions – typically elicited by monetary losses – is commonly known as *tilting* and often results in superfluous losses.

The aim of this thesis was to evaluate psychological and physiological *emotional processes* associated with poker *decision making*. Studies I–III were based on Internet-questionnaire data. Study I (N=60) was qualitative, and Studies II (N=354) and III (N=417) were correlative. The emphasis here was on exploring the underpinnings of the tilting phenomenon and the differences in emotion regulation abilities between experienced and inexperienced poker players. In Study IV (N=29), psychophysiological reactivity (electrodermal activity; EDA) was measured in a laboratory setting while participants played the *No Limit Texas Hold'em* (NLHE) poker variant on a computer.

Overall, the results suggest that tilting behavior is instigated by loss-induced feelings of *injustice/unfairness* (*moral indignation*). These feelings are also associated with *chasing* behavior, where players attempt irrationally to regain the money that they feel is *rightfully* theirs. The aftermath of tilting was characterized by reports of sleeping problems and rumination over lost resources (Study I). A higher tendency to experience loss-induced negative feelings was associated with a higher reported severity of tilting (Study III). Experienced players, when compared with inexperienced ones, exhibited a more mature/impassive disposition towards losing and tilting (Studies I–III), engaged in less self-rumination and more self-reflection, and made normatively better poker decisions (Study II). However, surprisingly, experienced players also reported more severe tilting (Study III). The EDA elicited while participants played poker on a computer was associated

with various poker decisions (actions): Pre-decision EDA levels increased in the order of *folding, calling* and *betting/raising*. Furthermore, actions taken with strong and weak poker hands elicited higher EDA compared with actions taken with poker hands of medium/uncertain strength (Study IV).

The results from Studies I–III shed light on the associations between poker experience, emotion regulation abilities ("mental skills") and tilting behavior. The results from Study IV allow for situating the game of poker within the theoretical framework of economic and neuroscientific theories of emotions and decision making by demonstrating that the EDA associated with NLHE decision making conceivably indexes the anticipated utility of the decisions.

TIIVISTELMÄ

Pokeri – erityisesti nettipokeri – on *taitoon* ja *sattumaan* perustuva peli, joka edellyttää jatkuvasti nopeaa ja riskialtista päätöksentekoa. *Pelitaitoon* liittyy pokerissa sekä *teknisiä* että *emotionaalisia* osa-alueita. Pokerissa pelitaitoja voi kehittää, ja pelaaja *voi jäädä voitolle* pitkällä aikavälillä. Jokainen pokerinpelaaja taidostaan riippumatta kuitenkin häviää ajoittain. *Tilttaamisella* viitataan hallitsemattomaan ja heikkoon päätöksentekoon, joka liittyy tyypillisesti tappioiden aiheuttamiin negatiivisiin emootioihin.

Tämän väitöskirjatyön tavoitteena oli arvioida psykologisten ja fysiologisten *emotionaalisten prosessien* yhteyttä *päätöksentekoon* pokerissa. Tutkimukset I–III perustuivat Internet-kyselytutkimusaineistoihin. Tutkimus I (N=60) oli kvalitatiivinen ja Tutkimukset II (N=354) ja III (N=417) olivat korrelatiivisia. Erityisesti tarkasteltiin tilttaamisen syntymekanismeja ja kokeneiden ja kokemattomien pelaajien välisiä eroja emootioiden säätelykyvyissä. Tutkimuksessa IV (N=29) psykofysiologista toiminnallisuutta (ihon sähkönjohtavuus; EDA; electrodermal response) mitattiin laboratorio-olosuhteissa koehenkilöiden pelatessa tietokoneella *No Limit Texas Hold'em* (NLHE) -pokerivarianttia.

Tulosten perusteella tilttaaminen käynnistyy häviötilanteessa *epä-oikeudenmukaisuuden/epäreiluuden* (*moraalisen raivon*) tunteiden johdosta. Nämä tunteet ilmenevät usein *jahtaamisen* yhteydessä, jolloin pelaajat yrittävät irrationaalisesti voittaa *oikeudenmukaisuuden nimissä* takaisin aiemmin häviämänsä rahan. Tilttaamisen jälkitilassa raportoitiin univaikeuksia ja menetettyjen resurssien *märehtimistä* (Tutkimus I). Mitä vahvempi taipumus pelaajilla oli kokea häviöiden aiheuttamia negatiivisia tunteita, sitä vakavammin he raportoivat tilttaavansa (Tutkimus III). Kokeneet pelaajat suhtautuivat kokemattomiin verrattuna emotionaalisesti kypsemmin rahan häviämiseen ja tilttaamiseen (Tutkimukset I–III). Kokeneet pelaajat olivat lisäksi kokemattomiin verrattuna taipuvaisempia itsereflektioon, vähemmän taipuvaisia märehtimiseen ja normatiivisesti parempia pokeripäätöksenteossa (Tutkimus II). Kokeneet pelaajat myös yllättäen raportoivat tilttaavansa kokemattomia vakavammin (Tutkimus III). Tietokonepokeripelin

aikana mitattu EDA liittyi ennakoidulla tavalla erityyppisiin pokeripäätöksiin. Päätöksentekoa edeltänyt EDAn taso kasvoi järjestyksessä *kippaaminen* (engl. *folding*), *maksaminen* (engl. *calling*), ja *panostaminen/korottaminen* (engl. *betting/raising*). Lisäksi havaittiin, että vahvoilla ja heikoilla pokerikäsillä tehdyt päätökset liittyivät korkeampaan EDAn tasoon kuin keskivahvoilla pokerikäsillä tehdyt päätökset (Tutkimus IV).

Tutkimuksien I–III tulokset valottavat tilttaamisen syntymekanismeja ja pokerikokemuksen ja emootioiden säätelyn välistä yhteyttä. Tutkimuksen IV tulokset osoittavat, että NLHE-pelin aikana mitattu EDA heijastaa mahdollisesti pokeripäätösten ennakoitua hyötyä, ja siten mahdollistavat pokeripelin tarkastelun neurotieteellisten ja taloustieteellisten teorioiden viitekehyksessä.

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My brother, Veli-Matti Palomäki, for speaking Mandarin Chinese, which is completely awesome.

And here, at the end, this sentence belongs to my wife, Eeva – as does the paragraph in which it is written. I dedicate my thesis to her, as there is no other. After this one, there is one more sentence in this paragraph, and, maybe, when we're old, we can laugh at 30-year old me for his silliness. Thank you, Eeva, Jee! :).

In Helsinki, September 2013

Jussi Palomäki

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original articles, which are referred to by their Roman numerals in the text:

Study I: Palomäki, J., Laakasuo, M., & Salmela, M. (2013): "This is just so unfair!": A qualitative analysis of loss-induced emotions and tilting in on-line poker. *International Gambling Studies*, *13*(2), 255–270.

Study II: Palomäki, J., Laakasuo, M., & Salmela, M. (2013): “Don't worry, it's just poker!” -Experience, self-rumination and self-reflection as determinants of decision-making in on-line poker. *Journal of Gambling Studies, 29*(3), 491–505.

Study III: Palomäki, J., Laakasuo, M., & Salmela, M. (2013): Losing more by losing it: Poker experience, sensitivity to losses and tilting severity. *Journal of Gambling Studies.* Advance online publication. doi: 10.1007/s10899-012-9339-4.

Study IV: Palomäki, J., Kosunen, I., Kuikkaniemi, K., Yamabe, T., & Ravaja, N. (2013): Anticipatory electrodermal activity and decision making in a computer poker-game. *Journal of Neuroscience, Psychology, and Economics, 6*(1), 55–70.

ABBREVIATIONS AND POKER GLOSSARY

BAD BEAT	Losing in a situation where losing is perceived to be highly improbable
BLINDS	Forced bets (small and big blind) that are placed into the **pot** by players before play begins
CALL	Matching a **bet** or a **raise** made by another player
CHECK	Declining to make a **bet**, but retaining the right to **call** or **raise** bets or raises made by subsequent players
FLOP	The first three cards dealt face-up to the board in Hold'em poker
EDA	Electrodermal Activity
EUT	Expected Utility Theory
EU	Expected Utility
EV	Expected Value
FISH	A bad poker player (“easy money”)
fMRI	Functional Magnetic Resonance Imaging
FOLD	To discard one’s cards and give up playing during the current **hand**, thereby forfeiting interest in the current **pot**
FREEROLL	A poker tournament with a free entry (can refer to both **SNG**s and **MTT**s)
HAND	Depending on the context, a Hold'em poker hand may refer to either (a) a single round of game play; the period beginning when cards are dealt and ending with the showdown (revealing of players’ cards and deciding the winner of a given hand), (b) the two cards dealt to each player at the beginning of each round of game play (also referred to as the starting hand or hole cards), or c) the best five-card combination that can be formed using the hole cards and the community cards (see **NLHE**)

LMM	Linear Mixed Models
MTT*number*	Multi-Table Tournament – A poker tournament with usually more than 40 participants, and at least 4 tables, with a buy-in amount indicated by the number
NLHE	No Limit Texas Hold'em – A variation of the standard game of poker. Any game of poker is a card game involving betting whereby the winner is determined based on the ranking of their cards. NLHE consists of two cards being dealt face down to each player, and then five community cards – cards that can be used by all players – being placed face-up. Players have the option to **check**, **call**, **bet**, **raise**, or **fold** either prior to the flop (**pre-flop**), on the **flop**, on the **turn**, and on the **river**
NL*number*	No Limit Hold'em game, with a maximum buy-in amount indicated by the number
PEET	Perceived Effect of Experience on Tilting (scale)
PES	Poker Experience Scale
PGSI	Problem Gambling Severity Index
PLO*number*	Pot Limit Omaha game (poker variant), with a maximum buy-in amount indicated by the number
POT	Sum of money (or chips) that players have waged during a single **hand** (definition **a**) of game play
PRE-FLOP	The period beginning with the dealing of cards and ending with the **flop** in Hold'em poker
RAISE	Increasing the size of a **bet** required to stay in the **pot**, forcing all subsequent players to **call** the new amount (or raise more) if they wish to remain in
RIVER	The fifth and final card dealt face-up to the board in Hold'em poker
SCR	Skin Conductance Response
SD	Standard Deviation

SL	Sensitivity to Losses (scale)
SMH	Somatic Marker Hypothesis
SNG*number*	Sit and Go – A small tournament, with usually less than 30 participants, buy-in amount indicated by the number. A typical Sit and Go -tournament starts with a single table, and either 6 (short-handed Sit and Go), 9 or 10 (full-table Sit and Go) players.
SOGS	South Oaks Gambling Screen
ST	Severity of Tilting (scale)
STACK	The money (or chips) currently held in play by a player
SUCK OUT	A strong poker **hand** (definition **c**) getting beat by another player's hand because they hit their draw (= an unfinished hand that needs one or more cards to turn into a made hand)
TURN	The fourth card dealt face-up to the board in Hold'em poker
WSOP	World Series of Poker
MISC.	h = hearts, s = spades, c = clubs, d = diamonds; As, Kh, Qc, Jd, Ts, 9h, 8d = Ace of spades, King of hearts, Queen of clubs, Jack of diamonds, Ten of spades, Nine of hearts, Eight of diamonds

FOREWORD

I feel that this thesis benefits from a short foreword clarifying my motivation for studying emotions and decision making in poker, as this particular topic may appear to be slightly esoteric for an academic dissertation.

I have played poker on-line since 2006, and I have been dealt more than 2 million poker hands. However, I have never been quite able to move up in stakes to where they colloquially say the "real money is made". Although, in my defense, I am still winning. According to our own Poker Experience Scale (PES; presented in Study II), I score 20 out of 30 points maximum.

I am quite confident in saying that one of the key reasons for me for failing to win at the higher stakes were those (fortunately) transient episodes of formidable frustration (sometimes even rage), induced most often by what I felt was "bad luck" or "ridiculously prolonged" losing streaks. During these episodes of *tilting*, I lost control and thereby also superfluous amounts of money – sometimes more than a thousand euros in one session. As a student, it was not pleasant. I remember thinking to myself: *"I'm smart, and I don't really enjoy losing. Pretty interesting that this is still happening to me"*.

I knew about tilting – it was quite hard not to, since it was so obviously a prevalent phenomenon often talked about in on-line poker forums. This suggested it was not just me, who tilted every now and then. It appeared that basically *every single person* who had played poker for more than just a few hands also had experienced tilting. In fact, some players' stories about tilting and what resulted thereafter were quite gruesome (not all stories ended with said players *only* losing all their money – which in itself, for some, was *quite a significant amount*). Surprisingly, despite my best efforts, I could find only a few relevant empirical peer-reviewed reports concerning tilting. In fact, there seemed to be a gap in scientific literature with almost no studies assessing *emotions* and *decision making in poker,* in general. With tilting, I took the high road: *If you can't beat it...study it!*

Thus, the starting point for observing the phenomena of interest in this thesis was

founded primarily on anecdotal evidence and personal experience. When there does not yet exist a substantial corpus of empirical evidence on a subject matter of prevalence and interest, it is great fun and intellectually challenging to contribute to building one.

This thesis is the modest beginning of my contribution.

Wishing everybody the best of luck,
Jussi Palomäki

1 BACKGROUND

1.1 The game of poker

Poker is a genre of card games involving betting and individualistic play, by which the winners are determined based on the rankings of their card-combinations. There are several poker game variants, which differ in their respective rules and betting procedures. Poker is currently arguably one of the most recognizable card game ”brands” in the world, whose popularity started first increasing in the 1970s. This was likely due to the introduction of the *World Series of Poker (WSOP)* -tournament series, and, in general, development of modern tournament poker play in American casinos. In fact, some of the earliest WSOP champions (such as Doyle Brunson) are still regarded as highly influential icons in the poker communities around the world (e.g., Brunson & Cochran, 2009; for the general rules of poker, see Krieger & Bykofsky, 2006).

In the last decade, the popularity of poker – especially the variant *No Limit Texas Hold'em* (NLHE) – has further increased exceedingly (for the general rules of NLHE, see Harrington, 2004; Sklansky & Miller, 2006). The latest increase in popularity is commonly attributed to at least two factors: i) Emergence of Internet poker, and ii) the so called *Moneymaker -effect:* Chris Moneymaker – then an accountant by profession – won the 2003 WSOP Main Event (a NLHE tournament) for $2.5 million, after having first won his Main Event entry ticket (worth $10 thousand) from an on-line tournament that cost $40 to enter. He then became the new ”poster boy” for poker, thereby launching a new international ”poker craze” (Moneymaker, 2006). Poker has since gained broad media visibility in many countries, which is currently reflected in dozens of television programs exclusively dedicated to it (e.g., Bjerg, 2011)[1]. Currently, poker is played professionally, semi-professionally or recreationally by millions of players world-wide in various gaming venues, most notably *on-line* (Fiedler & Wilcke, 2012; Harrington & Robertie, 2010;

1 Another factor in the increase of poker's popularity is the development of the ”pocket cam” – i.e., the small concealed camera that displays the cards players are holding to television viewers.

Mitrovic & Brown, 2009; O'Leary & Carroll, 2012).

Despite the popularity of poker, the range of scientific research focusing on its various aspects is relatively scarce. However, in the last few years there has been an apparent accumulation of empirical evidence concerning diverse aspects of the game (e.g., Abarnabel & Bernhard, 2012; Bjerg, 2010; Hopley et al., 2010, 2012; Kallinen et al., 2009; Linnet et al., 2010, 2012; Siler, 2010; Wolkomir, 2012; Wood et al., 2007, 2008). This chapter explores literature on the topic of emotional processes in the game of poker. The interplay between emotions and decision making in poker is evaluated from psychological, sociological and neuroscientific perspectives. Although the emphasis will be on literature concerning the associations between *emotions* and *decision making* in poker, the underpinnings of poker *experience* and *skill* will also be examined – these are relevant concepts especially in Studies I–III.

1.2 Experience and skill in poker

All poker game variants are games of skill and chance, where players need to make decisions of investment constantly and rapidly. Decision making in poker generally involves varying levels of risk and uncertainty – betting in poker is usually associated with substantial outcome variability. Moreover, players often do not have access to all the relevant information with which to make a decision. In other words, poker can be characterized as a financial decision making game involving the analysis of imperfect information[2] and constant risk taking (Chen & Ankenman, 2006; Sklansky & Malmuth, 1999).

The interplay between *skill* and *chance* in poker is a topic of ongoing debate (Bjerg, 2010; Croson et al., 2008; Dedonno & Detterman, 2008; Fiedler & Rock, 2009; Hannum & Cabot, 2009; Levitt & Miles, 2011; Meyer et al., 2013; see also Zhou et al., 2012). It is not yet well-established to which extent poker can be considered a game of skill as opposed to

2 By contrast, in games of *perfect information* (e.g. Chess), players have at all times access to all the relevant information with which to make a decision.

a game of chance. However, there appears to be a consensus on the fact that, in general, it is possible for players to acquire enough skill to win money in the long run by playing poker (to become *winning players*)[3]. Thus, poker games can be differentiated from games of *pure chance* (e.g., roulette and bingo), and other games of *skill and chance* (e.g., blackjack and craps), in which the element of skill cannot be applied to the point of becoming a winning player (Bjerg, 2010).

Poker playing *experience* relates to a player's level of knowledge and understanding concerning various aspects of the game. Arguably, the more experience a player has, the more skilled s/he will be, and the more likely s/he will also be a winning player. This contention is supported by empirical evidence. For example, in a laboratory experiment, teaching naïve participants poker game strategic concepts resulted in their improved success in the game (Dedonno & Detterman, 2008; see also Cabot & Hannum, 2005; Turner & Fritz, 2001). The success of self-defined professional and amateur poker players at the WSOP has been evaluated, and the results suggest that professional players are consistently more successful than amateur players (Croson et al., 2008; Levitt & Miles, 2010). Furthermore, experienced poker players were better able to estimate betting probabilities in poker decision making situations, as compared with inexperienced ones (Linnet et al., 2010, 2012). Finally, there exists abundant anecdotal evidence supporting the view of poker as a game where one's skills can constantly be improved (e.g., Angelo, 2007; Harrington, 2004; Sklansky & Malmuth, 1999; Tendler, 2011, 2013). The evidence presented above resonates also with the common saying: *Poker takes a minute to learn, and a lifetime to master.*

Notwithstanding, most poker players lose money in the long run by playing poker (most players are *losing players*) – some probably even in spite of their high level of poker experience (see Hayano, 1982; Lesieur, 1984; Sharkscopers, 2009). It is also worth noting

3 By virtue of this fact, poker can arguably also be defined purely as a game of skill. Due to statistical variation in betting results (i.e., chance), a winning player will *occasionally* lose money. S/he will, however, *by definition* (if s/he remains a winning player) never end up losing money in the long run. That is to say, there is *no chance* for a winning player to not eventually end up winning. Correspondingly, there is *no chance* for a losing player not to eventually end up losing. Thus, it is *theoretically* possible in poker to have enough skill to never end up losing (in the long run).

that in a recent laboratory experiment about poker decision making, experienced players did not outperform inexperienced ones (Meyer et al., 2013). Moreover, due to lack of consistent empirical evidence, it is difficult to estimate the exact ratio of winning players to losing players. Depending on the source of estimation, the overall percentage of winning poker players (i.e., those players who are *skilled* enough to win money in the long run) ranges from 5 % to 30 % (e.g., Browne, 1989; Sharkscopers, 2009; Siler, 2010). It should also be noted that some poker players, despite being *unskilled* and *losing* players in the long run, might have ended up winning money in a given period of time simply by chance alone – and *vice versa* for *skilled* and *winning* poker players. However, in contrast, the overall percentage of, for example, "winning roulette players" is *necessarily* 0 %. Essentially, these contentions illustrate the complications in assessing what specifically makes someone a skilled player, and what are the relevant factors in apprehending the underpinnings of poker playing experience.

1.2.1 Aspects of poker playing skill

The concept of poker playing skill encompasses both *technical* and *emotional* aspects. This view is supported by empirical evidence (Browne, 1989; Morgan, 2013; see also Radburn & Horsley, 2011; Rosenthal, 1995), and a strong corpus of anecdotal evidence (e.g., Angelo, 2007; Hilger & Taylor, 2007; Parke et al., 2005; Tendler, 2011, 2013). Technical poker skill aspects refer to, for example, knowledge about *betting strategy* (mathematical reasoning for maximizing betting profitability), *bankroll management* (mathematical reasoning for maintaining enough money available for playing in relation to the stakes played), and *table/game selection* (ability to recognize and select the most profitable poker tables/games to play on – that is, the tables/games where the level of competition is not too high). Emotional poker skill aspects refer to abilities in *regulating emotions* induced by elements of the game, thereby maintaining a robust quality of poker decision making. Colloquially, emotion regulation abilities in poker are often referred to as *mental game* skills (Tendler, 2011, 2013).

1.2.2 Tilting

Losing control due to strong negative emotions elicited by elements of the game, and the resulting reduced quality of poker decision making, is commonly known as *tilting*. Game elements that often elicit negative emotions and induce tilting include (but are not limited to) i) losing in a situation where losing is perceivably highly improbable (encountering a *bad beat*), ii) prolonged series of losses (*losing streaks*), and iii) factors external to the game mechanics, such as fatigue, or "needling" by other players. Evidence suggests that tilting is a very prominent and common cause of superfluous monetary losses for many poker players (Browne, 1989; Hayano, 1982; Tendler, 2011). Superfluous losses during tilting often result from *chasing* (of one's losses), which refers to out-of-control gambling behavior where players attempt to quickly win back the money that was previously lost (see Dickerson & O'Connor, 2006; Lesieur, 1984; Toneatto, 1999, 2002). Tilting essentially represents an overt condition where emotions have a direct and detrimental influence on poker decision making.

Bad beats and losing streaks often elicit negative feelings of *frustration*, *injustice, moral indignation/anger*, *helplessness* and *shame* (Browne, 1989; Rosenthal, 1995; Rosecrance, 1986; Tendler, 2011; Yi & Kanetkar, 2011). It has also been suggested that bad beats are in discrepancy with players' perceptions of "fair chance" (Rosenthal, 1995; see also Lesieur, 1984). Thus, chasing might in some cases reflect gambling behavior driven by a sense of moral justification, whereby players attempt to "make things right" by winning back that which "rightfully belonged to them in the first place". Tilting might in certain situations bear a resemblance to *pathological (i.e., disordered) gambling* behavior. Pathological gambling is commonly associated with chasing behavior (Lesieur, 1984; Toneatto, 1999, 2002; see also McCormack & Griffiths, 2012) and distorted cognitions (Barrault & Varescon, 2013; MacKay & Hodgins, 2012; Moore et al., 2012; see also Joukhador et al., 2004). However, due to the high prevalence of tilting, there is no *a priori* reason to presume that tilting is by and of itself pathological.

There is reason to presume that especially losing players – who are also often inexperienced – are more susceptible to negative emotions elicited by significant monetary poker losses. For example, Siler (2010) analyzed a substantial sample of over 28 million NLHE poker hands assessing the betting strategies of both winning and losing poker players. He discovered that, on average, winning players *bet* more frequently with strong hands, but play and win fewer hands in total, as compared with losing players. These results indicate that winning players win the majority of the *large* pots by betting with strong hands, while losing players win the majority of the *small* pots, but lose the large pots by *calling* too often (see poker glossary). Thus, in NLHE, losing players encounter *large* monetary losses more frequently than winning players. These large monetary losses often elicit strong negative emotions, which, in turn, conceivably predispose losing players to tilting and prolonged periods of detrimental decision making.

Some evidence also suggests that experienced players differ from inexperienced ones in their emotion regulation abilities by being better able to regulate negative emotions elicited by various game elements, such as significant monetary losses. This is arguably a skill learned through experience. For example, a profound understanding of relevant mathematical concepts, such as *variance*, might be related to a more ”mature” attitude towards encountering ”bad luck” (*”there is no luck, there is only variance”*; e.g., Bjerg, 2010; Browne, 1989; Parke et al., 2005; see also McCormack & Griffiths, 2012; McCormack et al., 2013; Morgan, 2013). It is possible that experienced players have a different conceptualization of ”luck” as compared with inexperienced ones. This might have an effect on the intensity and frequency of negative emotions induced by game elements, and consequently, on the decision making abilities of the two kinds of players. For example, in general, experienced players might regard bad luck impassively as “merely variance”, whereas inexperienced players might regard it as *befallen injustice,* which in turn elicits a negative emotional reaction. Therefore, it is also reasonable to propose that experienced poker players, as compared with inexperienced ones, are less prone to “dwelling on the negative”, or *self-rumination*, such as constantly second guessing their actions or displaying a detrimental inability to “let go” of unfavorable consequences of

decisions. Similarly, experienced players, as compared with inexperienced ones, might be more predisposed to *self-reflection,* which refers to a benign self-contemplative style of introspection, characterized by genuine curiosity towards one's feelings and thoughts (Elliott & Coker, 2008; Trapnell & Campbell, 1999)[4].

However, due to natural statistical variation in poker game results, every poker player – regardless of how skilled and experienced they are – occasionally loses. Evidence suggests that tilting is a prevailing phenomenon among both inexperienced and experienced players (even professional players; Angelo, 2007; Tendler, 2011). There are perhaps no other environments of asset investing that require as rapid financial decision making as those seen in on-line poker. For instance, active stock traders might be required to decide between various investment prospects on an hourly, or even a minute -scale, but active on-line poker players often make several investment decisions within seconds. Furthermore, in poker, the number of decisions to be made increases with the amount of tables the player is playing on. On-line, a player may choose to play on just one table, but it is not unheard of for players to have as many as 24 virtual tables open at the same time (e.g., Rhodes, 2010). On-line poker is a micro-level economic decision making environment where the quality of decisions should be maintained every second, sometimes even in the face of frustrating and arduous – yet statistically inevitable – losing streaks. Thus, a successful winning poker player needs not only to have substantial knowledge of the technical aspects of the game, but also proficient abilities in emotion regulation.

1.3 Methods and models in the field of emotions and decision making

The contentions presented above indicate that poker is a decision making environment whose various elements constantly elicit strong emotions in a social context. As such, poker provides a rich context within which the association between emotions and decision making

4 Both self-rumination and self-reflection are components of the "Private self-consciousness" -scale, developed by Fenigstein et al. (1975).

can be studied.

According to early decision making theories, individuals were assumed to evaluate by rational calculation – "dispassionately" – all possible consequences of their decisions, and to select the actions that maximized the utility of those consequences. However, the early theories have since been shown to be insufficient in accurately describing human decision making behavior. For example, according to prospect theory (introduced by Tversky and Kahneman; e.g., 1974) human decision making is subject to various cognitive biases, and evaluation of utility is better characterized as a "reference-dependent" process: In a decision making situation, possible final outcomes are interpreted as either wins or losses, depending on what is experienced as the *status quo* – which can be construed roughly as the "current level of wealth". Humans also generally exhibit in their decision making a tendency to prefer avoiding losses to acquiring gains (i.e., loss aversion), which could not be explained by the early decision making theories. Loss aversion, in turn, relates to the tendency of emotionally experiencing losses "more strongly" than gains (Tversky & Kahneman, 1974, 1986).

For example, suppose that two poker players have won 80 and 120 euros during separate poker sessions, and both decide to have a short break. Afterwards they return to play another session. Prospect theory postulates that at this time both players set "reference points" at 80 and 120 euros, respectively. During the second session, the former player goes on to win 20 more euros and the latter one to lose 20. This results in a net profit of 100 euros for both players – but conceivably also in a negative emotion-driven incentive for the latter player to "get even".

Currently, abundant evidence suggests a fundamental connection between emotion- and decision making processes (e.g., Bechara & Damasio, 2005; Clore & Huntsinger, 2007; Damasio, 1994/2006, 1999; Dickerson & O'Connor, 2006; Lewis et al., 2010; Loewenstein & Lerner, 2003; Slovic et al., 2005, 2007; Vohs et al., 2007; see also Rottenstreich & Hsee, 2001). It has been shown, for example, that the destruction of emotion-related brain areas can lead to severe decision making deficits in everyday life (Bechara, 2003, 2005; Bechara et al., 1994; Damasio, 1994/2006). The effect of emotions or affect on decision making is

also expressed in various models, such as the *affect heuristic* (Slovic et al., 2005, 2007) and *risk-as-feelings hypothesis* (Loewenstein et al., 2001), both of which emphasize the role of emotions or affect as implicit or explicit "motivators" of behavior that guide decisions in uncertain environments. For example, feeling *anger* or *fear* predicts *lower* and *higher* risk assessments, respectively (e.g., Lerner & Keltner, 2000).

1.3.1 Psychophysiology of human emotions and decision making

The psychophysiology of human decision making under risk and uncertainty can be assessed by methods such as brain imaging (e.g., functional magnetic resonance imaging [fMRI]), or measuring electrodermal activity (EDA). fMRI enables assessing the neural correlates of decision making by measuring participants' brain responses (the blood-oxygen-level dependent -signal) during performing various decision making tasks. For example, rejecting unfair offers in the *ultimatum game* was associated with activity in the anterior insula, whereas accepting fair offers was associated with activity in the dorsolateral prefrontal cortex (Sanfey et al., 2003). In a decision making task where choice options were framed as either losses or gains, activity in the amygdala was higher in participants who were more susceptible to deviations from "rational" choices (De Martino et al., 2006).

Changes in EDA (tonic skin conductance level, or phasic skin conductance responses, SCRs) relate to changes in eccrine sweating, which in turn relates to activity in the sympathetic nervous system (Dawson et al., 2000). EDA is a consequential psychophysiological index of arousal, and several studies using the picture-viewing paradigm have shown that EDA is highly correlated with self-reported emotional arousal. EDA is often employed as an index of the intensity (although not the valence or "tone") of affect, and as such, has become a widely used tool in assessing affective processes and their association with decision making (e.g., Bechara & Damasio, 2005; Dawson et al., 2011; Figner & Murphy, 2011; Kallinen et al., 2009; Ravaja et al., 2006; however EDA can be an indicator of other, non-affective, processes as well: e.g., Lang et al., 1993).

Studies using the Iowa Gambling Task (Bechara, 2005; Bechara et al., 1994) have shown that healthy subjects exhibit SCRs to both the outcomes of their decisions (either wins or losses) and the anticipation of making a decision. These anticipatory reactions suggest an indexing of emotional arousal prior to decision making, reflecting anticipated *utility* (which can be either positive or negative) of a given decision. Based on these findings, among others, Damasio and colleagues (Damasio, 1994/2006; see also Bechara & Damasio, 2005) formulated the somatic marker hypothesis (SMH): Through associative learning, mental images of options in a decision making situation become marked by somatic or bodily states, linked directly or indirectly to positive and negative feelings (”gut feelings”).

Poker is a decision making environment where players are constantly required to rapidly assess the profitability of taking one of five *actions*: folding, checking, calling, betting and raising. Depending on the situation, each action is assumably associated with a different measure of anticipated utility. That is to say, some actions are generally estimated to be more profitable than others. Hence, the SMH framework has relevance in also understanding poker decision making processes. EDA can be employed to index emotional arousal associated with various poker actions. Thus, EDA can arguably also be employed as an index of differing levels of anticipated utility associated with said actions. It is appropriate to suggest that various poker decision making constituents are distinctly reflected in psychophysiological reactivity (emotional arousal), as measured by EDA.

These contentions are sensible also within the context of normative economic decision theories, such as the expected utility theory (EUT; Schoemaker, 1982; see also Glimcher et al., 2004). According to the EUT, poker players are assumed to subjectively evaluate the expected (anticipated) utility (EU) of a poker action in a given situation. The EU of an action corresponds to the *sum of utility* of all possible consequences of said action weighted by their probability. In general, the EU of calling is always contingent on the preceding actions taken by other players. By calling, a player can only expect to win that which was previously wagered by someone else. However, by betting or raising, the player can not only choose the size of his/her bet or raise, but also has the option of *re*-raising, should any opponent decide to raise or re-raise the original bet. It is thus generally reasonable to

presume that, if a player chooses to bet or raise, the preceding calculation of the EU has yielded a higher value, as compared with calling.

Although the mathematical expected value (EV) of folding is exactly 0, the EU of folding is arguably dependent on the amount of money/chips previously wagered in the pot. For example, if a player has invested a substantial amount of money/chips – that are now in the pot – prior to folding, s/he might experience folding as "losing the pot" and thus receiving negative utility. However, if little or no money/chips has been invested prior to folding (which is often the case), there is reason to presume the preceding calculation of EU for folding has yielded a value close to 0.

1.4 The aims of the present thesis

The general aim of this thesis was to assess how *emotional processes* – both psychological and physiological – are associated with *decision making* in the game of poker. In other words, this thesis primarily sought to begin producing new scientific knowledge concerning the multifaceted phenomenon of *emotions and decision making in poker,* as there seemed to be an obvious gap in current scientific understanding on the subject.

Studies I–III generally aimed at assessing the underpinnings of poker experience and skill, and their associations with players' various emotional characteristics and behavior (with emphasis on tilting), as well as poker decision making. Study IV generally aimed at assessing psychophysiological reactivity during poker decision making, and thereby situating the game within the theoretical framework of neuroscientific and economic theories of human decision making and emotions. The specific aims of Studies I–IV are elaborated on below.

Study I

Study I was exploratory by nature. The specific aims were to assess qualitatively the following:

i) Phenomenology and aetiology of *losing* and *tilting* in on-line poker.

ii) Differences in experiences of losing and tilting between experienced and inexperienced poker players.

These aims – and the qualitative method – were chosen for the following reasons:

1) Previous empirical evidence concerning tilting was scarce, and thus no previously presented and/or validated tools for measuring tilting existed.

2) Anecdotal evidence alone was not sufficient for understanding and defining unambiguously the underpinnings of tilting behavior.

3) The qualitative method is consequential in order to produce *new phenomenological knowledge* – i.e., knowledge about the *experiential constituents* of a specific phenomenon, namely losing and tilting in poker.

Study II

Inspired partly by the results of Study I, Study II aimed to:

i) Evaluate the associations between poker playing experience, specific emotional characteristics (self-reflection and self-rumination; Elliott & Coker, 2008), and a belief in one's ability to influence luck.

ii) Determine if the level of poker playing experience predicts mathematical accuracy in poker decision making tasks.

It was hypothesized that participants with more poker experience would:

1) Display a reduced tendency to self-rumination and a higher tendency to self-reflection.

2) Be less likely to believe they can influence luck.

3) Perform better in the poker decision making tasks.

Study III

Inspired by the results of Studies I and II, Study III aimed to:

i) Further explore the tilting phenomenon by defining experiential and emotional characteristics (i.e., by constructing scales) that assumably *protect* participants from tilting or *predispose* them to it.

ii) Use these characteristics in predicting participants' severity of tilting.

iii) Provide validation for a previously (in Study II) introduced measure of poker playing experience, the Poker Experience Scale (PES).

It was hypothesized that:

1) Participants with more poker experience are more likely to have an impression of having tilted less severely, as result of accumulating poker experience.

2) Participants with more poker experience tilt less severely.

3) Participants with more poker experience report lower emotional sensitivity to losses (i.e., they descry fewer loss-induced negative emotions, such as feelings of injustice, anger or frustration).

4) Participants with higher emotional sensitivity to losses tilt more severely.

Study IV

The aims of Study IV were partly exploratory. However, two specific hypotheses were also formulated, inspired by existing models of both neuroscientific and economic theories of decision making and emotions. Based on the underlying assumptions of the somatic marker hypothesis (SMH; Bechara & Damasio, 2005), and expected utility theory (EUT; Schoemaker, 1982), it was presumed that psychophysiological reactivity during playing NLHE, as measured by EDA, indexes the anticipated utility of various actions. Thus it was also hypothesized that:

1) Pre-decision EDA increases in the order of folding (indicating no/low anticipated utility) < calling (indicating some anticipated utility) < betting and raising (indicating high anticipated utility).

2) Pre-decision and post-decision EDA increases in the order of actions taken with weak hands (reflecting anticipation of little or no profit) < actions taken with a medium-strength hand (or strength is uncertain; reflecting anticipation of an "uncertain" amount of profit) < actions taken with a strong hand (reflecting anticipation of profit).

2 SOCIAL CONTEXT OF RESEARCH

For the purpose of the current thesis, it is consequential to understand the societal factors that influence gambling behavior in Finnish poker players. Thus, the social context within which the research was carried out needs to be evaluated. This is relevant in interpreting the results of Study I in particular (due to the qualitative method of narrative and thematic analyses; see *Data-analyses*). By extension, also the results of Studies II and III should be interpreted within this framework – these studies were inspired in part by the results of Study I.

In Finland, poker is not among the most popular forms of gambling (Taskinen, 2007, p. 9). Still, there exists a prominent on-line poker subculture, consisting of at least three highly active poker communities and forums constantly organizing social activities and reporting poker-related news (i.e., www.pokerisivut.com, www.pokeritieto.com, and www.pokerista.net; see also O'Leary & Carroll, 2012). According to some professional poker players (personal communications), Finnish mainstream media often display lack of understanding of poker and its subculture, thereby provoking negative attitudes towards poker in the general public[5]. This, in turn, is reflected in a sour demeanor displayed by many poker players towards what are perceived as attempts (often by the media) to portray poker in a ”bad light”. For example, during data gathering of Studies I–III, many on-line poker forum members were suspicious about the ”true” objectives of the studies – presumably, scientists studying poker are often viewed as part of the social welfare establishment, aiming to limit individual freedom in poker playing.

Despite Finland having a strong gender-egalitarian culture and social history, poker is without doubt a male-dominated game. Furthermore, Finns are, in general, influenced by the Protestant work ethic (Jokinen & Saaristo, 2010). Traditionally, males are also seen as

5 Examples of mainstream news headlines seemingly portraying poker in bad light (translated from Finnish): 1) “Internet poker causes financial problems for young people” retrieved from: http://keskustelu.suomi24.fi/node/3309606, 2) “Ministry of health wants to limit Internet poker playing in Finland” retrieved from: http://www.iltasanomat.fi/kotimaa/art-1288338415338.html, 3) “Internet poker is dividing apart the family of Ahde” retrieved from: http://www.iltasanomat.fi/kotimaa/art-1288338743221.html

the household breadwinners, which is reflected in a distinguishable ”male pride” within social identities. The Protestant working ethos also manifests itself in the notion that an individual should always receive a fair/just compensation or acknowledgement for his/her work – i.e., a compensation for *due work*. Furthermore, the Nordic welfare state amalgamation of social equality and capitalism stresses the ideal that everyone is entitled to an ”equal chance” of achieving a certain level of well-being, happiness, and financial agency (Andersen et al., 2007).

In poker, however, in order for someone to win, someone else has to lose – often in spite of having played ”by the book” and to one's best abilities. Believing strongly that work needs to be duly compensated might not resonate with the inherent nature of poker, where efforts and skills are rewarded only contingently with wins, and where someone (most players) always loses. This ruthless logic of poker, which Bjerg (2011) characterizes as a parody of capitalism, is fundamentally at odds with the values and ethos of the Nordic welfare state, and its culture of egalitarianism and social care.

It has been argued that gambling *per se* is no longer viewed as a violation of a ”decent” working ethic in capitalist Western economies. This possibly relates to people in Western societies growing increasingly accustomed to recent societal developments in capitalism from industrialist to post-industrialist phase. In the post-industrialist phase, uncertainty and insecurity associated with various everyday economic phenomena, such as stock market fluctuations and general employment status, have become commonly accepted aspects of contemporary ”lifestyles”. In other words, visiting casinos, buying stocks and lottery tickets, betting on sports, and, colloquially, rolling the dice every once in a while, are no longer seen as morally questionable activities (see Bernhard & Frey, 2007; Bjerg, 2011).

However, the above contentions do not necessarily hold true for the Nordic welfare states, which, due to their sizes and social structures, are not typical examples of Western capitalist economies (Andersen et al., 2007). Finland, in particular, has prominent systems of progressive taxation and social security, along with strict laws preserving workers’ rights. Furthermore, most Finnish poker players have been brought up with the ”ethos of fair compensation”, during the 1980s and 1990s. Currently, poker is most often played

on-line, and typical players are male adults in their 20s and early 30s. Poker is a form of gambling whereby players can make a living, and thus lends itself to be evaluated, for some players, as a profession. As such, the game of poker can be viewed as both gambling and working. Therefore, it can be argued that the ”harshness” inherent in the nature of poker – where work does not always guarantee reward – is indeed in discrepancy with the ethos of fairness and equality still prevalent in postmodern Finland.

3 METHODS

3.1 Study designs and participants

Studies I–III were based on data from Internet questionnaires. Study I was primarily qualitative, and Studies II and III were correlative. In Study IV, a laboratory experiment was designed. In Studies I–III, participants were recruited primarily through various Finnish on-line poker communities (e.g., www.pokerisivut.com, www.pokeritieto.com, and www.pokerista.net) by posting invitations on their web-forums. In addition, participants were recruited through social media (e.g., Facebook and various Internet Relay Chat channels), and by posting invitations on various Finnish student organization email-lists. In Study IV, participants were recruited primarily by posting invitations on the aforementioned email-lists. All participants were from Finland and spoke Finnish as their first language. Table 1 summarizes participant demographics and study designs in Studies I–IV.

Table 1. Participant demographics and study design in Studies I–IV

Study	N (females)	Age range (mean, SD)	Study design
I	60 (2)	17–41 (27.1, 6)	Internet questionnaire (qualitative)
II	354 (23)	17–62 (28.4, 7.7)	Internet questionnaire (correlative)
III	417 (31)	16–61 (27.9, 7.45)	Internet questionnaire (correlative)
IV	29 (3)	20–47 (25.1, 5.1)	Laboratory experiment

3.2 Experimental procedures and materials

The ethical guidelines set by the American Psychological Association were adhered to in all studies. In Studies I–III, on the questionnaire front page, participants were informed that their anonymity was guaranteed, and that the data would be used only for scientific purposes. In Study IV, participants gave their written informed consent. In Studies I and II,

participants were not compensated. In Study III, on the questionnaire front page, participants were informed that a price of ten movie tickets (awarded in sets of five, to two participants) would be drawn between participants who have completed the entire questionnaire and entered their email addresses, when prompted at the end. Participants were also informed that the email addresses would be used only to contact them in case of winning the price, and erased from the database thereafter. In Study IV, all participants received movie tickets for their participation.

In Study I, abiding by the theoretical viewpoint of narrative psychology (Willig, 2008, pp. 133–134), participants were instructed to write a story with the following guidelines (translated from Finnish):

"*Write a story about a period in your life when you have lost a personally significant amount of money while playing on-line poker at home. Elaborate especially on the emotions associated with losing: What thoughts occurred, what exactly transpired prior to losing, what you ended up doing afterwards, and what the emotion felt like precisely. Describe the situation and all related events freely.*

Please write your story below (the length is not limited)."

After writing a story, participants' level of poker experience was assessed with two questions: 1) "How many years have you played poker?" and 2) "What is the rough estimate of how

many hands you have played during your life?".

In Study II, participants first filled the Self-Rumination- and Self-Reflection scales (Elliott & Coker, 2008). The Self-Rumination scale consists of 10 7-point Likert items and measures the individual tendency of not being able to "let go" of negative consequences of past actions. In other words, self-rumination refers to an individual tendency to "dwell on the negative". Example items are: "I often reflect on unfavorable outcomes in my life", and "It is easy for me to put unwanted thoughts out of mind" (reverse coded). The Self-Reflection scale consists of 12 7-point Likert items and measures the individual tendency of benign, self-contemplative and genuinely curious introspection and analysis of

one's feelings. Example items are: “Knowing myself is very important to me”, and “Contemplating myself is something I don't do very often” (reverse coded). The items in both scales were coded from 1 = “strongly disagree” to 7 = “strongly agree”.

After filling the scales, participants undertook two tasks designed to simulate on-line poker decision making (the tasks were designed for the purpose of this study). In these tasks, participants were given a textual description of the decision making situation – a fictitious NLHE game scenario –, and forced to choose between two options/actions (i.e., *fold* or *call*). Folding was the mathematically correct decision in both tasks. In short, in both scenarios, the participant is facing an opponent on-line *heads-up* (one versus one). The opponent is described as constantly betting or raising *all-in* (i.e., betting all the money s/he currently has in play), indicating with an extremely high likelihood that his/her range of starting hands (the set of starting hands s/he bets or raises with) for betting or raising includes the vast majority of NLHE starting hands. Knowing an opponent's range of starting hands (and your own starting hand) for a specific action enables a mathematical calculation of *equity* (the likelihood of a known starting hand winning against a specified starting hand range). Thus, participants had enough information to estimate whether folding or calling is reasonable. Detailed explanations and mathematical reasoning for the poker tasks are presented in Appendix 1 in Study II.

Next, participants answered a question concerning their belief in their ability to influence luck (single forced choice dichotomous question: “Do you think luck can be influenced?” Yes/No). Finally, participants' level of poker experience was measured with the Poker Experience Scale (PES), which was developed and introduced in this study. PES consists of three 10-point Likert items: “How many years have you played poker?” (1 = “less than 1”; 10 = “more than 15”), “At what level of stakes do you usually play?” (1 = “Freerolls, NL2–5, PLO2–5, SNG1–5, MTT1–5”; 10 = “Above NL600, PLO600, SNG500, MTT500”), “What is the rough estimate of how many poker hands you have played during your life?” (1 = “0–50 000”, 10 = “more than 5 million”). Complete coding for PES is presented in Appendix 2 in Study II (see also poker abbreviations). Also the poker experience measure used in Study I was scored according to the scoring of PES, with the

exception of using two items instead of three.

In Study III, the following four measures (scales) were used. Perceived Effect of Experience on Tilting (PEET), Sensitivity to Losses (SL), Severity of Tilting (ST), and PES. PEET, SL and ST were developed and introduced in this study, based on the results of Studies I and II. PEET consists of four positively coded 7-point Likert items and measures the self-perceived impression of how accumulating poker experience has reduced the intensity, frequency and perceived harm (i.e., the *severity*) of tilting. An example item is: "The more poker experience I have gained, the less frequently I have tilted". SL consists of 11 7-point Likert items and measures the extent to which players experience negative emotions (e.g., feelings of injustice, anger and frustration) elicited by losses – i.e., their *sensitivity* to losses. Example items are: "I feel losing is unfair", and "Losing is part of the game" (reverse coded). All items in PEET and SL were coded from 1 = "completely disagree" to "7 = completely agree". ST consists of four Likert items and measures the intensity, frequency and perceived harm (the severity) of tilting during the last 6 months of active poker playing. Example items are: "On estimate, how many times have you tilted within your last 6 months of active poker playing?" (1 = "0", 7 = "more than 10"), and "When I have tilted (within my last active 6 months of playing), I have managed to quit playing before the losses have become too big" (reverse coded; 1 = "completely agree", 7 = "completely disagree", 8 = "I have not tilted"). A definition of *tilting* was presented to participants prior to answering to PEET and ST. The complete coding for PEET, SL and ST is presented in Appendix 1 in Study III.

Due to some similarity between the items in PES, PEET and ST, factor analysis was employed to determine whether these scales represent distinct constructs. The items from all three scales were pooled (11 items in total), and an exploratory factor analysis for a three-factor solution was employed with maximum likelihood extraction and direct oblimin rotation methods (correlation was assumed between the factors). The first, second and third factors had eigenvalues of 3.37, 2.85 and 1.41 and explained 30.69 %, 25.96 % and 12.83 % of the variance, respectively. The eigenvalues of the subsequent eight factors were below 0.65. The factor loadings on the three-factor solution corresponded to the items of PES,

PEET and ST, suggesting that the scales were distinct constructs (see the Appendix for the factor loadings table).

The questionnaires used in Studies II and III also included several exploratory measures, which are not reported here (these were aimed at assessing secondary working hypotheses unrelated to current ones). Table 2 summarizes the measures used in Studies I–III, including their inter-item reliability (internal consistency, as measured by Cronbach's alpha).

Table 2. Descriptions of measures used in Studies I–III

Study	Measures used	Number of items	Cronbach's alpha
I	Written story	Not applicable	Not applicable
	Poker experience measure	2	.67
II	Poker Experience Scale	3	.80
	Self-Rumination scale	10	.91
	Self-Reflection scale	12	.88
	Poker decision making tasks	2	Not applicable
	Belief in luck question	1	Not applicable
III	Poker Experience Scale	3	.74
	Perceived Effect of Experience on Tilting scale	4	.88
	Sensitivity to Losses scale	11	.78
	Severity of Tilting scale	4	.80

Note. Bolded measures were used as the primary dependent variables in the study.

In Study IV, participants (novice poker players) played a modified version of NLHE on a computer against four artificial intelligence (computer) opponents, who were “sitting” at the same virtual table as the participants. The PokerTH (www.pokerth.net) open source software was used in the experiment. The participants played 128 hands in two identical

sets of 64 hands[6]. All hands were identical across participants. There was a break of five minutes after the first set. After the second set, Likert-scaled questionnaires and verbal open-ended questions were used to evaluate the following: **i)** Did participants notice the poker game consisted of two identical sets of 64 hands? **ii)** How closely did participants think the poker game resembled a "normal" poker game (i.e., did participants feel as if the game was "rigged")? **iii)** What type of strategy (playing style) participants used in the game?

A mobile physiological data acquisition system (Varioport-B, Becker Meditec, Karlsruhe, Germany) was used to record EDA, using a constant 0.5 V voltage across Ag/AgCl electrodes with a contact area of 4 mm diameter (Becker Meditec), sampled at 32 Hz. Electrodes were attached to the medial phalanges of the ring and little fingers of the participants' left hand using self-adhesive electrode collars and electrolyte gel. Physiological signals were preprocessed using Matlab software (version 1.6.0_17). The following in-game events were logged: Actions (Fold, Call, Bet, and Raise) during all hand positions (Pre-Flop, Flop, Turn and River; see poker glossary), hand numbers (from 1 to 128), and leaderboard scores.

In a normal NLHE game, the majority of starting hands dealt to a player are considered weak in strength, thereby being often folded (e.g., Sklansky & Miller, 2006). When assessing decision making during playing NLHE in a controlled laboratory environment with only 64 unique dealt poker hands, using an ecologically valid distribution of poker hand strength is not feasible. Therefore, the poker hand strength distribution (for the participant) was manipulated to include hands of high strength (14/64 hands that are generally considered strong), medium strength (26/64 hands that are generally considered medium/uncertain in strength), and low strength (24/64 hands that are generally considered weak), appearing in a pseudo-randomized order.

6 The experiment included also a biofeedback condition (but biofeedback is not in the focus of the current thesis, and biofeedback-related results are not reported here). During one of the two sets of 64 hands, participants heard sound beats that were synchronized with their own heartbeats, and during the other set, they heard the same sound beats at a non-synchronized steady pace (participants had headphones on during the entire experiment). The order of the set during which biofeedback was received was counterbalanced across participants.

The poker game abided by the standard rules of NLHE for five players, with the following exceptions. Each dealt hand would start with the small and big blinds (forced bets placed into the pot before play begins) set at 10 and 20, respectively, and with each player at the table having 2000 chips (units of play money, totaling 100 big blinds) to play with (for a picture, see Appendix in Study IV). Unlike in a normal NLHE game, the amount of chips was reset to 2000 after each played hand. This was done to enable statistical comparability between corresponding hands across participants. The hands dealt to the computer opponents were identical across participants (i.e., pseudo-randomized).

Initially unbeknownst to the participants, the computer opponents played by calling bets and raises very often, and by only betting or raising with a very strong hand. Due to this, a profitable strategy was to play mainly strong hands, and by betting and raising with them (see Siler, 2010). After each hand played, the amount of chips won or lost was recorded and displayed in a leaderboard, visible at the bottom right corner of the game-screen. The leaderboard displayed the current score of the participant and was updated after each hand. The leaderboard also displayed scores of four other fictitious players (not the computer opponents). The scores of the fictitious players were also updated, predetermined, as the game progressed. Participants were told that the scores displayed in the leaderboard were attained by human players playing exactly the same game, prior to the current experiment, but who were not themselves participants in the experiment (this was a fictitious story). Participants were also told their reward for participation would depend on their final ranking in the leaderboard, as follows: four movie tickets for first place, three for second place, two for third place and one for both fourth and fifth places.

3.3 Data-analyses

In Study I, six stories were interpreted as “mock” replies, and thus excluded from further analysis. Thus, 54 stories were analyzed. The average story length was 166.4 words, and ranged from 60 to 850 words. *Thematic* and *narrative* analyses were employed. The stories

were first coded in order to identify recurring themes by employing thematic analysis (Bran & Clarke, 2006). Thereafter, narrative analysis (Biggerstaff, 2012, pp. 190–191; Willig, 2008, pp. 133–134) was employed to construct organized interpretations of sequences of events, involving the previously observed themes, in the stories. Atlas.ti (version 6.1.1.) was used in all analyses.

In thematic analysis, a *theme* correspond to an observable patterned response – that is relevant to the research question – within the data. Entries in the stories associated with descriptions of emotions and losing were assessed. Narrative analysis involves observing and interpreting ways in which people bring order to their experiences. By narrating, people replicate "dormant stories" in the implicit social representations of the general culture (Lazslo, 2008; Moscovici, 2001; Parker, 2005). In other words, narrative analysis assesses how people make connections between various events, and how they interpret those connections – i.e., how they construct narratives. In Study I, authors J.P. and M.L. coded the data, initially independently and thereafter in collaboration. Only the themes identified and mutually agreed upon by both J.P. and M.L. were further subjected to substantial reviewing. Reviewing of the themes was done in collaboration by all three authors. Finally, the most consequential themes were defined and named: "Dissociative feelings", "Moral indignation and chasing", "The aftermath of tilting", "Experienced vs. inexperienced players", and "Benefits of poker experience". The data showed sufficient re-occurrence of the five central themes. Therefore, it was assumed that the data had reached the point of saturation. Thereafter the authors organized the interpretations concerning consequential sequences of events (narratives) in collaboration. Finally, a model ("meta-narrative") was created where both the observed themes and narratives are depicted as causal sequences of events. Data excerpts were translated from Finnish, and confirmed by a professional linguist.

In Study II, linear regression analysis was employed to evaluate the associations between PES, Self-Rumination and Self-Reflection. Logistic regression analysis was employed to evaluate the associations between PES (predictor) and the dichotomous poker

decision making tasks (dependent variables). Both poker decision making tasks were also combined into a single dichotomous measure (2 = Correct answer in both tasks / 1 = One or less correct answers). Multiple binary logistic regression and simple slopes analyses were employed to further assess the associations between the single dichotomous measure (dependent variable) and PES, Self-Rumination, Self-Reflection, and their interactions (predictors). All scales were centered.

In Study III, a two-step multiple regression analysis was employed (Aiken & West, 1991). As the first step, PES and PEET, and their interaction, were entered in the analysis as predictors, and ST as the dependent variable. As the second step, SL was entered in the analysis as a predictor. Associations between PEET and SL, and PES and SL were also evaluated. Furthermore, a moderated partial mediation model – with SL as the mediator and PES as the moderator – was composed. Sobel's test and simple slopes analysis were employed to evaluate the moderated partial mediation effects. All scales were centered. In Studies II and III, no data were identified that were out of the permissible range, logically inconsistent or that had extreme values. Therefore, no participants were excluded from the analyses. Some kurtosis and skewness were observed in the distributions of the variables and the model residuals. However, linear regression models with large sample sizes (>300) are fairly robust against deviations from normality (Cohen et al., 2003).

In Study IV, mean EDA values were derived for one 3-s epoch before event (action taken) onset, and for one 3-s epoch after event onset. EDA data were log-transformed to normalize the distribution. The data were analyzed by employing the linear mixed models procedure (LMM) in SPSS, with maximum likelihood estimation, and a first-order autoregressive covariance structure for the residuals. Hand number (running from 1 to 128) was specified as the subject variable, and an aggregate variable “hand sequence” that indexed each action within a single hand, was selected as the repeated variable. Correlation was assumed between the residuals within a given hand, and the correlation was modeled with the first-order autoregressive covariance. “Action” and “hand strength” were selected as factors and a fixed-effects model that included these factors as main effects was specified. Player ID was also specified as a random effect with the variance components

covariance matrix, allowing between subject variance in the intercepts. Two linear contrasts were assessed: 1) a linear trend across actions (Fold, Call, Bet/Raise) and 2) a linear trend across actions taken with hands of different strengths (weak hands, medium-strength hands, strong hands). For simplicity, betting and raising were regarded as a single action and were not analyzed separately. In exploratory analyses, event-related changes in EDA were also tested using the following three contrasts: 1) Bet/Raise during River vs. Bet/Raise during Pre-Flop, Flop, and Turn, 2) Call during River vs. Call during Pre-Flop, Flop, and Turn, and 3) Fold during River vs. Fold during Pre-Flop, Flop, and Turn.

4 RESULTS

4.1 Loss-induced emotions and tilting (Study I)

4.1.1 Dissociative feelings, moral indignation and chasing

A distinct pattern of emotion-related narratives characterizing tilting was observed. Firstly, a theme was observed in which a significant monetary loss, usually following a bad beat, elicited feelings of *dissociation*[7] – namely, *emptiness, numbness* and *disbelief*. For example (emphasis added):

"The turn card was inconsequential, and my pulse was probably nearly at 200 – it was the biggest post of my life, and I just kept thinking "don't suck out on me on the river", and, well, they sure did. ***I was struck by disappointment and some sort of silence fell upon me****: 'No fucking way,"* (M22, experience: 3–4 years, 200 000 played hands)

"*It was a completely powerless, 'anesthetized' feeling, as if my entire body had been paralyzed.*" (M41, experience: 3–4 years, 500 000 played hands)

Secondly, a theme was observed in which losing felt *unfair*. This theme was sometimes observed in association with dissociative feelings, and often in association with narrations of *chasing* behavior. Chasing reflected an attempt to restore a *fair* balance of wins and losses, in light of the player's expectations (of "what is fair"). For example:

7 The term "dissociation" can be used to refer to both mild and severe (and somewhere in between) disruptions in the usually integrated functions of consciousness, identity or perceptions of the environment (e.g., Dell & O'neil, 2009). Accordingly, the severity of the experienced dissociation can be assessed in a continuum. In the current context, the term "dissociation" refers to mild psychological disruptions.

"In the end I ended up completely tilted as every single chip thrown on the virtual table ended up in my opponents' stacks, regardless of my own actions. [. . .] I felt that if I had the worse hand, ***it was unfair*** *that my opponent happened to have a better one. If I had the better hand and still lost,* ***it was unfair*** *to lose with the better hand.* ***I convinced myself that regardless of the situation, my losses were a Great Injustice, which would surely eventually be rectified by Fate.****"* (M27, experience: 3–4 years, 500 000 played hands)

"*I played a longer session than normally,* ***because I wanted to win back what I had lost.*** *I made this decision because, while playing,* ***I felt that variance had 'mistreated me'".*** (M24, experience: 3–4 years, 200 000 played hands)

4.1.2 The aftermath of tilting

After tilting had subsided, reports of *depression, anxiety, sadness* and *sleeping problems* were observed throughout the data. In addition, reported feelings of *disappointment (in self)* or *remorse* were observed. For example:

"*Finally, after I had lost enough, I realized I needed to quit, and after having closed the tables I was overcome by* ***despair and depression.*** *[. . .] I felt* ***great sadness****, because in just one day I had flushed down the toilet my winnings from the past 2 months."* (M23, experience: 3–4 years, 250 000 played hands)

"***I could not fall asleep normally for a couple of nights,*** *because I kept thinking why I once again had to throw away the winnings I had accumulated during the last month, in one short tilt-session."* (M40, experience: over 4 years, 500 000 played hands)

"*After a few hours and a few cigarettes I calmed down. But after that, I felt very* ***disappointed in myself,*** *and also* ***disappointed in my complete failure to control my tilt."*** (M22, experience: 2–3 years, 400 000 played hands)

Furthermore, there was indication that the observed feelings of self-focused disappointment and remorse were associated with participants' general view of poker as a game of skill, and of themselves as skilled players:

"*There have been excessive general feelings of 'being pissed off' and my mind has been too agitated to relax. In particular; when these emotions occur during a session,* ***I feel afterwards that I have failed as a poker professional.*** *[. . .], In poker communities many professional players feel the same.* ***It is considered kind of shameful if you let your losses affect your life.****"* (M32, experience: over 4 years, 1 million played hands)

4.1.3 Experienced vs. inexperienced players

The most prominent difference between experienced and inexperienced players in the data was associated with narrations related to *variance* and *bad luck*. This observed theme can be decomposed into two components: (1) Inexperienced players often reported that bad luck (e.g., bad beats) was a direct cause of negative emotions, most commonly anger, and (2) Experienced players often reported that self-made mistakes were a direct cause of negative emotions, whereas bad luck was interpreted as "merely variance", and regarded impassively. Experienced and inexperienced players were defined as those who received an "experience score" of at least 1 standard deviation above (+1 SD), and below (–1 SD) the sample mean, respectively.

Inexperienced players (–1 SD):

"But if you don't try to bluff – when you hold a good hand – and go all-in and lose, it feels even worse than when you bluff. Because in that moment, you have bet it all. ***Bad beat is such a painful thing****."* (M32, experience: 4 years, 60 000 played hands)

"*What really* ***pisses me off*** *is losing money to a completely bad player. I mean, losing to a player who has no idea how badly he's playing. [. . .]. For sure, these* ***complete fish hit cards so much better than mathematical odds should allow***." (M34, experience: less than one year, 150 000 played hands)

Experienced players (+1 SD):

"*I am aware that in the end* ***variance will balance itself*** *to the level 'that I deserve', and thus even the bigger pots that I lose mean nothing* ***if I have played them correctly***." (M20, experience: over 4 years, 5 million played hands)

"Normally losing doesn't feel bad at all ***if you realize that you have played it more or less 'correctly'***. *Variance will make sure that by playing correctly, you will lose some, but also win some.* ***But if you happen to lose because you did something stupid****, by playing half- heartedly, tired or otherwise badly,* ***then the losses irritate me more than usual****."* (M35, experience: over 4 years, 500 000 played hands)

4.1.4 Benefits of poker experience

Some experienced players (+1 SD) narrated in their stories that acquiring poker experience in itself had increased their emotional tolerance of losses. In addition, some experienced players narrated that their stories of losing did not relate to the immediate past, but rather reflected memories from years ago. For example:

"*Even though you feel nasty, you mustn't let the fear get a hold of you. Standard and common losses are therefore easily tolerable, they are 'business as usual' [. . .]* ***The more I have played, the greater my tolerance has grown***." (M30, experience: 4 years, 900 000 played hands)

"*I have to say that it has been a couple of years since even the bigger losses have significantly affected my emotional life, so my memories are not that fresh.*" (M27, experience: 3–4 years, 500 000 played hands)

"*I have been more or less able to win by playing poker for almost five years, and I have learned the nature of variance and other mechanisms of the game [. . .] When I was getting to know poker, losing and winning did elicit great emotions and thrills.*" (M24, experience: over 4 years, 500 000 played hands)

Based on the results, two diagram representations related to tilting were constructed: Figure 1 illustrates on a general level the phenomenology and aetiology of tilting. Figure 2 depicts differences in reacting to significant monetary poker losses between poker players of varying experience.

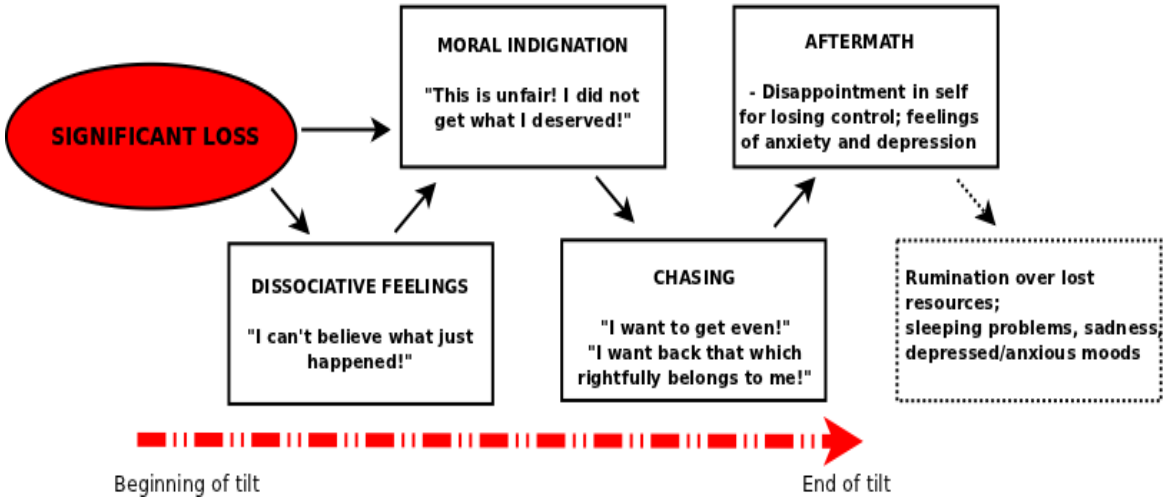

Figure 1. A diagram representation of the narrative structure (meta-narrative) related to the phenomenology and aetiology of tilting on a general level. Tilting is first instigated by a significant (monetary) loss, followed by dissociative feelings and/or moral indignation. Chasing then occurs, reflecting a desire to restore a previously lost "moral order", or "fair balance" of wins and losses. Finally, in the aftermath of tilting, self-focused feelings of disappointment, anxiety and depression are experienced. After tilting has subsided, rumination over lost resources occurs, expressed as sleeping problems, sadness and depressive/anxious mood states. The arrows indicate the direction of time. Reproduced from *International Gambling Studies, 13*(2), 255–270. (Study I).

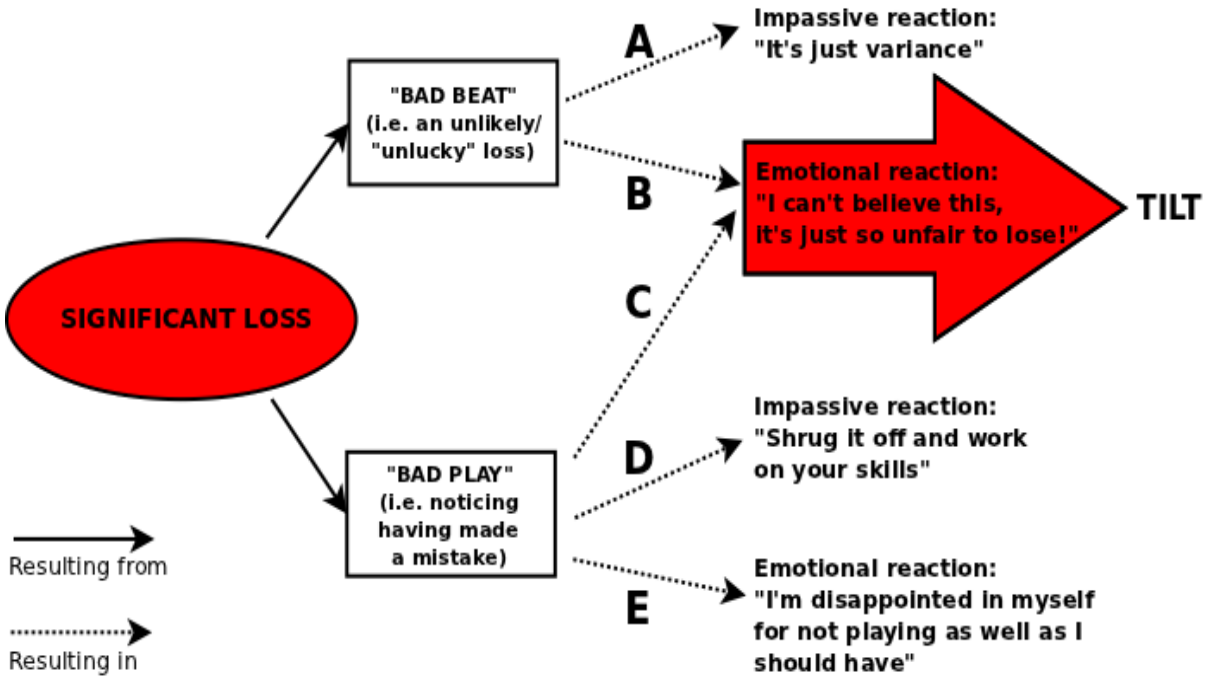

Figure 2. A diagram representation of the narrative structure (meta-narrative) related to two possible causes of a significant loss, bad beats and bad plays, and five pathways resulting in emotional and impassive reactions to the loss. Pathways B and C are characterized by feelings of injustice and unfairness (i.e., moral indignation), and they are also associated with tilting. Pathways A and D are characterized by a reportedly impassive (or emotionless) reaction in response to a significant loss. Pathway E is characterized by self-focused feelings of disappointment, anger and frustration for not playing as well as one believes s/he should have played. Putatively, pathways A, D and E are more likely followed/taken by experienced players, and pathways B and C are more likely followed/taken by inexperienced players. Reproduced from *International Gambling Studies, 13*(2), 255–270. (Study I).

4.2 Determinants of poker decision making (Study II)

Participants with more poker playing experience (higher PES scores) reported lower levels of self-rumination (B = –0.07, t(353) = –2.52, p = .01; adjusted for age and education B = –0.07, SE = 0.2, t(351) = –2.36, $p < .05$). There was no direct association between poker playing experience and self-reflection. Thus, Hypothesis 1 was partly supported. Poker playing experience was also associated with a lower likelihood of believing in one's ability

to influence luck (standardized OR = 0.88, SE = 0.05, $p < .05$), supporting Hypothesis 2. Participants with more poker playing experience were more likely to answer correctly in both decision making tasks/scenarios (task/scenario 1: OR = 1.2, SE = 0.07, $p < .01$; task/scenario 2: OR = 1.13, SE = 0.06, $p < .05$), supporting Hypothesis 3.

When both dependent variables (task/scenario 1 and task/scenario 2) were combined into a single dichotomous measure (2 = Correct answer in both tasks / 1 = One or less correct answers), interaction- and simple slopes analyses indicated that for experienced players (PES scores +1 SD), the tendency to self-reflection was associated with better decision making. For inexperienced players (PES scores –2 SD), the tendency to self-rumination was associated with better decision making. Poker playing experience predicted correct answers in the poker decision tasks in all analyses, further supporting Hypothesis 3. The interaction effects, and the results of simple slopes analysis, are presented in Table 3, and Figures 3 and 4.

Table 3. Multiple binary logistic regression presenting the main effects, interaction effects and simple slopes analysis of self-rumination, self-reflection and poker experience scales when using the combined dichotomous measure as a dependent variable

	Standard logistic regression statistics					**Simple slopes with PES as the moderator**					
Model	**B**	**SE**	**Wald**	***p***	**OR**	**Slope**	**B**	**SE**	**Wald**	***p***	**OR**
Self-rumination						Simple slopes for self-rumination at different levels of PES scores					
PES	0.12	0.05	5.25	<.05	1.13	−2 SD	0.41	0.21	3.89	<.05	1.51
Self-rumination	0.02	0.10	0.03	n.s	1.02	−1 SD	0.21	0.13	2.69	.10	1.24
PES × self-rumination	−0.09	0.04	4.00	<.05	0.91	+1 SD	−0.17	0.15	1.39	n.s.	0.83
						+2 SD	−0.37	0.23	2.58	.10	0.68
Self-reflection						Simple slopes for self-reflection at different levels of PES scores					
PES	0.11	0.05	4.29	<.05	1.12	−2 SD	−0.38	0.29	1.72	n.s.	0.67
Self-reflection	0.15	0.13	1.28	n.s	1.16	−1 SD	−0.11	0.18	0.42	n.s.	0.88
PES × self-reflection	0.12	0.12	3.74	.05	1.13	+1 SD	0.42	0.20	4.31	<.05	1.52
						+2 SD	0.69	0.32	4.61	<.05	1.9

Note. Grey background color denotes a statistically significant effect. PES = Poker Experience Scale.

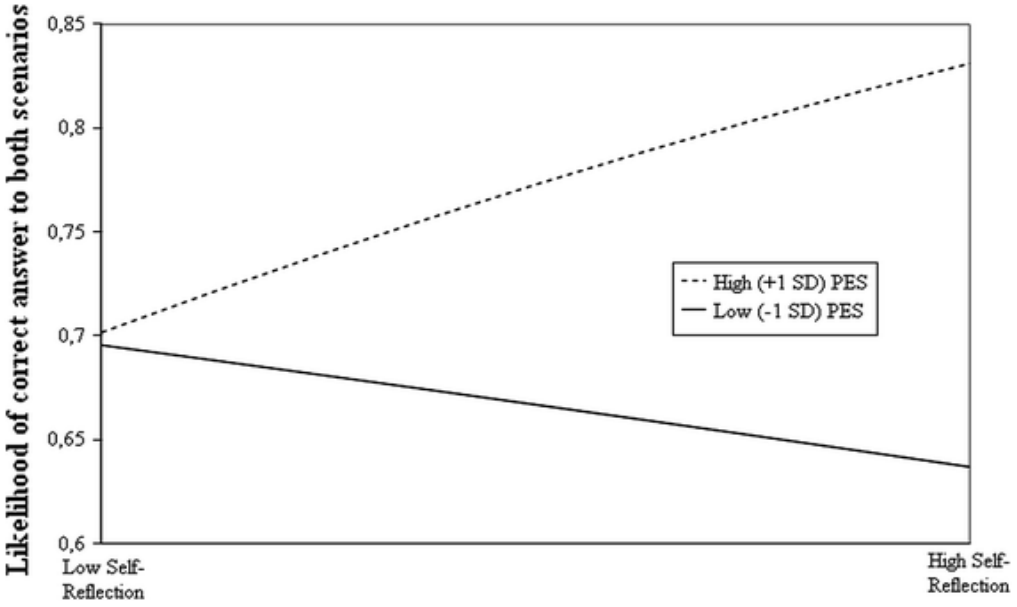

Figure 3. Association between Self-Reflection scores and likelihood of correct answer to both poker decision tasks/scenarios in participants with high versus low poker experience (PES scores). Simple slopes are one standard deviation above and below the mean. Only the slope for experienced players (+1 SD) is statistically significant. Reproduced from *Journal of Gambling Studies, 29*(3), 491–505 (Study II).

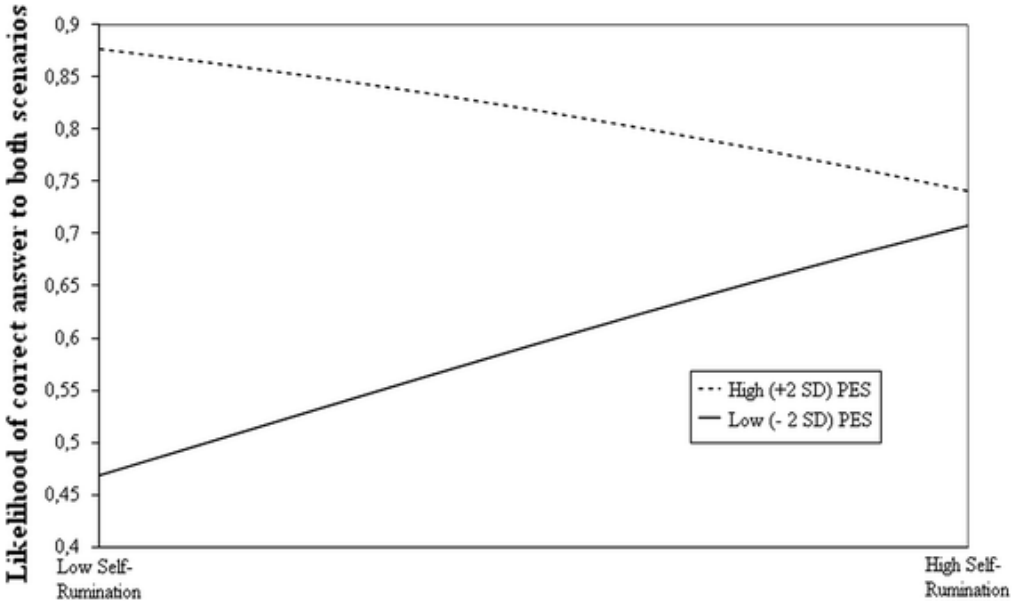

Figure 4. Association between Self-Rumination scores and likelihood of correct answer to both poker decision tasks/scenarios in participants with high versus low poker experience (PES scores). Simple slopes are two standard deviations above and below the mean. Only the slope for inexperienced players (−2 SD) is statistically significant. Reproduced from *Journal of Gambling Studies, 29*(3), 491–505 (Study II).

4.3 Sensitivity to losses and tilting severity (Study III)

The first step in the (two-step) multiple regression analysis resulted in a statistically significant model ($F(3, 412) = 31.98$, $p < .001$, $R^2 = 0.18$). Poker playing experience (PES) was positively associated with a self-perceived impression of having tilted less severely as a result of accumulating experience in poker (PEET; B = 0.148, $p < .001$), supporting Hypothesis 1. Poker experience was *positively* associated with tilting severity (B = 0.22, $p < .001$), contrary to Hypothesis 2. However, PEET was negatively associated with tilting severity (B = –0.25, $p < .001$), and the interaction term (PES x PEET) was also significant (B = –0.118, $p < .001$). A simple slopes analysis of this interaction suggested that the observed effect was driven by participants who scored high on PES (+1 SD: B = –0.482, $p < .001$). This result indicates that higher PEET scores buffer experienced poker players against severe tilting. Figure 5 illustrates the first step model.

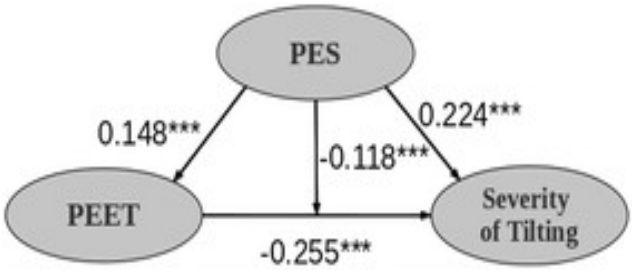

Figure 5. First step model. Associations between PES (Poker Experience Scale), PEET (Perceived Effect of Experience on Tilting) and ST (Severity of Tilting; Dependent Variable), and the Interaction effect (PES × PEET) presented graphically. Unstandardized B-values are shown (***p <.001). The model is statistically significant ($F(3, 412) = 31.98$, $p < .001$, $R^2 = .18$). All predictors are centered. Reproduced from *Journal of Gambling Studies.* Advance online publication. doi: 10.1007/s10899-012-9339-4 (Study III).

The second step in the multiple regression analysis resulted in a better fitting model (ΔR^2 = 0.09, $F(4, 411) = 39.89$, $p < .001$). A statistically significant moderated partial mediation effect was also found (all Sobel's Zs > 2.00, all ps < .05)[8]. The moderated mediation effect at different levels of PES -scores is presented in Figure 6a and b.

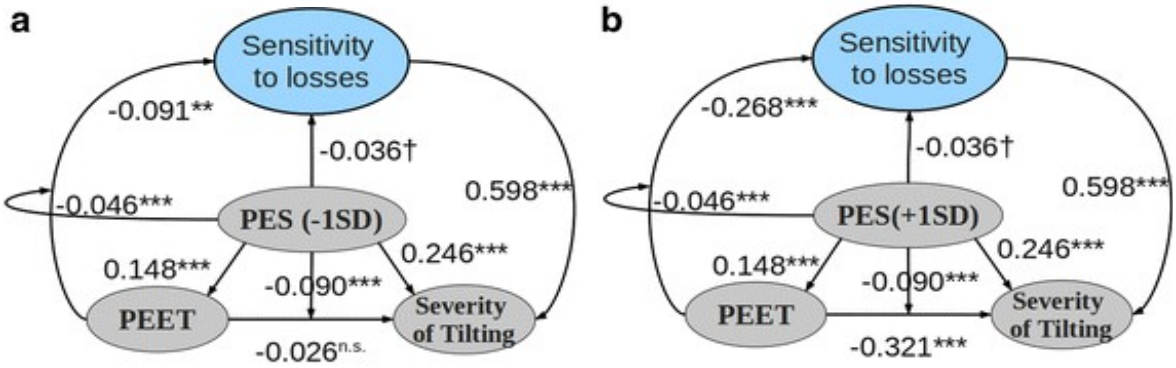

Figure 6. Second step model (moderated mediation model presented at two different levels of PES [**a** −1 SD and **b** +1 SD]). Associations between PES (Poker Experience Scale), PEET (Perceived Effect of Experience on Tilting), SL (Sensitivity to Losses) and ST (Severity of Tilting; Dependent Variable), and the Interaction effects (PES × PEET) presented graphically. Unstandardized B-values are shown (***$p < .001$. **$p < .01$. $^{\dagger}p < .1$). The model is statistically significant ($F(4, 411) = 39.89$, $p < .001$, $R^2 = .28$). All predictors are centered. Reproduced from *Journal of Gambling Studies.* Advance online publication. doi: 10.1007/s10899-012-9339-4 (Study III).

Sensitivity to losses was the strongest individual predictor of tilting severity at all levels of PES-scores (B = 0.598, $p < .001$), supporting Hypothesis 4. Poker experience was marginally negatively associated with sensitivity to losses (B = –0.036, $p = .08$). This association was stronger when sensitivity to losses was regressed on poker experience outside the context of the second step model (B = –0.048, $p < .05$), suggesting support for Hypothesis 3. Additionally, especially those experienced players (+1 SD) who held the impression of having benefited from their experience (as measured by PEET), successfully down-regulated their sensitivity to losses (providing additional support for Hypothesis 3). Full statistics for both models are presented in Table 4.

8 This effect was observed also by employing a bootstrapping technique based on the “model 2” method presented in Preacher et al. (2007).

Table 4. Two step multiple regression analysis presenting the main effects, interaction effects and simple slopes analysis of the Perceived Effect of Experience on Tilting (PEET), Poker Experience Scale (PES), and Sensitivity to Losses on the Severity of Tilting

Model				Model statistics			Simple slopes with PES as the moderator			
	B	***t***	***p***	R^2	***F***	***p***	**Slope**	**B**	***t***	***p***
1st step				0.18	31.98	<.001				
PES	0.22	5.75	<.001				−1 SD	−0.02	−0.46	n.s.
PEET	−0.25	−5.44	<.001							
PES × PEET	−0.11	−5.61	<.001				+1 SD	−0.48	−7.69	<.001
2nd step				0.28	39.89	<.001				
PES	0.24	6.67	<.001				−1 SD	0.02	0.45	n.s.
PEET	−0.14	−3.16	<.01							
PES × PEET	−0.09	−4.50	<.001							
Sensitivity to Losses	0.59	7.19	<.001				+1 SD	−0.32	−4.50	<.001

4.4 Electrodermal activity and poker decision making

Pre-decision EDA increased in the order of folding < calling < betting and raising. Due to this, a significant linear trend was observed across actions, supporting Hypothesis 1. A significant linear trend revealed that also post-decision EDA increased in the order of folding < calling < betting and raising. Pre-decision and post-decision EDA did not increase in the order of actions taken with a weak hand < actions taken with a medium-strength hand (or strength is uncertain) < actions taken with a strong hand. Due to this, the linear trend across hand strength categories was nonsignificant, and Hypothesis 2 was not supported. However, based on visual inspection of the EDA data, an a posteriori quadratic contrast was performed (i.e., actions taken with weak hands and actions taken with strong hands versus actions taken with medium-strength hands). This contrast was statistically significant – that is, actions taken with weak hands and actions taken with strong hands elicited higher pre-decision and post-decision EDA as compared with actions taken with medium-strength hands. Exploratory analyses also showed that the Bet/Raise action taken during the River hand position elicited higher EDA as compared with the Bet/Raise action taken during the other hand positions. Table 5 summarizes the contrast analyses. Figures 7–9 depict EDA responses related to Hypotheses 1 and 2, and the exploratory analyses, respectively.

Table 5. Summary of contrast analyses

Variable Source	Contrast Estimate (ln|µS/m|)	*SE*	*df*	*t*
Pre-decision EDA				
Linear trend across actions (Hypothesis 1)	0.00763	0.00121	5438.04	6.26***
Linear trend across hand strengths (Hypothesis 2)	0.00438	0.00697	3122.64	0.63
Strong and weak hands vs. medium-strength hands	0.03299	0.00804	3054.55	4.1***
Bet/raise during the river vs. bet/raise during other hand positions	0.02812	0.01221	1122.33	2.3*
Call during the river vs. call during other hand positions	0.01246	0.00960	2409.31	1.3
Fold during the river vs. fold during other hand positions	–0.06813	0.03859	1442.09	–1.77 (p = 0.078)
Post-decision EDA				
Linear trend across actions	0.00931	0.00118	5410.35	7.86***
Linear trend across hand strengths (Hypothesis 2)	0.00664	0.00697	3116.74	0.95
Strong and weak hands vs. medium-strength hands	0.03347	0.00805	3052.98	4.2***

Note. Pre-decision electrodermal activity (EDA) = mean EDA during the three seconds preceding event onset. Post-decision EDA = mean EDA during the three seconds following event onset. Actions are fold, call, and bet/raise. Hand strength categories are weak, medium, and strong. Hand positions are pre-flop, the flop, the turn and the river. *p < .05. ***p < .001.

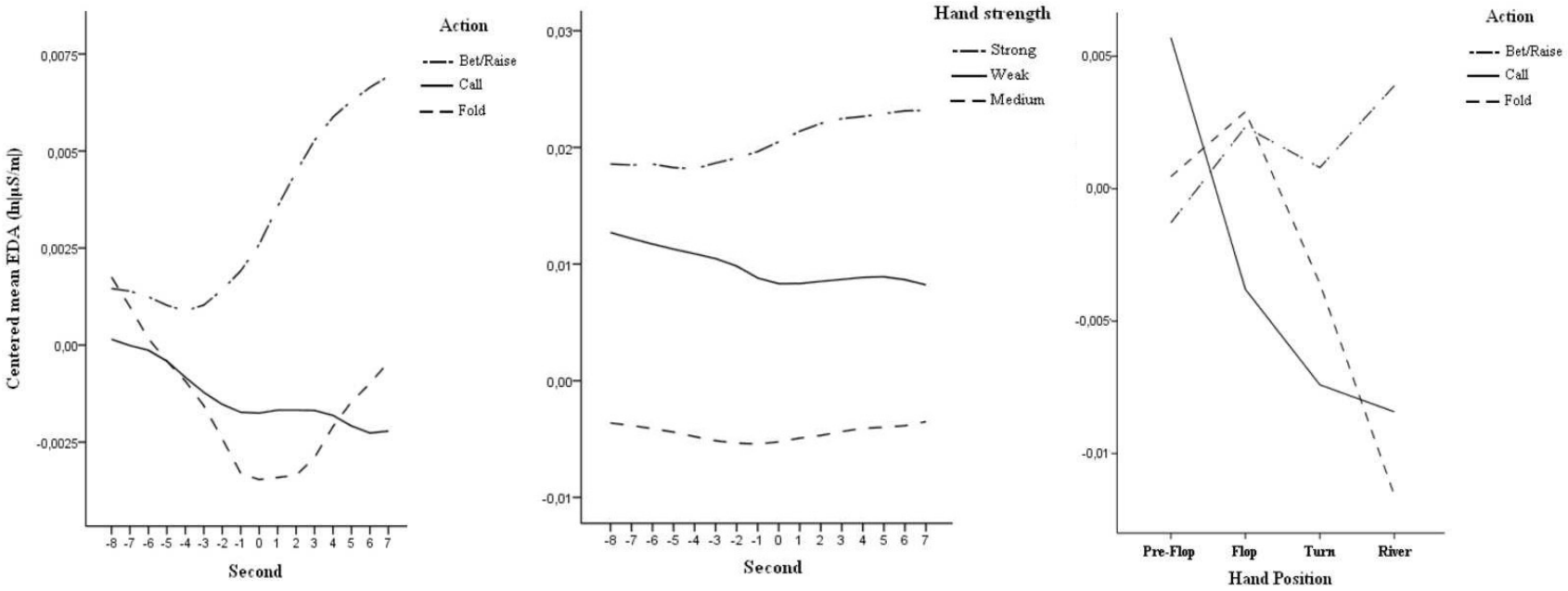

Figure 7 (left; Hypothesis 1). Centered mean EDA (ln|µS/m|) elicited by three different NLHE poker game actions: Bet/Raise, Call and Fold. The x-axis depicts seconds (–8s – 7s) preceding and following an action. Second 1 is the first second after action onset.

Figure 8 (middle; Hypothesis 2). Centered mean EDA (ln|µS/m|) elicited by NLHE poker game actions taken with hands that belong to one of three categories: Strong hands, hands with medium strength, and weak hands. The x-axis depicts seconds (–8s – 7s) preceding and following an action. Second 1 is the first second after action onset.

Figure 9 (right; Exploratory analyses). Centered mean EDA (ln|µS/m|) elicited by three different NLHE poker game actions (Bet/Raise, Call and Fold) during four different hand positions. The x-axis depicts hand position (Pre-Flop, Flop, Turn and River).

Figures 7 – 9 are reproduced from *Journal of Neuroscience, Psychology, and Economics, 6*(1), 55–70. (Study IV).

Verbal reports to open ended verbal questions and the Likert-questionnaire indicated that most participants did not notice the game consisted of two identical sets of 64 hands. Five participants reported having "suspected" that some of the hands dealt in the second set might have been similar to ones dealt in the first set. Performing the analyses by omitting these five participants did not change the results. Verbal reports and the Likert-questionnaire also indicated that participants did not feel the game resembled a "normal" poker game. Many participants reported that they were unsure as to what specifically made them feel the game was "rigged", and that they felt they were being dealt too many strong NLHE starting hands. Furthermore, most participants reported having noticed that the computer opponents did not often fold, and that they therefore felt the best strategy was to bet/raise with strong hands and not to attempt bluffing (betting/raising with weak hands in an attempt to make the opponent fold).

5 DISCUSSION

The present thesis evaluated the association between emotions and decision making in the game of poker, with emphasis on the tilting phenomenon. Prior to conducting Study I, there existed little scientific knowledge concerning tilting (see also Browne, 1989; Griffiths et al., 2010; Rosecrance, 1986; Rosenthal, 1995). Thus, an empirical framework needed to be established against which tilting could be evaluated – Study I was designed to this end. Both Studies II and III were inspired by the results of Study I, and as such they can be interpreted as its extensions – i.e., Studies II and III were carried out within the framework of Study I. Study IV aimed at further exploring the basis of emotion-related psychophysiological reactivity and decision making in poker, from neuroscientific and economic perspectives. More specifically, in Studies I–IV, four topics were investigated: 1) The phenomenology and aetiology of losing, and by extension, tilting in poker, 2) The associations between poker experience, poker decision making, self-rumination and self-reflection, 3) The associations between poker experience and specific emotional characteristics that either protect players from tilting, or predispose them to it, and 4) The psychophysiological reactivity, as measured by EDA, elicited during NLHE poker decision making.

5.1 The phenomenology and aetiology of tilting

The results of Study I suggested that the most consequential emotion-related elements of tilting behavior were *dissociative feelings, moral indignation, chasing behavior*, and the *aftermath* of tilting, during which participants seemingly displayed *ruminative behavior.* In particular, rumination was primarily manifested as *disappointment in self,* and *feelings of depression* and *anxiety*[9] over lost resources.

9 It needs to be noted that the terms ”depression” and ”anxiety” refer to emotion vocabulary observed in participants' narrations. In other words, they refer to the words used by participants to describe their feelings. Hence, ”depression” and ”anxiety” are not used here in the context of clinical pathologies.

The observed theme of dissociative feelings following a significant loss is in line with a previous report by Rosenthal (1995), in which experiencing bad beats was associated with feelings of disbelief and dissociation among gamblers. Such feelings are typically reported in association with various psychological traumas, such as bereavement and post-traumatic stress disorder (Foa & Hearst-Ikeda, 1996). Therefore, it is conceivable that the reported feelings of disbelief and emptiness *protect* players from immediately experiencing strong negative emotions that would otherwise be elicited by a sober affirmation of the outcome. Poker losses may appear less severe than the aforementioned psychological traumas during which dissociation typically occurs. However, given that many players reported having lost both significant amounts of money *and* time, the reported feelings of disbelief and emptiness seem reasonable and suggest that poker losses also can be traumatizing. It is possible that dissociative feelings are beneficial in the short run, but become detrimental in the long run, if they occur frequently and result in an inability to process the traumatizing losses.

The theme of moral indignation was often observed in association with dissociative feelings, and it can also be interpreted as the core instigator of tilting. In order to better characterize the phenomenological basis of moral indignation in poker, suppose a hypothetical poker scenario where a player bets all-in pre-flop (see poker glossary) with the strongest starting hand in (Texas Hold'em) poker, pocket aces, and gets called by one opponent. Typically, in this situation, the likelihood of pocket aces winning is around 80 %. Hence, by betting all-in and getting called, the player is rationally expected to win 80 % of whatever money is in the pot – in the long run. However, arguably, what players subjectively feel they normatively rather than statistically ought to win (or what they feel they are *entitled to*) is not 80 % of the money in the pot. Instead, players merely feel that they ought to win, period, on the basis of their statistically rational expectations. In most cases, however, the entire pot is either won or lost. After losing the pot, players conceivably feel that what ought to have happened, did not happen – they feel they did not get what they were entitled to. Correspondingly, after winning the pot, players feel that what ought to have happened, did happen – they feel they got what they were entitled to.

Notwithstanding, mathematically, neither outcome corresponds to what is *expected* to happen. This contention resonates also with Rosenthal's (1995; see also Tendler, 2011) interpretation of bad beats as being in discrepancy with gamblers' perceptions of "fair chance": People seem to have a tendency to believe that, in a general ethical sense, "things ought to be fair".

Furthermore, participants' narrations of *chasing* behavior were characterized by descriptions of attempts to *regain* that which rightfully belonged to them. Hence, it is important to note that chasing should not be defined merely as behavior whereby players aim at regaining a positive emotional state by winning back quickly the money that was previously lost. Instead, chasing (in the stories of Study I) reflected behavior whereby players attempted to rectify what they felt was a morally unjustified course of events. Putatively, a successful chase would have restored in participants' minds the moral order broken by, e.g., a bad beat. The aforementioned observations resonate also with the working ethic connected to the socio-historical context of the post-protestant Finnish society, according to which *work* should always be duly compensated, and when this does not happen, moral indignation ensues (Jokinen & Saaristo, 2010).

Another consequential observation was made in Study I concerning differences in the experiential ambiance of losing and tilting between experienced and inexperienced poker players. There was clear indication that uncontrollable game elements, such as self-perceived bad luck, elicited negative emotions – including moral indignation – especially in inexperienced players. By contrast, experienced players seemed to think of bad luck as "merely variance" that should be regarded impassively. Evidently, for experienced players, an understanding of variance results in a mature disposition towards losing: Bad luck does not matter, as variance eventually "balances your luck". If a player does not understand the mathematics of variance (as might be the case with inexperienced poker players) bad beats and other incidences of self-perceived bad luck might be attributed to, e.g., unfairness and injustice, thereby eliciting negative emotions[10].

10 However, self-made mistakes were a cause of negative emotions especially for experienced players. In other words, self-perceived bad *plays* – but not bad *beats* – elicited negative emotions in experienced players.

It needs to be noted that being an experienced player, and more skilled than an average player, is not necessarily sufficient to be a winning player, as most players belong to the losing majority. Therefore it is reasonable to presume that many experienced and skilled players undergo negative emotions induced by losses, and tilt. Furthermore, previous anecdotal evidence (and also evidence presented in the current thesis) suggests that even many winning players sometimes tilt (e.g., Hilger & Taylor, 2007; Tendler, 2011). Notwithstanding, it is also reasonable to propose that *technical* skills, including knowledge of poker concepts, form a dynamic contingency with players' *emotional* (mental game) skills. Inflated beliefs about skill are common among tilting gamblers whose chasing behavior is motivated by an illusion of control, even when constant losing proves the contrary. Arguably, this illusion of control is mitigated by way of appreciating the inalienable role of variance in poker. The route for acquiring poker experience and skill goes through an adequate epistemic understanding of the relationship between skill and chance in the game (Dickerson & O'Connor, 2006; see also Bjerg, 2010).

5.2 Emotion regulation and poker playing experience

In poker, a consequential difference between experienced and inexperienced players seems to be the ability to differentiate the circumstances one can control from those one cannot, and this ability may grow only *by* experience. Previous anecdotal evidence also suggests that the success of many players might in part depend on their ability to successfully regulate negative emotions induced by (often uncontrollable) elements of the game (Angelo, 2007; Hilger & Taylor, 2007; Tendler, 2011). Being able to “let go” of (to not *ruminate* on) unfavorable outcomes of previous actions is a consequential poker skill element. In other words, emotional aspects of poker playing skills (mental game skills) play a significant role in poker skill development. Due to the overt influence emotions have on decision making, it is material for players to develop their mental game skills if they aspire to be successful poker players. It is well established that mental game skills, or mental

tolerance under pressure, are important factors also in many competitive sports (e.g., Rotella, 1996). Essentially, the same holds true also for the game of poker. For example, a player who has proficient technical skills, but insufficient emotional skills in poker, might be in danger of losing *all his/her money* as a result of a single tilt-session.

The aforementioned negative emotions experienced in the aftermath of tilting suggest that *rumination* is implicated in poker experience and poker skill development. Furthermore, the results of Study I suggested that for experienced players, monetary losses resulting from uncontrollable game elements (such as bad beats) were not a particularly prominent source of negative emotions – instead, experienced players often expressed a benign indifference (a reflective "*que sera, sera* -mentality") towards losing due to bad luck. As such, the results of Study I are in line with the results of Study II, where trait self-rumination and self-reflection were implicated in poker experience and poker decision making. Thus, the hypotheses formed based on qualitative observations made in Study I, were supported by quantitative data in Study II. Firstly, experienced poker players, as compared with inexperienced ones, were less predisposed to self-rumination, and also less likely to believe in their ability to influence luck. Secondly, experienced players were mathematically more accurate in poker decision making. Finally, self-reflection (but not self-rumination) was implicated in the decision making accuracy of experienced players, whereas self-rumination (but not self-reflection) was implicated in the decision making accuracy of inexperienced players. It therefore seems that as players accumulate experience and develop their poker skills, they should at some point learn to stop self-ruminating and start self-reflecting.

A possible way to interpret these results is as follows. Some poker players might have played for many years and have been dealt a substantial amount of poker hands without succeeding to "move up the stakes"[11]. It is conceivable that self-reflection is beneficial *especially* at the higher stakes, where the range of losses and wins – and the emotional turmoils they entail – can be immense. If this were the case, it would not be enough to merely play for many years and be dealt many poker hands in order to acquire a high level

11 In fact, the author of this thesis is one of these players!

of poker skill. At the higher stakes, the level of competition places increasing demands on players for both proficient emotion regulation and technical skill development. Putatively, the inability to self-reflect hinders the progress whereby players acquire the technical and mental skills necessary for advancing to play at higher stakes. In other words, the time to stop self-ruminating and start self-reflecting might be when players aspire to "step up their game and raise the stakes" (see the Appendix for further discussion on this possibility).

Based on the results of Studies I and II, it was further hypothesized that while experienced players occasionally tilt, they probably do so less frequently and less intensely than experienced players, because they appreciate the limits of their skills and the inherent role of chance in the game. It was also hypothesized that the occurrence of negative emotions, such as anger, frustration, and feelings of unfairness induced by losses (i.e., emotional sensitivity to losses), would be a compelling predictor of the frequency, intensity and perceived harm (i.e., severity) of tilting, and that experienced players would be emotionally less sensitive to losses, as compared with inexperienced ones.

As expected, the results of Study III suggested that emotional sensitivity to losses was prominently associated with higher severity of tilting. Furthermore, the results indicated that experienced players were emotionally less sensitive to losses, as compared with inexperienced ones. These findings are congruent with the conclusions presented in Studies I and II, and thus provide further evidence in support of the role of emotion regulation in poker experience and skill development, and poker decision making in general.

It was also found that, contrary to the hypothesis, experienced poker players reported more severe tilting than inexperienced players. This result appears to be in tension with the previous results of Studies I and II. However, a number of reasoned interpretations can be made to explain the apparent contradiction. It is possible that experienced players are less likely to tilt in relative terms, *per single hand*, but more likely to tilt *in the long run*. Thus, the positive association between poker experience and tilting severity might relate to an overall larger amount of tilt-inducing situations that experienced players are bound to

encounter in playing, as compared with inexperienced players[12]. Another explanation is that experienced players might have a different perception of what tilting means, as compared with that of less experienced players. Although the same definition of tilting was provided in the survey to all participants, experienced players might, for example, believe they are "losing control" – this description was part of the given definition – in the same situation in which inexperienced players believe they have full control.

It should be noted that these interpretations are compatible with the finding from the same study, which indicated that experienced players – although reporting severe tilting – also held the personal impression of having previously (before having accumulated a high level of poker experience) tilted even more severely. Moreover, additional evidence supporting the credibility of the aforementioned conclusions comes from a recent unpublished study, which successfully replicated in a sample of international poker players the results of Studies II and III concerning the association between poker playing experience, self-rumination and sensitivity to losses (Palomäki et al., unpublished data).

Together, the findings from Studies I–III establish a preliminary framework suggesting that emotion regulation abilities – or mental game skills – are an important factor in protecting players from tilting and thereby also increasing their financial success in the game. Various emotional characteristics were identified that either protect players from, or predispose them to, negative tilt-inducing emotions elicited by various elements of the game. These emotional characteristics, in turn, differ between experienced and inexperienced poker players. In particular, acquiring poker experience seems to be associated with an "emotionally mature" disposition regarding monetary losses in poker, and, arguably, decreased (relative) likelihood of detrimental decision making as seen in tilting behavior.

12 This, in turn, might relate to i) higher overall amount of poker hands played, ii) higher average stakes played at, resulting in, on average, higher occasional monetary losses (despite the fact experienced players in, in the long run, more money than inexperienced players), and iii) higher overall amount of times betting with statistically strong hands (experienced players probably bet more frequently than inexperienced players with strong hands and therefore encounter potential bad beats more often than the latter).

5.3 Psychophysiology of poker decisions

In addition to assessing the basis of tilting behavior and its association with poker playing experience and skill, this thesis sought to begin producing new knowledge on the psychophysiological basis of poker decision making processes and emotional reactivity. Hence, Study IV aimed to assess how emotional reactivity elicited by various NLHE poker actions is reflected in EDA, which is a robust index of emotional arousal. In particular, based on both economic (EUT) and neuroscientific (SMH) theories of decision making and emotions, it was hypothesized that different actions taken with poker hands of varying strength are associated with different levels of anticipated utility, as measured and indexed by EDA.

The results of Study IV indicated that, as expected, pre-decision EDA increased in the order of folding < calling < betting/raising. This result supports the hypothesis that pre-decision EDA reflects the anticipated utility of a given decision in a NLHE poker game, and allows also for situating the game of NLHE poker within the general context of both neuroscientific and economic models of human decision making and emotions. For example, the SMH postulates that mental images of choice options in a decision making situation become "marked" by distinct somatic states through associative learning (Bechara & Damasio, 2005; Damasio, 1994/2006). It is reasonable to propose that somatic states associated with the mental images of betting/raising, calling, and folding – that is, the somatic states that "mark" these actions – are activated (as indicated by EDA), when participants are deciding which action to take. Due to participants recognizing the profitability of *not bluffing* and betting/raising *only with strong hands* (this style of play was profitable because the computer opponents rarely folded or bet/raised, and frequently "just" called), the higher levels of EDA preceding betting/raising, as compared with folding and calling, arguably reflect a learned association between betting/raising and a higher likelihood of profit. This, in turn, possibly indicates that higher levels of emotional arousal precede/predict situations where betting/raising is likely to be the action chosen – i.e.,

reflecting positively valenced enthusiasm in anticipation of profit.

It should be noted that while EDA is a useful index of emotional *arousal* (i.e., the intensity of affect; e.g., Levita et al., 2009), it is non-specific with respect to emotional *valence* (i.e., the positive vs. negative -dimension of affect). As such, it is possible that the observed EDA responses preceding various actions also reflect negatively valenced arousal – for instance, *frustration* in the case of folding and having to relinquish a previously made large investment in the pot. However, in the experiment, folding almost never resulted in relinquishing a large investment (of chips). On average, participants played by *not* betting/raising with hands that might have to be eventually folded. When participants did fold, the size of the pot was almost always modest. Arguably, relinquishing only a modest amount of previously invested chips is not a prominent cause of negative *or* positive arousal. In other words, participants knew that by folding they would not lose *or* gain any chips, whereas by betting/raising or calling at least some chips were attainable.

The non-specificity of EDA regarding the valence of affect is reflected also in the fact that the hypothesis on the relationship of EDA with hand strength was not supported. That is, contrary to the hypothesis, actions taken with hands whose strength was medium (i.e., risky/uncertain) elicited the lowest levels of EDA. In the experiment, participants adopted a playing style where they favored betting/raising with strong hands to merely calling with them. Therefore, it is reasonable to presume that betting/raising with strong hands involved little risk or uncertainty, because betting/raising with said hands more often than not resulted in profit. Similarly, actions taken with weak hands also involved little risk or uncertainty, as participants would almost always eventually fold. In other words, playing with these hands was associated with very little outcome variability. Hence, the higher levels of EDA associated with actions taken with both weak and strong hands conceivably relates to an emotionally arousing state, such as positively valenced enthusiasm (in anticipation of profit/reward with strong hands) or negatively valenced frustration and/or anxiety (from having to allocate time to play a hand with no prospects of profit, and eventually having to give up and fold). By contrast, risk and uncertainty associated with hands of medium strength might be related to an analytical, emotionally "detached" and

non-arousing cognitive strategy in decision making – i.e., decision making that elicits neither positively (i.e., enthusiasm) nor negatively (i.e., frustration and/or anxiety) valenced arousal.

These assumptions, however, are contended by evidence suggesting that uncertainty is associated with an affectively "charged" state, thereby being related to strong degrees of aversive arousal (e.g., Hirsh et al., 2012). Thus, the current results need to be interpreted with caution. Notwithstanding, the concept of "risk and uncertainty" is not unambiguously defined between, for example, poker and "real life" decision making. In the former (but not the latter), risky or uncertain decisions always relate to a limited number of choice options (i.e., five actions at maximum), which is cognitively manageable and thus not necessarily associated with an affectively charged state.

5.4 Limitations and future directions

Producing new knowledge in a field of science where pre-existing empirical evidence is scarce often requires creating novel study designs. However, novel study designs also often introduce a fair number of limitations that need to be considered, and directions for future research in addressing these limitations should be given.

The sample demographics in Studies I–IV were highly specific – i.e., mostly young Finnish males. Although these samples probably did accurately represent a Finnish poker playing population, the results cannot be generalized across gender, or across nationality. Due to this, the results obtained from Study I, in particular, need to be interpreted within the socio-historical context of the (post-protestant) Finnish society (see Jokinen & Saaristo, 2010). Arguably, when narrating about significant poker losses, poker players (implicitly) replicated in their stories the meta-narrative structures connected to the Finnish welfare society ethos. Therefore, for further tilting and chasing -related qualitative research, the local societal conditions under which poker is typically played, should be given thorough attention, and sociological theories of social identities should be considered (Jenkins,

2008).

In Study I, tilting was primarily assumed to result from experiencing a significant monetary loss in poker. However, multiple phenomenologically dissimilar instigators of tilting might exist. These include (but are not limited to) prolonged periods of minor losses, or factors external to the game, such as exhaustion or "needling" by other players (Browne, 1989; see also Tendler, 2011). Further research is thus required to evaluate if tilting differs phenomenologically when induced by dissimilar events.

Studies II and III face many limitations inherent in correlative (questionnaire/survey) studies. The most noteworthy limitation is the inability to infer directions of causality between the analyzed measures. This limitation is especially relevant due to the results of Study I, which clearly alluded to a causal mechanism in that acquiring poker experience *resulted* in improved emotion regulation abilities. That is to say, participants in Study I narrated that playing poker and thereby acquiring poker experience had been a significant *reason* for them to have become more proficient in regulating their emotions. For them, poker had been a "learning ground" for emotional maturity. Notwithstanding, the results of Studies II and III cannot support this assumption of a specific direction of causality. The emotional characteristics measured by questionnaires are often trait-like (i.e., stable across time), and it is thus conceivable that people who possess these traits are predisposed to *continue* playing poker, thereby accumulating poker experience. A possible way of investigating this contention is by measuring poker players' personality- and/or temperament traits, and assessing their associations with poker experience (see Brown & Mitchell, 2010). Personality- and temperament traits are known to be to a large extent stable across time. Therefore, any association – or lack thereof – between these traits and poker experience would provide consequential information concerning causal relations between poker experience and emotion regulation[13]. It also needs to be noted that the above

13 Some preliminary evidence already exists. Results from an unpublished study (Palomäki et al., unpublished data) showed a significant negative correlation between the personality trait of *emotionality* (in the HEXACO model of personality; Ashton & Lee, 2009) and poker experience (as measured by PES). This finding arguably supports the assumption that acquiring poker experience does not by and of itself result in changes in emotion regulation abilities.

contentions are not mutually exclusive – it is possible that playing poker at the same time "teaches" emotion regulation, *and* that players who are adept in emotion regulation are more likely to continue playing poker than those who are inept in it.

Systematic selection bias for certain types of participants might have been introduced in Studies I–III. For example, in Studies I and II, some participants publicly stated on poker web forums that they were suspicious about the scientific motivation behind the study, and would thus boycott the survey. In addition, some participants complained about the length of the survey used in Study II, and stated that they left it unanswered. Moreover, in Study II, the poker decision making tasks could have been effectively solved by employing a variety of statistical software specifically tailored for poker decision making analysis.

The present thesis introduced a number of new psychometric scales (in Study III) aimed at measuring various emotional characteristics implicated in tilting behavior. Thus, the psychometric properties of these scales have not been thoroughly evaluated. A possible venue for further research is to assess the associations between, for example, emotional sensitivity to losses and non-poker gambling behavior (e.g., playing slot-machines, sports betting, or buying lottery tickets). If the scales (such as the SL -scale) can be employed to predict detrimental out-of-control decision making during other forms of gambling besides poker, then it is reasonable to presume the psychometric properties of the scales (and by extension, the phenomenon of tilting) have wider relevance in understanding human gambling behavior (see also Brown et al., 2004; Moodie & Finnigan, 2005; Teed et al., 2012).

In Study IV, the observed differences in EDA between poker game actions were relatively modest. Although the LMM method has many advantages, an obvious disadvantage is the lack of well-established means for estimating effect sizes. For that reason, no unambiguous index of effect size could be provided. It can thus be argued that the observed modest differences in EDA, although statistically highly significant, might not be subjectively easily distinguishable (i.e., they might not have "practical" significance in predicting poker decision making).

The modest differences in EDA between actions might relate to a lack of ecological validity in the study design. The modified version of the game did not accurately resemble the poker games players usually play on-line. Ecological validity can be increased by employing more recognizable poker software (e.g., poker game interfaces used in popular on-line poker sites), and by having participants play for real money prizes, instead of movie-tickets. Ecological validity of the distribution of poker hand strengths could be increased also by increasing the number of hands played, and by decreasing the percentage of strong starting hands – many participants thought that they were being dealt too many of them (see also Dedonno & Detterman, 2008).

It should also be noted that the participants in Study IV were all novice poker players with little experience in NLHE. Furthermore, in the experiment of Study IV, participants played on one virtual poker table. It is very common for active on-line poker players to play on multiple tables at once (e.g., Rhodes, 2010). Assessing poker decision making in a laboratory setting while participants play on multiple tables at once is a possible venue for future research. Thus, in order to further integrate the findings from Studies I–IV, a laboratory experiment is suggested. At least the following factors in a poker decision making task should be considered and/or manipulated: i) number of tables played on, ii) level of poker experience (e.g., as measured by PES), iii) characteristics related to emotion regulation (e.g., as measured by personality- and/or temperament traits, or by the measures presented in this thesis), and iv) psychophysiological measures of emotional reactivity (e.g., EDA). Based on the findings of the current thesis, it is reasonable to hypothesize that experienced poker players, as compared with less experienced ones, are better able to regulate their emotions, and that this ability is reflected in decreased EDA during poker decision making. Furthermore, it is reasonable to presume that playing on multiple tables at once is less likely to have a detrimental effect on the decision making accuracy of experienced players, as compared with less experienced ones.

5.5 A note on problem gambling

The current thesis did not assess participants' problem (or disordered) gambling. The aims of Studies I–IV were purely non-pathological. Arguably, tilting cannot be defined *a priori* as a pathology due to a large proportion of poker players who sometimes tilt. Tilting is, however, also defined by behaviors often associated with problem gambling, such as losing control and chasing. Due to this, it is conceivable that an association between problem gambling and tilting severity exists. *Excessive* tilting, in particular, under certain conditions appears to be isomorphic with problematic gambling behavior (see Rosecrance, 1986; Williams et al., 2012). Therefore, individuals suffering from disordered gambling might be at a high risk of severe tilting, and the consequences thereof might be especially perilous for these individuals.

At least two earlier studies employing ethnography have evaluated the relationship between tilting and problem gambling. Rosecrance (1986) identified tilting behavior resulting from bad beats in racetrack bettors, and concluded that tilting often was the main impetus for the development of problematic gambling behavior. In contrast, Browne (1989) observed gamblers' (mainly poker players) behavior in legal commercial card parlors and at open Gamblers Anonymous meetings. He contended that although all gamblers described having experienced tilting, it was their emotional reactions – which could be mild or agitated – to tilt and tilt-inducing situations that determined whether or not gambling became problematic. This contention is also in line, to some extent, with the results presented in the current thesis. Notwithstanding, the appearance of isomorphism between tilting and problem gambling alone does not allow concluding that a meaningful association between the two necessarily exists. Further research is needed to evaluate these claims.

Assessing the associations between problem gambling and tilting severity is *ostensibly* straightforward, and could be achieved by a correlative study paradigm employing standardized questionnaire measures. In order to assess the connection between problem gambling and tilting behavior, standardized methods for measuring problem gambling

(such as the South Oaks Gambling Screen, SOGS; Lesieur & Blume, 1987; or the Problem Gambling Severity Index, PGSI; Ferris & Wynne, 2001; Holtgraves, 2009) need to be employed. However, evidence suggests that these commonly used methods for measuring pathological aspects of gambling are ill-equipped to assess a poker playing population – especially in the case of experienced poker players, who play for long hours and/or as a means to make money (e.g., Bjerg, 2010). For example, a professional or semi-professional poker player measured with SOGS might be labeled a "problem gambler" despite having a high level of both well-being and financial agency. In other words, the concepts of "poker experience" and "problem gambling" are entangled, and it is cumbersome to assess their causal association (see also McCormack et al., 2013; Shead et al., 2008; Weinstock et al., 2013).

Preliminary data from three separate Internet-based correlative studies suggest that while poker experience is positively associated with problem gambling (as measured by both SOGS and PGSI), there is *no* association between poker experience and *satisfaction in life* or *social well-being* (Palomäki et al., unpublished data). In other words, experienced poker players are more likely to exhibit pathological gambling behavior but no more likely to report lower levels of general well-being, as compared with inexperienced players (well-being was measured by scales such as The Trait Hope Scale [Snyder et al., 1991], and The Life Satisfaction Scale [Diener et al., 1985]). These results challenge the validity of the SOGS and PGSI in assessing pathological aspects of gambling in experienced poker players. The results also suggest that the concepts of problem gambling, tilting and poker experience need to be properly disentangled before further conjectures regarding them can be made.

At present, Western psychiatry is, arguably, still not fully able to provide an unambiguous definition of mental illness that would appear consistent over larger historical periods and/or cultural boundaries (e.g., Perring, 2010). It is also worth noting that there is no proper universally accepted theory of what mental health essentially is (see Nesse, 2005a, 2005b; Williams & Nesse, 1994). Furthermore, because tilting is a very prevalent phenomenon among poker players, it might represent a "normal" emotional reaction to a

loss of resources – similarly, it is “normal” to react with anger when facing injustice (by, e.g., having someone steal your money).

6 CONCLUSIONS

This thesis sought out to produce new knowledge on the multifaceted phenomena of poker decision making and emotional processes therein, as existing knowledge on this topic was primarily anecdotal. First, the phenomenology and aetiology of emotions related to losing were qualitatively explored, thereby providing an empirical framework against which later scientific studies on the same subject matter could be evaluated. Second, evidence from two correlative studies provided support for the notion that poker playing experience is closely related to both poker decision making accuracy and emotion regulation abilities (i.e., mental game skills, or emotional "maturity"). Third, evidence from a psychophysiological laboratory experiment demonstrated that EDA is closely associated with emotion-related processes implicated in NLHE poker decision making, thus placing the game within the context of current neuroscientific and economic decision making theories, namely the SMH and EUT. Finally, when a proposed hypothesis was not supported by the data, alternative interpretations for the observation were offered, and suggestions for further research were identified and closely examined.

The combined results contribute to existing knowledge on i) the general underpinnings of the tilting phenomenon, ii) the associations between poker playing experience, poker playing skill, and various emotional characteristics implicated in emotion regulation abilities, iii) psychophysiological reactivity during NLHE poker decision making.

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APPENDIX: ADDITIONAL STATISTICAL ANALYSES

A1 Factor loadings on the pooled items of PEET, ST and PES

Table 6. Factor loadings (direct oblimin rotation) on the pooled 11 items of Perceived Effect of Experience on Tilting (PEET; Factor 1; items 1–4), Severity of Tilting (ST; Factor 2; items 5–8), and Poker Experience Scale (PES; Factor 3; items 9–11) on the first three factors. Loadings ≥ 0.55 are highlighted

Factor loadings			
	Factor		
Pooled items of PEET (1–4), ST (5–8) and PES (9–11)	**1**	**2**	**3**
1. How many times have you tilted within your last 6 months of active poker playing?	.065	.657	.121
2. If you have tilted (within your last 6 months of active poker playing), on estimate how strong was the tilting in your experience?	-.020	-.740	.018
3. When I have tilted (within my last active 6 months of poker playing), I have managed to quit playing before the losses have become too big.	.018	-.655	-.073
4. Tilting has been a problem for me (within my last active 6 months of playing).	-.074	.799	-.099
5. The more poker playing experience I have accumulated, the less frequently I have tilted.	.795	-.021	.022
6. The more poker playing experience I have accumulated, the shorter lasting my periods of tilting have been.	.964	.133	-.096
7. The more poker playing experience I have accumulated, the less “intensive” my periods of tilting have been.	.853	-.005	-.041
8. The more poker playing experience I have accumulated, the less I have felt tilting is a problem for me.	.652	-.148	.147
9. How many years have you played poker?	.068	.008	.764
10. What is the rough estimate of how many poker hands you have played during your life?	.020	-.017	.785
11. At what level of stakes do you usually play?	-.070	.060	.561
Eigenvalues	3.37	2.85	1.41
% explained	30.69	25.96	12.83
Cumulative % explained	30.69	56.65	69.48

A2 Exploratory analyses

According to the results of Study II concerning poker decision making accuracy, experienced poker players benefit from self-reflection, whereas inexperienced players benefit from self-rumination. Thus, at some point in time during poker skill development, poker players apparently benefit from "switching" from self-ruminative to self-reflective tendencies.

An exploratory analysis was performed to evaluate the hypothesis proposed in the main text, according to which the aforementioned "switch" might occur when players pursue moving up in the stakes. It is conceivable that a subgroup of poker players exists who, despite having played for many years and a substantial amount of poker hands, have failed at acquiring the level of skill required to play at the higher stakes. Poker experience scale (PES) includes three items, two of which assess the *amount of years* and the *number of poker hands* played, and one that assesses the *level of stakes* players currently played at. In the data of Study II, the aforementioned subgroup of players would be represented by those participants who played at low stakes despite having scored high on the remaining two items of PES.

Thus, a new two-item scale (PES-2) was first formed that included only the "amount of years played" and "number of poker hands played" PES items. Thereafter, simple slopes analysis with "level of stakes" as the moderator was employed to assess the association between PES-2 and self-reflection. All variables were centered and standardized.

A2.1 Results and discussion

Figure 10 and table 7 show that self-reflection as a function of level of stakes is expressed differently at different levels of PES-2. However, no significant differences in self-reflective tendencies were observed in high stakes players with low versus high PES-2 scores. Therefore, the hypothesis presented in the main text was only partly supported.

Regardless, these results might imply that a specific subgroup of poker players with high PES-2 scores are "stuck at the lower limits" *due to* insufficient self-reflective abilities.

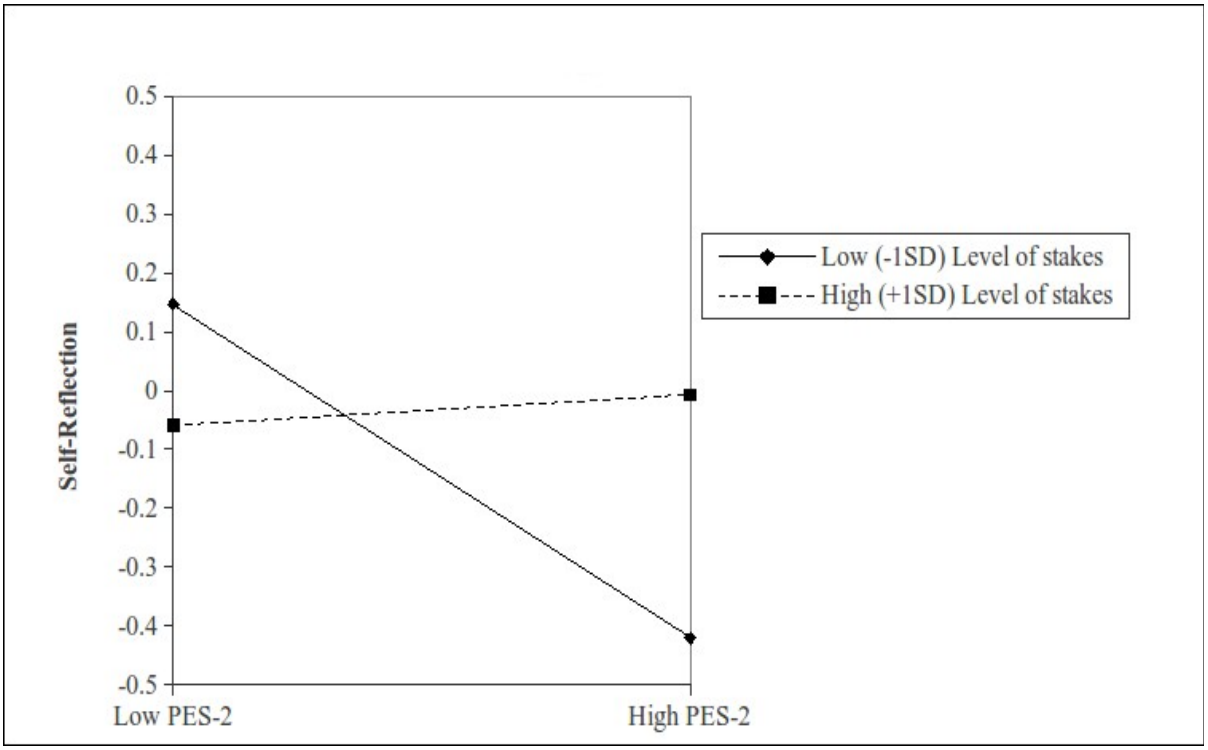

Figure 10. Association between standardized PES-2 and Self-Reflection scores in high versus low Level of stakes. Simple slopes are one standard deviation above and below the mean. Only the slop for low Level of stakes (-1SD) is statistically significant.

Table 7. Multiple regression analysis presenting the main effect, interaction effect and simple slopes analysis of PES-2 and Level of stakes on Self-Reflection

	Standard multiple regression statistics			**Simple slopes with "Level of stakes" as the moderator**			
Model	**B**	***t***	***p***	**Slope**	**B**	***t***	***p***
PES-2	–0.13	–2.04	<.05	−1SD	–0.28	–3.62	<.001
Level of stakes	0.05	0.83	n.s.				
PES-2 x Level of stakes	0.15	2.97	<.01	+1SD	0.02	0.31	n.s.

Note. Grey background color denotes a statistically significant effect. PES-2 = two-item Poker Experience Scale.