**SLIDE 1**

*Exploring spatio-temporal, neural event-related potential patterns in a complex, sequential, decision-making environment.*

1. Exploring is used as not enough information is available to indicate that there will be the patterns I am looking for. I have not found this research having been done before.
   1. **Event-relate potential** can be described as electrophysiological responses in the brain to a specific motor or cognitive event or stimulus. A cognitive event (eg. Decision making) can trigger an ERP.
   2. **Complex, sequential, decision-making environment.** I am using the context of chess and specifically ‘blitz’ chess which is played in 1 minute, 3 minute and 10 minute games.The game of chess provides me with a complex, sequential, decision-making environment.
2. I am wanting to determine if there are EEG patterns that occur on a regular basis associated with a high cognitive load. Much of the theoretical framework I am using falls under decision-making, but other psychological theories also come into play, for example Damasio’s somatic marker theory.

**SLIDE 2**

*Do event-related potentials (ERPs) associated with a sequence of high-speed, high cognitive involvement, value-based decisions exhibit discernible pre- and post event patterns?*

Important here is establishing whether EEG waves before and after the cognitive event related potential of a decision exists.

Research objectives:

1. To explore the existence of repeated neural ERP patterns, both spatially and temporally, as well as related physiological responses associated with the sequence of decisions made in online 1-, 3-, and 10-minute blitz chess matches by low-ranked and high-ranked chess players, using EEG and related psychophysiological measurement methods.
2. Focus on time, brain area, emotions and cognitive load
3. To examine the moment of realisation or “AHA” moment. This moment or event (there could be several in a game) occurs when a subject realises that they have made as good/bad move or they realise that they are about to win. Emotion would come into play here as well.
4. To create a descriptive model of the patterns if they exist.

**SLIDE 3**

1. The ERP requires a series of similar decisions over time in order for specific events to be isolated from surrounding measurements.
2. Blitz chess has a time-limit, it involves value-based decisions – value based here refers to decisions which have a good or bad outcome or as is mentioned in much of the decision-making literature, a reward and punishment paradigm. Restricting the time that players have to move reduces their ability to utilize slow processes, such as search. The decision making theoretical framework to be applied is that of Kahnemann with his System 1 and System 2 decision making processes. System 1 are fast, intuitive decisions such as in the 1 minute game and System 2 are slow, reasoned decisions which I suspect will happen in the 10 minute game.
3. According to the literature, chess is a high cognitive load activity and which has emotional/rational elements attached to it.
4. Blitz chess provides me with a clear start and finish with an end of winning or losing
5. The AHA moment which is a cognitive event in its own right can be isolated with the ERP together with subjective verbal protocols post-experiment.
6. Different contexts of ERP measurements are needed for comparison purposes to determine if a pattern really exists. I refer to different here in terms of the time constraints placed on participants and their cognitive load.
7. I want to avoid learning coming into play so what I choose needs to be familiar to the participant to avoid learning being measured.
8. Inexperienced and experienced subjects will provide comparison opportunities. I also would like to see if the patterns between experienced and inexperienced players are comparable in the 1 minute (System 1 decisions -Kahnemann)
9. The subject’s insight is important, particularly to verify the AHA event
10. There is quite a lot of research having been done on chess - psychological and decision-making theories. For example, theories on emotion, stress, competition, learning, experience, memory, strategy
11. The game involves clear, visible decisions (on average 40 decisions per game). In 1 minute, a decision is made every 1.5 seconds (little time for thinking – mainly intuitive/emotional play), while in 3 minutes there is a decision every 4.5 seconds (a little more time – some reasoning may occur), and in 10 minutes, there is a decision every 15 seconds (much more time for reasoning) and involves goal-directed behaviour which is often used as one of the descriptors of decision making.

**SLIDE 4**

1. In addition to a focused literature search, a panel of high-ranking chess players will be interviewed to determine what aspects of chess they feel would be important to take cognisance of
2. The game of chess has a recognised ranking (FADA) allowing for cohorts to be placed in the two groups namely low ranking and high ranking. These can be recruited from chess clubs in Pretoria. Three low ranking and 3 high-ranking participants will be recruited. My interest is mainly in the novice players as I suspect that their play will be based more on intuition, particularly in the 1 minute game. The experienced players are required as a benchmark and it is expected, according to the literature, that they primarily use memory (experience) of chess moves and reasoning.
3. The game can be played on computer. Several open source versions that can be adjusted to the player’s ranking, are available
4. The games of “Blitz” or “fast” chess are recognised games.
5. I will use EEG, galvanic skin response, eye tracking, pupillometry, and facial recognition software
6. Creating a baseline which consists of the various EEG brain waves is necessary for later analysis of the results
7. Subjects subjective insights will be useful
8. In addition, the same expert group as was used at the beginning of the study, will be asked to give their opinions of when different events occurred (such as the moment of realisation

**SLIDE 5**

1. Measurement tools used will be:
   1. EEG to establish brain wave patterns of attention, cognitive load, emotion, arousal, engagement
   2. Galvanic skin response to measure emotions -particularly during a moment of realisation
   3. Pupillometry – measuring arousal
   4. Eye tracking to determine gaze paths and areas of interest
   5. sLORETA – low resolution electromagnetic tomography. 3d brain imaging software which is available free-of-charge from the University of Zurich
2. These tools will be analysed using
   1. WinEEG that will also be able to remove artifacts (coincidental noise)
   2. MatLab EEG
   3. sLORETA
   4. ANOVA
   5. iMotions software
   6. Pattern recognition: I will have to approach the decision sciences to help me with pattern recognition algorithms

**SLIDE 6**

1. All instruments that will be used are non-invasive – no signals are being sent to the participants.
2. The usual ethical clearance will be obtained from the university
3. Dry EEG will be used to avoid any discomfort which could be associated with wet EEG
4. The experiment should take no longer than 1 ½ hours (including verbal protocols). Participants will be informed of this
5. No unusual ethical considerations are envisaged.