VALIDATION OF THE APPROACH-AVOIDANCE PARADIGM: INVESTIGATING DIFFERENCES IN RISK PREFERENCE BETWEEN CHRONIC PAIN AND PAIN-FREE SUBJECTS

A Thesis

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ABSTRACT

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The Approach-Avoidance Paradigm (AAP) is a nine item test of pain tolerance that uses hypothetical scenarios depicting varying relationships between monetary reward and pain. The AAP stimuli are organized into four scales that describe the reward and threat conditions presented by the stimuli: High Reward, Low Reward, High Threat, and Low Threat.

This study sought to validate the AAP against a similar measure, the Avoidance-Endurance Questionnaire (AEQ), using chronic pain and chronic pain-free participants. Decisions for the High Reward scale positively correlated with the AEQ's Avoidance of Social Activity subscale, and decisions for the High Threat scale negatively correlated with the AEQ's Avoidance of Physical Activity subscale. These correlations are low, yet relatively stable across alternate scoring methods. Implications and considerations for future research are discussed.

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CHAPTER 1

INTRODUCTION

Pain is a multi-dimensional phenomenon most frequently characterized by heightened arousal responses (Treed et al., 2015). It has a neurological basis (Sator-Katzenschlager et al., 2003; Amandusson & Blomqvist, 2013) and is considered chronic when the experience of pain lasts 12 weeks or longer (Treede et al., 2015). The stress of acute and chronic pain have been shown to impact human behavior (Crombez, et al., 1999; Martin et al., 2014, Sator-Katzenschlager et al., 2003) and decision making (Hess et al., 2014). Considerable research has examined the ways in which humans cope with pain and its stressors, either through perseverance (Crombez, et al., 1999; Dysvik et al., 2005; Tan et al., 2001) or escape from it (Crombez, et al., 1999; Hooley et. al, 2014; Sator-Katzenschlager et al., 2003).

Approach-Avoidance Theory

Approach-Avoidance is a descriptor of cognitive and emotional-based activity intended to cope with stress (Roth & Cohen, 1986). In practice, approach-avoidance behavior is evident in an organism's propulsion toward or away from stressful stimuli. Behavioral analysis of approach-avoidance paradigms (AAP) assume that approach-based behaviors will always be intended to bring an organism closer to positive stimuli and that avoidance-based behaviors will always be intended to separate the organism from noxious stimuli (Elliot, 2006). This dichotic model is problematic, as it singly supports the acute stress response theory that flight responses predate fight responses (Bracha, 2004) and ignores contexts in which an organism will adopt fight (approach) strategies before attempting to escape (avoid; Thompson & Sturm, 1965; de Barros et. al,, 2010). Evidence for this root motivation within the binary AAP models may be found in appetitive and aversive reactions to stimuli. Gable et al. (2003) attempted to validate

this model but found very weak support for their constructs (see below for a more substantial analysis of this work). A better concept of approach and avoidant tendencies may be to consider them as behavioral mechanisms that are undertaken to either reduce the severity of stress or to increase the experience of positive experiences.

The framework of approach-avoidance research is grounded in early psychobiological theory (Cogswell et al., 2006) and is based on the immediate experience of stress (or the immediate threat of stress), independent of trauma-inspired memory (Bachanas & Blount, 1996; Carver & White, 1994; Elliot, 2006; Gable et al., 2003). Animal research has strongly indicated that two separate neural systems underlie appetitive and avoidant behaviors and cognitions (Gray, as cited in Gable et. al, 2003). These discrete neural systems (the Behavioral Activation System, or BAS; and the Behavioral Inhibition System, or BIS) form the basis on which the BAS/BIS questionnaire was based; this measure is described later in this paper. Although Gray's research is built on animal models, current psychoneural research has found support for the applicability of animal model-based findings to humans within the context of approach-avoidance behaviors overlapping neural patterns of emotional activity (Gainotti, 2021). There is substantial evidence that human neural hemisphere asymmetry operates as a mediator or moderator of motivation generally (Reznik & Allen, 2018) and approach-avoidance behavior specifically (Lacey & Gable, 2022; Reznik & Allen, 2018). Rolle et. al. (2021) have found evidence for the neural substrates of approach-avoidance decision making within humans within the prefrontal cortex. Using transcranial magnetic stimulation, Fini et. al. (2020) suggested a direct correlation between positive and negative visual stimuli and approach/avoidance behavior.

It has been proposed that the dichotic analysis of approach and avoidance may offer fundamental guidelines in the development of personality (Elliot & Thrash, 2002), particularly as

it relates to individual motivation and perceptual valence (Elliot, 2006). Many approach/avoidance psychometrics observe moderate correlations to personality and mood-based psychological traits (Carver & White, 1994; Gable et. al., 2003; Smith et. al., 2021); however at present, causal relationships between these behaviors and constructs have not been clearly established.

Cross-cultural research indicates that approach and avoidant behaviors are universally human, although strategy preference is shaped by an individual's cultural background. When faced with confrontation, Western individuals favor approach mechanisms, while East Asian individuals display avoidant preferences (Hamamura et al., 2009).

Research on goal-directed behavior is well-established within psychology and neuroscience and will not be expressly reviewed here. The most pertinent research in the area as it relates to approach-avoidance based cognition and behavior stems from Gray's (1975) two-process theory of neurological learning, Higgins' (1997) work on regulatory behavior, and Elliot's (2006) personality and motivation-based research. For a recent and thorough comparison and integration of these theories, see Monni et al. (2020). It has recently been determined that when an organism is sufficiently stressed, particularly in the adoption of a fear response, neural activity can trigger the breaking of DNA strands within brain tissue (Stott et al., 2021). These dramatic effects can be found across the cortex and provide support for consideration of whether the neurological underpinnings of fear-based responses - and emotional responses in general - result in powerful neurological phenomena that can be measured through noninvasive techniques.

Harmon-Jones and Allen (1997) illustrated that transcranial electroencephalography could detect asymmetric patterns of neural activity during appetitive (approach-based) cognition.

Other researchers have identified the operations of apparently discrete approach and avoidant-based operational mechanisms, although the priority of approach over avoidant systems remains to be established (Monni et al., 2020).

Numerous psychometric tests have been developed to measure and classify approach-avoidant behavior into a meaningful construct. At the heart of most models is the approach-avoidance conflict, a forced decision paradigm in which participants are given a scenario that offers the potential for both reward and punishment. Using this format, Rolle et al. (2021) found evidence for a neural basis of withdrawal behaviors and reward sensitivity. Their study presented tasks wherein both reward and punishment of varying intensities were experienced - or both avoided. Manipulation of electrical signals in the frontal cortex indicated that the right prefrontal cortex is involved in the appraisal of rewards (reward sensitivity) during conflict decision-making (Rolle et al. 2021). Passadouro et al (2021) detected a similar front-right pattern of frontal alpha asymmetric activation, associated with catastrophizing scores and negative emotional states believed to be associated with withdrawal.

The methods used by Rolle et al. are promising because organisms are not always able to escape the threat of pain and may have to approach painful experiences to satisfy another motivational goal. For example, a hungry animal might be required to approach a noxious stimuli in order to achieve the reward of food (Salcido et al., 2018) or a child may have to endure a painful medical procedure to maintain their health (Bachanas & Blount, 1996).

The BAS/BIS scale was developed by Carver and White (1994) and is still used in behavioral and neurological studies: Approach-related answers have been shown to correlate with variation in alpha band activity in the prefrontal cortex, as measured by EEG (Harmon-Jones & Allen, 1997). Even so, the scale has been criticized due to its structure (it

contains four subscales that are not conceptually distinct regarding activation and inhibition responses) and there has been difficulty correlating it with other measures due to this structure (Cogswell et al., 2006).

Although a valid measure of approach-avoidance behavior (Cohen's kappa reliability coefficients .77 - .96), the Behavioral Approach-Avoidance and Distress Scale (Bachanas & Blount, 1996) relies heavily on observational measurements (Hubert et al., 1988) by highly trained and/or subjective specialists (the participant's primary care doctor, attending nurse and primary caregiver). The scale's dependency on multiple trained observers effectively cripples its use in large-scale studies.

The Avoidance Endurance Questionnaire (AEQ) was developed from the Kiel Pain Inventory to predict real-world manifestations of avoidance and endurance behaviors (Hasenbring et al., 2009). This self-report survey was intended to assess a pain sufferer's willingness to avoid or endure pain, particularly in the workplace (i.e. in exchange for monetary reward). The measure was developed through factor analysis of the Kiel Pain Inventory (KPI), coupled with reported experiences of pain sufferers (sick days taken, disability experienced). Affective measures (not somatic) were included in scale development. The AEQ contains five avoidance-based subscales (anxiety/depression, helplessness/hopelessness, catastrophizing thoughts, avoidance of social activities, avoidance of physical activities) and five endurance-based subscales (positive mood despite pain, thought suppression, behavioral endurance, humor and distraction, and pain persistence). Three of the AEQ's subscales (avoidance of social activities, avoidance of physical activities, and pain persistence) exhibit strong theoretical similarities to the approach-avoidance framework described here and as such were selected for use in the current study.

Approach-Avoidance Conflict

The Approach-Avoidance Conflict task was developed to discriminate between anxiety and decision-related uncertainty as primary moderators of a participants' decision to approach or avoid negative experiences (Smith et al., 2021). The model uses a video-game like interface with stick figures and simple graphic illustrations to convey the threat level of each scenario presented and the corresponding reward (points). However, this measure was developed for use with psychiatric patients and also includes pictures that represent real-world examples of the presented scenarios. Many of these images are explicit depictions of pain or violence, which dramatically limits the appropriateness of this measure for broad research purposes (Smith et al., 2021).

Multiple studies have used a similar technique to present the potential for reward and risk: Rolle et. al. (2021) used five-point graphical representations in their model, and Fisher et al. (2016) used vignettes and goals to establish their approach-avoidance conflict. Both of these studies sought to clarify the role of pain and reward in decision-making, and both found evidence that offer theoretical support for the Approach-Avoidance-Conflict task as a viable tool for measuring approach and withdrawal behaviors. Using a similar measure construct (conflicting rewards and pain), Van Damme et al. (2012) found motivational differences in approach and avoidance behaviors when approach-based goals were expressly given to participants.

Present Study

The purpose of the current study was to validate a novel approach/avoidance self-report measure that can be used to measure pain approach-avoidance. This measure is designed to be an estimate of a participant's attitudes and intended behaviors, scalable to large and small participant models, and congruent with current neurofeedback research methods (particularly

electroencephalography):

Hypothesis 1 (Replication): Participants will be more likely to make approach decisions than avoidant decisions when rewards (e.g. money) outweigh the cost (pain).

Hypothesis 2 (Extension and Validation): Approach-avoidance stimuli scores will correlate with AEQ scores.

CHAPTER II

Method

Participants

An a priori sample size calculation was computed for the largest inferential statistic model using G*Power software with an alpha criterion of .05, .80 power, an effect size of .25, and the minimum sample size needed was $n = 66$. Optional stopping was used to assess sample size once the study was underway and responses slowed dramatically. Participants were adults 18+ recruited via social media (Instagram, Facebook, Twitter), emails, learning platforms, and virtual advertisements using the following script: "Participants are sought for a short survey study concerning chronic pain. Participants must be right-handed and can have chronic pain or be without chronic pain." They were directed to a page explaining the purpose of the study and asked to provide informed consent to participate. No personally identifying information was collected.

Procedure

The study was created via Qualtrics and participant responses were recorded by that system. Participants provided informed consent and answered a short demographic survey (Appendix A) that captured age, biological sex, gender identity, current country of residence, and whether participants were experiencing chronic pain (lasting 12 weeks or longer). Personally identifying information was not collected. Additionally, participants were provided with the Edinburgh Handedness Inventory (to control for any possible differences arising from left-or right-hand dominance, thereby ensuring the measure can be used with EEG procedures) and the McGill pain questionnaire (to test for differences in decision-making related to the experience of pain). Participants were administered each AAP stimuli and the AEQ's avoidance of social

activities, avoidance of physical activities, and pain persistence subscales. Institutional Review Board approval was acquired prior to the study being launched.

Measures

The *Edinburgh Handedness Inventory* (Oldfield, 1971) was developed to identify the dominant hand of participants. Within EEG studies, only right-handed participants should be used due to variations in brain asymmetry amongst left-handed individuals (Papousek & Schulter, 1999). The AAP is intended for use with an EEG machine in future studies; therefore, dominant handedness was identified to ensure that our data can be compared with EEG data. The four item short form was used, as it is brief and has better factor analytic loading than the longer forms (Veale, 2014). In the current study, questions were presented with these instructions: "Please indicate your preferences in the use of hands in the following activities or objects (always right, usually right, both equally, usually left, always left): writing, throwing, toothbrush, spoon" (Oldfield, 1971). Items were scored as [(always right = 100; usually right = 50; both equally = 0; usually left = -50; always left = -100)/4]. Participants with summed scores ranging from -100 to -61 (left handed) and -60 to 60 (ambidextrous) were excluded from analysis.

The *McGill Pain Questionnaire short form* (MPQ-SF, Appendix A) consists of three batteries designed to measure subjective pain experience (Melzack, 1975) and is well-validated (Lovejoy et al., 2012; Melzack, 1987; Wright et al., 2001). The measure is reliable, showing Cronbach Alpha scores ranging from .73 to .94 for subscales and total severity (Mason et al., 2008). This measure was given to participants who indicated they were experiencing chronic pain (pain that lasts longer than 12 weeks). Chronic pain participants were presented with 11 sensory words (throbbing, shooting, stabbing, sharp, cramping, gnawing, hot-burning, aching, heavy, tender, and splitting), which they rated on a scale of none-1, mild-2, moderate-3, and severe-4. Scores were added into a *sensory dimension score.* Participants rated 4 affective words (tiring-exhausting, sickening, fearful, and punishing-cruel) on the same scale, which were added into an *affective dimension score.* The *Present Pain Intensity index* (PPI) question asks participants to rate their current pain intensity as no pain-0, mild-1, discomforting-2, distressing-3, horrible-4, or excruciating-5.

The *Approach Avoidance Paradigm* (AAP) stimuli consists of nine graphic representations of varying levels of personal risk with varying levels of personal reward; for example, high-risk, high reward (the threat of pain and monetary reward are both high), high risk, low reward (high threat of pain, low money reward), etc (see Appendix B). Each stimuli was intended to be presented 8 times, for a total of 72 presentations. Due to an error with Qualtrics, only 5 repetitions of the AAP were delivered.

Hasenbring et al.'s *Avoidance-Endurance Questionnaire* was designed to measure a respondent's motivation to escape (avoidance) and approach (endurance) painful stimuli 9see Appendix C). Like the KPI, the AEQ records participant responses on a 7-point likert scale. Item responses are summed for each subscale and no items are reverse scored. The Avoidance of Social Activities and Avoidance of Physical Activities collectively represent a participant's desire to avoid pain, while the Pain Persistence subscale represents a participant's willingness to endure pain. High scores represent high behavior traits for the subscales measured - e.g. high scores on Pain Persistence would indicate that the participants tend to persevere in the presence of pain. All items on the AEQ scales used displayed a Chronbach's A score greater than .81. All items have factor loadings greater than .4 and no items exhibit cross loading (.35 or greater; Hasenbring et al., 2009).

Data Analyses

The Edinburgh Handedness Inventory was used only for exclusion criteria; the scale was not used for statistical comparisons. Therefore it was measured against chronic pain group identity via a Chi-Square analysis to determine whether participant demographics significantly influenced their responses.

Data analysis was conducted with R via RStudio (R Core Team, 2021) and JASP (JASP Team, 2022). Data was exported from Qualtrics to Microsoft Excel for cleaning and organizing. Data are presented as $M \pm SD$.

Hypothesis 1 was designed with replication of a previously conducted and currently unpublished experiment in mind (Harris Bozer et al., 2017). As such, statistical aims were matched to those of the previous experiment. The McGill Pain Questionnaire was administered to the chronic pain group. Results for present pain intensity, sensory and emotional pain were summarized into descriptive data (Table #, Appendix F). Approach and avoidance decisions were coded as approach = 1 and avoid = 2. Approach scores were summed for each participant group (pain and no pain) and compared via t-test. To assess the hypothesis that participants will be more likely to make approach decisions than avoidant decisions when rewards (e.g. money) outweigh the cost (pain), an independent samples t-test was conducted to compare avoidance scores on low and high threat stimuli across groups.

Due to the shortcomings of frequentist hypothesis testing – expressly, that the observed data is used only to estimate the evidence *against* the null hypothesis – Bayesian tests were used to estimate the ratio of support for both the null and research hypotheses, based on the observed data and assuming equal likelihood of the null and research hypotheses. Due to the nature of Bayes analysis, both the null and research hypotheses must be expressly defined. For all Bayes correlations considered within this study, the Null Hypothesis is that there is no relationship between AAP and AEQ scales being tested; the Research Hypothesis is that there is a relationship between AAP and AEQ scales being tested. A Bayesian t-test was computed to assess the ratio of likelihood for the null hypothesis (there is no relation between chronic pain identity and AAP scores) over the research hypothesis, across stimuli threat levels. For simplicity, Bayes Factors will be expressed in the form BF_{01} when the data supports the null hypothesis, and BF_{10} when the data supports the alternative hypothesis (BF_{01} and BF_{10} are reciprocals of each other).

To extend the research, participants also received three of the Approach-Endurance Questionnaire's subscales: Social activities, avoidance of physical activities, and pain persistence. Meaningful correlations between these measures and the AAP would provide evidence of the AAP's usefulness as a measure of pain avoidance. To examine the hypothesis that approach-avoidance stimuli scores will correlate with AEQ scores, participant AAP and AEQ scores were compared via a correlation matrix. Alternative scoring methods for the AAP (see Appendix D) were tested and evaluated against scores from the AEQ. It was presumed that there may be differences in reaction times between pain groups. Multiple factors could prevent accurate measurement of reaction times, especially when the stimuli are delivered electronically on a wide range of devices. In an exploratory effort to compare reaction times to AAP stimuli between chronic pain and pain-free groups within Qualtrics, a segment of JavaScript code designed for that purpose was obtained from the Qualtrics Community forum and added to AAP and AEQ questions (Mills, 2019; see Appendix E).

CHAPTER III

Results

Optional Stopping

Data was investigated using Bayes Optional Stopping when survey responses dramatically slowed. Data was cleaned and tested using a Bayes correlation between AAP and AEQ scores to estimate precision of the data. Analysis yielded a Bayes Factor of $BF_{01} = 15.056$, $r = 0.003$. Data showed a 95% credible interval of -0.1 to 0.107, indicating a near-symmetrical distribution and a reasonably narrow range of precision (See Figure 1 in Appendix F). With this Bayes Factor, we can conclude that these results would be observed in repeated experiments at a rate of 15 to 1; therefore, the survey was halted and data analysis began.

A total of 603 participants took part in the survey. Subsequent cleaning for incomplete responses ($n = 196$) and non-right handedness (left handedness and ambidextrousness, as determined by the Edinburgh Handedness Inventory; $n = 50$) yielded a usable pool of 357 participants, aged 18-74 years (mode = 20-24 years of age). Chi Square analysis was used to evaluate participant demographics to ensure they did not contribute significantly to variation within observed survey responses. Chi Square analyses indicated that participant age, gender identity, sex, and country of origin did not vary significantly with chronic pain status. Participant demographics and Chi Square results are detailed in Table 1 (Appendix F). There were 197 participants with chronic pain, and 160 participants without chronic pain.

McGill Pain Questionnaire

The MPQ was delivered to participants in the chronic pain condition. Responses were organized into the following dimensions: *Sensory dimension* ($M = 27.76$, $SD = 7.20$), *Affective dimension* ($M = 7.78$, $SD = 3.66$), and *Present Pain Intensity index* ($M = 3.228$, $SD = 1.08$).

A Bayesian correlation matrix was used to compare pain intensity to AEQ composite and subscale scores, AAP composite, AAP High Threat level, and AAP Low Threat level scores within the chronic pain condition (these measure composite and subscale scores are detailed in the next section, Approach-Avoidance). *Sensory dimension* pain scores strongly correlated with AEQ composite (r = 0.390, BF_{10} > 100), ASA subscale (r = 0.12, BF_{10} = 100), and moderately with APA subscale (r = 0.21, BF_{10} = 5.92). *Sensory Dimension* pain scores did not correlate with the AAP Composite (r = -0.03, BF_{01} = 10.20), AAP Low Threat (r = -0.04, BF_{01} = 9.98), AAP High Threat (r = -0.02, BF_{01} = 10.66) or the AEQ's PP subscale (r = 0.09, BF_{01} = 5.3).

Affective dimension pain scores showed a strong correlation with AEQ composite scores (r = 0.40, BF_{10} > 100), Avoidance of Social Activities (r = 0.42, BF_{10} > 100), and Avoidance of Physical Activities (r = 0.23, BF_{10} = 15.41).

Present Pain Intensity index scores strongly correlated with AEQ composite scores (r = 0.417, BF10 > 100), APA subscale (r = 0.33, BF_{10} > 100), and ASA subscale (r = 0.40, BF_{10} > 100).

Approach-Avoidance Measures

Reliability estimates for the five repetitions of AAP stimuli displayed Cronbach's α scores ranging from 0.821 to 0.949, with a measure total of 0.924 (see Table 2 in Appendix F). Cronbach α scores in this range indicate a high degree of internal reliability.

To assess Hypothesis 1 (participants will be more likely to make approach decisions than avoidant decisions when rewards outweigh the cost), AAP approach responses were given a value of 1 and avoid responses a value of 2. Participant responses were condensed into three categories: High Reward (wherein stimuli reward levels outweigh the threat; e.g. high-reward/medium-pain, high-reward/low-pain, medium-reward/low-pain), Low Reward 1

(wherein all stimuli in which the reward does not outweigh the threat are summed) and Low Reward 2 (wherein stimuli threat outweigh the rewards; e.g. low-reward/medium-pain, low-reward/high-pain, medium-reward/high-pain). Low Reward 1 was computed to consider all approach decisions that do not fall into the High Reward category; Low Reward 2 was computed to create a low-reward composite score that matched the number of stimuli summed into the High Reward score.

To assess Hypothesis 2 (AAP stimuli scores will correlate with AEQ scores), participant responses to the AAP and AEQ were organized into the following additional dimensions: an AAP Composite score (the sum of all responses to AAP stimuli, where approach responses were given a value of 1 and avoid responses a value of 2), High Threat level (high pain and any combination of high, medium, or low money) and Low Threat level (low pain and any combination of high, medium, or low money). For all Bayes correlations considered within this study, the Null Hypothesis is that there is no relationship between AAP and AEQ scales being tested; the Research Hypothesis is that there is a relationship between AAP and AEQ scales being tested. In keeping with the AEQ's design and practical use, participant were organized into the following dimensions: an AEQ composite score, Avoidance of Social Activities (ASA) subscale, Avoidance of Physical Activities (APA) subscale, and the Pain Persistence (PP) subscale. Reliability for ASA and APA scales as measured by Cronbach α was good (0.861 and 0.860, respectively). Pain Persistence subscale α scores were surprisingly low (0.547), yielding a total reliability of 0.796.

Qualtrics delivered five repetitions of the AAP, resulting in 45 total stimuli presentations, not the intended 72 presentations. Additionally, the JavaScript code added to the survey failed to record participant reaction times. It is not known whether the JavaScript code was responsible

for the reduced number of stimuli presentations.

Approach-Avoidance Paradigm responses formed a positively skewed bimodal distribution, while AEQ responses were normal.

An independent samples t-test was conducted to compare participant AAP composite scores across pain conditions. There was not a significant difference in AAP composite scores between chronic pain ($M = 67.77 \pm 8.41$) and non-chronic pain groups ($M = 66.69 \pm 8.05$), $t(355) = -1.229$, Cohen's d = -0.131, 95% CI [-0.340, 0.078] $p > .05$ (See Table 3 in Appendix F).

Comparisons of AAP Reward Levels

To test Hypothesis 1 (participants will be more likely to make approach decisions than avoidant decisions when rewards outweigh the cost), participant reward level scores were compared by pain group via independent samples t-test. In the High Reward condition there were significant differences in response patterns between the chronic pain and control conditions (chronic pain $M = 17.17 \pm 3.41$; non-chronic pain $M = 16.36 \pm 2.51$), $t(355) = -2.52$, Cohen's d = -0.268, 95% CI [-1.143, -0.180], $p = .012$. These differences were not found in Low Reward 1 (chronic pain $M = 42.619 \pm 5.428$; non-chronic pain $M = 42.63 \pm 5.329$), $t(355) = 0.021$, Cohen's d = 0.002, 95% CI [-1.115, 1.139], $p > .05$; or in the Low Reward 2 conditions (chronic pain $M = 28.46 \pm 3.17$; non-chronic pain $M = 28.49 \pm 2.76$), $t(355) = 0.116$, Cohen's d = 0.012, 95% CI [-0.590, 0.664], $p > .05$.

Bayesian t-tests of High Reward level yielded a BF_{10} score of 2.449; chronic pain 95% CI [16.693, 17.652] non-chronic pain 95% CI [15.964, 16.748]. These findings are nearly two and a half times as likely to be observed if the alternative hypothesis is true, compared to the null hypothesis. Low Reward 1 yielded a BF_{01} score of 8.5; chronic pain 95% CI [41.857, 43.382] non-chronic pain 95% CI [41.799, 43.463] and Low Reward 2 yielded a BF_{01} score of 8.45;

chronic pain 95% CI [28.011, 28.902] non-chronic pain 95% CI [28.063, 28.925]. These results mean that compared to the alternative/experimental hypothesis, the null hypothesis is about 8.5 times more likely to be accurate regarding both the Low Reward 1 and Low Reward 2 stimuli scores. Due to the similarities of Low Reward 1 and Low Reward 2 scores, only the Low Reward 2 responses will be used in the remainder of these analyses.

The direction of these scores indicate that under both frequentist and Bayesian analysis, we find evidence that chronic pain participants are *more likely* than non-chronic pain participants to *avoid* seeking rewards when the rewards outweigh the threat of pain.

Comparisons of AAP Threat Levels

Participant threat level scores were compared by pain group via independent samples t-test. Results were not significant in both the Low Threat (chronic pain $M = 18.12 \pm 3.26$; non-chronic pain $M = 17.65 \pm 2.69$), $t(355) = -1.47$, Cohen's d = -0.156, 95% CI [-0.365, 0.053], $p > .05$; or High Threat conditions (chronic pain $M = 27.07 \pm 3.51$; non-chronic pain $M = 26.69 \pm 3.62$), $t(355) = -1$, Cohen's d = -0.106, 95% CI [-0.315, 0.102], $p > .05$.

Bayes correlations of Low Threat levels yielded a BF_{01} score of 3.025, 95% CI [-0.356, 0.055] and the High Threat level yielded a BF_{01} score 5.26, 95% CI [-0.307, 0.102]. These results mean that the observed data is just over 3 and 5 times more likely to be found if the null hypothesis is true for Low Threat and High Threat levels, respectively (See Table 4 in Appendix F for test descriptives).

Correlations Between the AAP and AEQ

To test the validity of the AAP, correlation analyses were used to compare AAP Composite scores, High Reward, Low Reward 2, High Threat and Low Threat levels against the AEQ and its three subscales. Correlation analyses found no relationship between composite

scores for the AAP and the AEQ (r = -0.03, p > .05), although there was a significant negative correlation between composite AAP scores and the AEQ's PP subscale (r = -0.13, p = 0.014). Pain Persistence scores were negatively correlated with Low Threat levels (r = -0.11, p = 0.044). None of these relationships were supported by Bayes correlation (See Table 5 in Appendix F).

High Reward responses correlated with the AEQ's ASA subscale (r = 0.12, p = 0.024). Bayesian correlation was also significant (r = 0.149, BF_{10} = 3.47), indicating that the data is 3.5 times as likely to be found if there is a relationship between the scales. The APA subscale was positively correlated with the High Threat level (r = 0.118, p = 0.026). Bayesian correlation supported this relationship, indicating that the data is nearly 1.3 times as likely to be observed under the research hypothesis over the null hypothesis (r = -.129, BF_{10} = 1.288).

Alternate Scoring Methods

The default scoring method of the AAP gave approach decisions a value of 1 and avoid decisions a value of 2, regardless of the stimuli. The AAP stimuli vary in cognitive and emotional weight (e.g. high reward, low pain; medium reward, high pain) and three alternate scoring methods were proposed, with each offering a different ranking structure for approach decisions of stimuli items, based on each item's unique combination of reward and pain variables. In all alternate scoring methods, avoid decisions were assigned a value of 0. The alternate scoring methods are detailed in Appendix D.

These alternate scoring methods were tested with both frequentist and Bayesian calculations. Frequentist probability testing is the most wide-spread method used in psychological research and was the method used to validate all of the established measures considered in this research project. Even so, probability testing is fraught with Type I and II errors and garners only indirect evidence for the research hypothesis, two elements that

contribute to psychology's ongoing replication crisis. Bayesian analysis offers the unique ability to evaluate the ratio of support for both the null and experimental/alternate hypotheses and to quantify the strength of support for each, based on the observed evidence. Bayesian hypothesis testing methods have become an attractive option for many psychologists in recent years (Ly et al., 2016; Van de Schoot et al, 2017; Wetzels et al., 2011) and by their nature prevent many of the shortcomings of frequentist methods - specifically, overestimating results and obtaining Type I and Type II errors (Wetzels et al., 2011). Results of alternate scoring methods (presented below) are summarized in Tables 6-8 and Figures 2-3 in Appendix F.

Alternate Scoring Model 1

Frequentist correlation analysis of Alternate Scoring Model 1 indicated a significant negative relationship between the APA subscale and High Threat level, $r = -0.157$, $p = .003$; and the AAP Composite score, $r = -0.127$, $p = 0.017$. The AAP Composite score was also correlated with the PP subscale, $r = 0.11$, $p = 0.047$.

Bayesian correlation analysis of these scores supported a relationship between the AEQ's APA subscale and the High Threat level ($r = -0.17$, $BF_{10} = 11.415$; indicating that the data is more than 11 times as likely to be observed if the research hypothesis is true, over the null hypothesis. The APA subscale also correlated with AAP Composite scores ($r = -0.145$, $BF_{10} = 2.848$, indicating that the data is more than twice as likely to be observed if the research hypothesis is true). Bayes analysis indicated that there is not a meaningful relationship between the composite AAP score and the AEQ's PP subscale, with the observed data being more than five times as likely under the null hypothesis, rather than the research hypothesis; $r = 0.077$, $BF_{01} = 5.301$.

Alternate Scoring Model 2

Using Model 2, a frequentist correlation analysis found significant relationships between the APA subscale and High Threat level, $r = -0.13$, $p = 0.014$. High Rewards negatively correlated with ASA. $r = -0.11$, $p = 0.035$. AAP Composite scores also correlated positively with the PP subscale, $r = 0.12$, $p = 0.024$.

Bayesian correlation analysis supported a relationship between the APA subscale and the High Threat level ($r = -0.142$, $BF_{10} = 2.358$), indicating that the data is more than twice as likely to be observed when the research hypothesis is true, rather than the null hypothesis. The data supported a negative relationship between High Reward and ASA, as indicated if the research hypothesis is true, by a factor of 2 ($r = -0.141$, $BF_{10} = 2.241$). The relationship between the AAP Composite and the PP subscale suggested by the frequentist calculations were refuted by Bayes analysis, which indicated that the observed data were more than three times as likely ($r = 0.091$, $BF_{01} = 3.452$) if the null hypothesis were true.

Alternate Scoring Model 3

Frequentist correlations of Alternate Scoring Model 3 found significant relationships between the ASA subscale and High Reward, $r = -0.121$, $p = 0.022$; Low Threat level, $r = -0.12$, $p = 0.019$; and the AAP Composite score, $r = -0.13$, $p = 0.016$.

Bayesian correlation analysis indicated the data was more likely to be observed under the null hypothesis for the correlations between ASA and Low Threat levels ($r = -0.117$, $BF_{01} = 1.322$); and between the ASA and the AAP Composite scores ($r = -0.036$, $BF_{01} = 12.039$). The data was slightly more likely to be observed under the research hypothesis for correlations between ASA and High Reward scales ($r = -0.148$, $BF_{10} = 2.358$ 3.24). Interestingly, Bayesian correlation analysis modestly suggested the data observed while correlating the High Threat level

and the APA subscale was more likely to be true under the research hypothesis - a finding that was *not* reflected in the frequentist model (r = -0.142, BF_{10} = 2.358).

CHAPTER IV

Discussion

The purpose of this study was to test the validity of the Approach Avoidance Paradigm as a tool for EEG studies to measure a participant's willingness to approach or avoid painful experiences in exchange for a reward. The AAP was compared to the Avoidance-Endurance Questionnaire (Hasenbring et al., 2009), as the latter is already a validated measure of approach-avoidance behavior.

Hypotheses 1 held that participants would make approach decisions when reward levels outweigh threat levels. This hypothesis was refuted by the evidence; chronic pain participants were less likely to approach scenarios in which reward outweighed threat. The High Reward condition in this exploration included items where reward was 1 and 2 intervals above risk. As such, it is unclear whether chronic pain participants avoided rewards of any level, or specifically rewards that were not substantially greater than the presented threats (e.g. high reward, low pain).

Hypothesis 2 held that AAP responses would correlate with responses from the AEQ. This hypothesis is partially supported; there was not a 1-1 correlation between AAP scores and AEQ measures; however the consistency of certain correlations suggests a level of validity in measuring approach-avoidance behaviors. Scores for the AAP's High Pain condition showed meaningful Bayes correlations with the AEQ's Avoidance of Physical Activities subscale in all possible scoring methods. Understanding the full potential of this relationship is hindered by several considerations: while Bayes analysis can offer evidence for both the null and research hypothesis, JASP does not allow Bayes correlations to be split by pain group (a feature that is possible with frequentist correlation analysis). Other statistical packages were explored,

particularly in RStudio, but a solution was not identified. However, Frequentist correlations were repeated without splitting by chronic pain group. While results from these analyses differed slightly from those reported in the results section of this paper, they were not dramatic differences: Significant correlations (as determined by *p* values) remained significant, and non-significant results remained non-significant. The only significant differences found between groups was in approach-based behavior in the high reward condition, as reported previously.

The usefulness of the AAP is potentially limited by the fact that there were not significant variations in responses between chronic pain and non-chronic pain participant groups - a difference evidenced by the AEQ and its subscales. It is worth noting that the unpublished study using the AAP also found no difference in participant responses between chronic pain and non-chronic pain participants (Harris Bozer et al., 2017). Even so, the chronic pain and non-chronic pain conditions were of unequal sizes; 197 and 160, respectively. Unequal sample sizes have been known to compromise statistical power, particularly as it relates to variation from the assumption of equivalence (Rusticus & Lovato, 2014). Another potential confound related to sampling error, the AAP's Low Threat, the AEQ Compositie and ASA and APA subscale scores all failed Levene's test of normality.

Out of 603 participants, 196 (32%) did not complete the survey. This number may have been reduced if the survey was set to force duration (it was set up where participants did not have to complete all measures at one time). The high number of repetitions of the AAP may also have inspired respondent fatigue, even though the number presented was smaller than the number of repetitions intended. One participant who did not complete the study contacted us to advise that our survey was caught in a loop. While the AAP stimuli were randomized within the Qualtrics structure block, the repeat feature presented the stimuli in the same randomized order with each

repetition. True randomization for each repetition could only have been achieved by programming multiple AAP blocks (one block per intended repetition) and setting each block to randomize the stimuli. Due to the large sample size, it is ultimately unlikely that the reduced number of AAP repetitions delivered by Qualtrics significantly impacted the observed means of each participant's AAP scores.

The chronic pain condition could not be officially validated because the Mcgill Pain Questionnaire was not delivered to both groups. However, chronic pain participant results may be directly compared to participant results from other studies using the MPQ. A 2004 study assessing electronic (compared to paper) responses to the MPQ found mean affective scores of 5.7; $SD = 3.5$, $n = 200$ (Cook et al., 2009). Affective scores for the present study with 197 participants were very similar, $M = 7.78$, $SD = 3.66$. Reported PPI was also very similar, $M = 2.9$, $SD = 1.3$; our findings were $M = 3.2$, $SD = 1.1$. Sensory Dimension scores in the 2004 study were lower than those obtained in the current study: $M = 17.4$, $SD = 7.1$ compared to present findings $M = 27.76$, $SD = 7.20$. However, this study's mean was within the 95% CI for the 2004 Sensory Mean, the SD was nearly the same, and a cursory review of MPQ studies indicates broad variations in Sensory Dimension means (Cook et al., 2004; Dudgeon et al., 1993; Dworkin et al., 2009; Harris-Bozer et al., 2017). Overall the means reported in the current study are comparable to those identified in chronic pain samples of approximately equal sizes, offering support for the validity of this study's results.

Given the reliable if varied correlations between the AAP's High Threat and the AEQ's Avoidance of Physical Activities subscales across all scoring methods, and the near-constant correlations between the AAP's High Reward and the AEQ's Avoidance of Social Activities subscale, it is likely that the AAP is detecting a niche form of approach-avoidance judgments.

The varying strength of evidence for the correlations found between the AAP's and AEQ's subscales likely hints at discriminant validity. The varying levels and consistency of correlations is likely due to the fact that the AAP's subscales were scored based on 1) replication of a previous study, 2) face validity, and 3) in direct response to the grammar used to express this study's research hypotheses. As such, the AAP scales as calculated in this study may include items that do not contribute to accurate measurement of approach-avoidance. Bayes analysis offers more conservative estimates of significance; thereby it is less susceptible to Type I and Type II research errors. Future research with the AAP should endeavor to identify the loadings of each AAP stimuli onto the four scales of High Reward, Low Reward, High Threat, and Low Threat with factor analysis. Such an exploration will likely clarify the relevant items contributing to the findings of this study. Alternate scoring methods should also be revisited and likely revised or expanded: The methods explored in this study were biased toward approach decisions and the assignment of 0 to avoid decisions made it difficult to capture meaningful data for those decisions, except in comparison between experiment groups.

Once AAP items are tested for scale loadings and a more robust scoring mechanism is developed, the AAP should be compared with another related pain avoidance measure, possibly Carver and White's (1994) BAS/BIS battery. Future studies should also endeavor to properly validate chronic pain conditions by presenting pain measures (e.g. the MPQ) to both chronic pain and pain free conditions.

Due to the hypothetical nature of the AAP, it may lend well to real-world pain assessment in experimental conditions - specifically, being combined with the cold pressor test (Walsh et al., 1989). In such an application, participants would have a limb submerged in cold water (a procedure known to induce increasing pain the longer the limb is submerged). Varying levels of

monetary reward (e.g. $1, $5, $10) would be balanced against the length of time a limb was to be submerged (e.g. 1 minute, 2 minutes, 3 minutes). Participants may then decide whether to approach (endure) a reward - pain scenario expressed by each AAP stimuli, or to avoid them.

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APPENDIX A

Link to survey (Qualtrics): [placeholder]

Demographic questions

- Age (continuous)
- Biological sex (categorical)
- Gender identity (categorical)
- Current country of residence (nominal)

Edinburgh Handedness Inventory Short Form

"Please indicate your preferences in the use of hands in the following activities or objects (Always right, Usually right, Both equally, Usually left, Always left)":

- Writing
- Throwing
- Toothbrush
- Spoon

Chronic Pain Self-Identification

Are you currently experiencing pain that has lasted for 12 weeks or longer?

- Yes
- No

If yes:

Please name your pain disorder, if you can (or write N/A if you do not know the name of your pain disorder).

[text entry]

McGill Pain Questionnaire Short Form

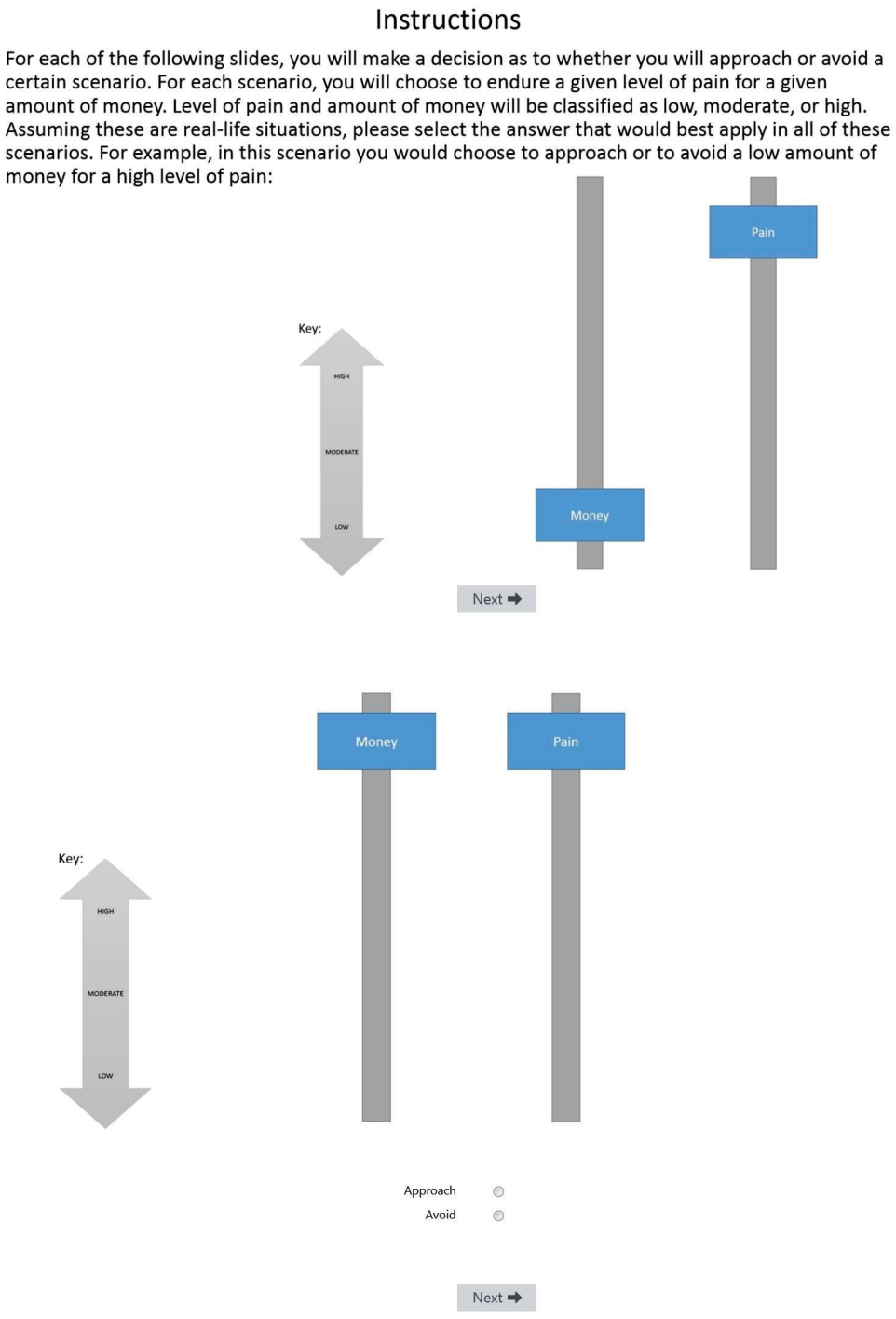
	NONE	MILD	MODERATE	SEVERE
THROBBING	0) _____	1) _____	2) _____	3) _____
SHOOTING	0) _____	1) _____	2) _____	3) _____
STABBING	0) _____	1) _____	2) _____	3) _____
SHARP	0) _____	1) _____	2) _____	3) _____
CRAMPING	0) _____	1) _____	2) _____	3) _____
GNAWING	0) _____	1) _____	2) _____	3) _____
HOT-BURNING	0) _____	1) _____	2) _____	3) _____
ACHING	0) _____	1) _____	2) _____	3) _____
HEAVY	0) _____	1) _____	2) _____	3) _____
TENDER	0) _____	1) _____	2) _____	3) _____
SPLITTING	0) _____	1) _____	2) _____	3) _____
TIRING-EXHAUSTING	0) _____	1) _____	2) _____	3) _____
SICKENING	0) _____	1) _____	2) _____	3) _____
FEARFUL	0) _____	1) _____	2) _____	3) _____
PUNISHING-CRUEL	0) _____	1) _____	2) _____	3) _____

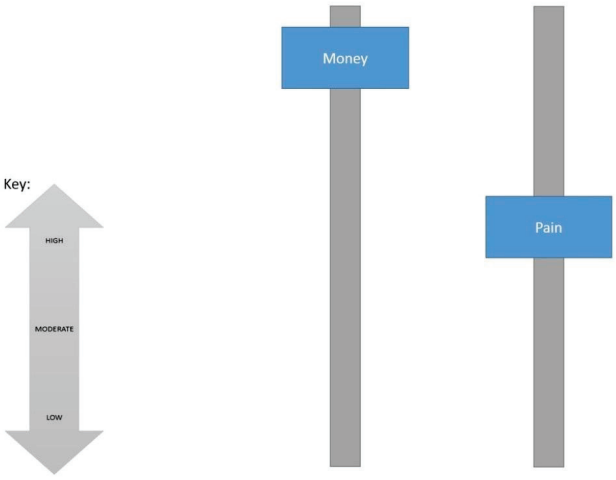
P P I

0	NO PAIN	_____
1	MILD	_____
2	DISCOMFORTING	_____
3	DISTRESSING	_____
4	HORRIBLE	_____
5	EXCRUCIATING	_____

APPENDIX B

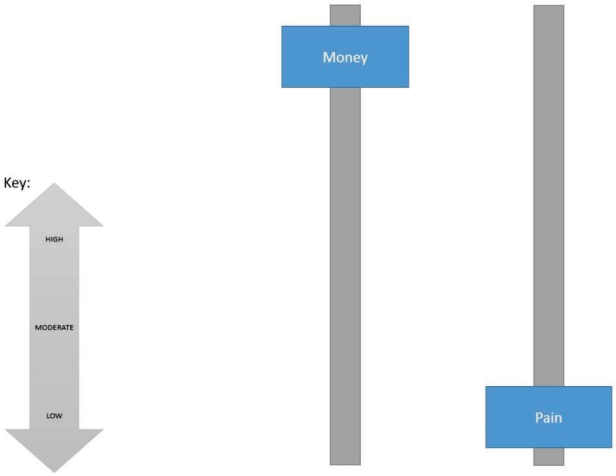
Approach-Avoidance Paradigm graphical stimuli





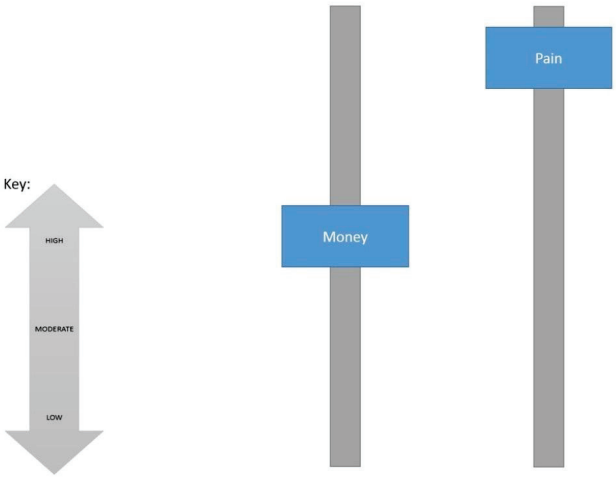
Approach
Avoid

Next ➡



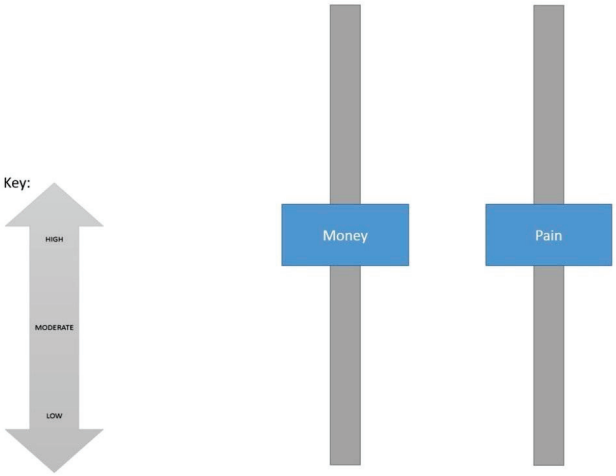
Approach
Avoid

Next ➡



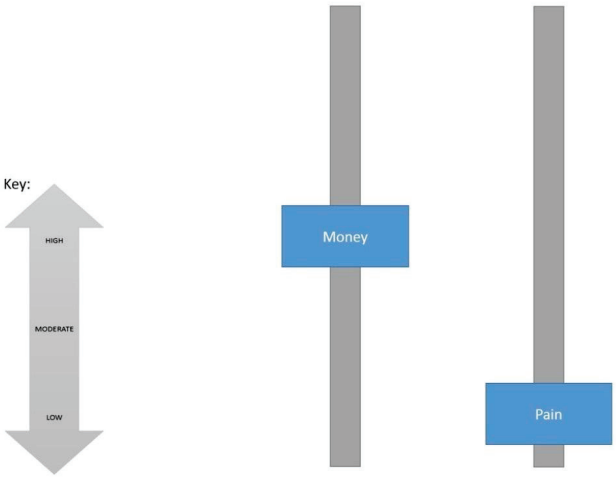
Approach
Avoid

Next ➡



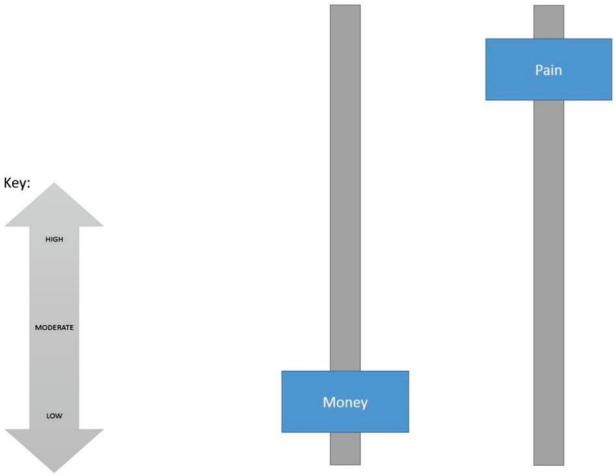
Approach
Avoid

Next ➡



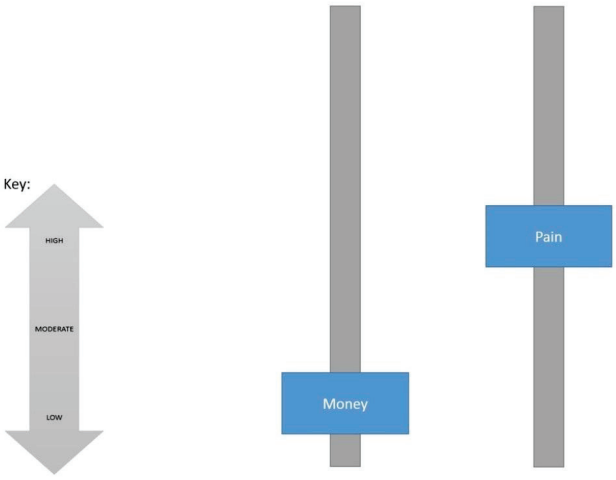
Approach
Avoid

Next ➡



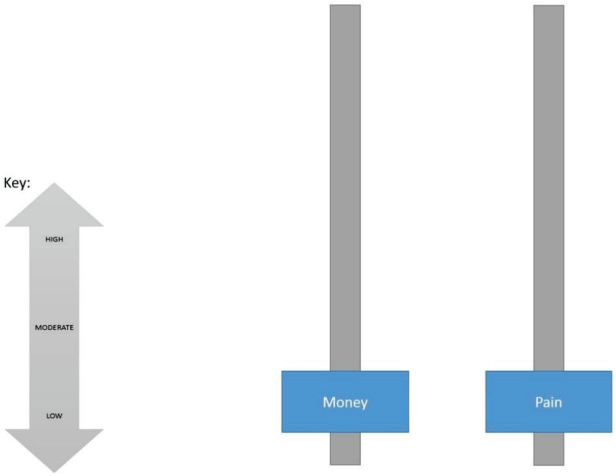
Approach
Avoid

Next ➡



Approach
Avoid

Next ➡



Approach
Avoid

Next ➡

APPENDIX C

Hasenbring et. al.'s Avoidance-Endurance Questionnaire

Participants asked to indicate how frequently they experience these thoughts or actions on a 7-point likert scale.

Avoidance of Social Activities subscale

I avoid visiting my friends.

I cancel private appointments.

I cancel a visit to an event.

I break off meeting with friends.

I call guests to cancel invitations.

I avoid other people's company.

Avoidance of Physical Activities subscale

I stop physically demanding activities.

I take a rest.

I avoid physical strenuous activities.

I avoid doing sports.

I hand over strenuous activities.

I laugh heartily anyway.

Pain Persistence subscale

I take care not to let myself go.

I try not to take any notice of it.

I clench my teeth.

I say ‘‘Don’t make such a fuss!”.

I keep my appointments, even if I don’t feel up to it.

I tell myself: ‘‘I don’t have time for this right now!”

I carry on doing what I am doing, no matter what.

APPENDIX D:

Alternate scoring methods of the Approach-Avoidance Paradigm

Table D1: Scoring Model 1

Pain scale	Reward scale 1	0	-1
1	HR / HP 2	MR / HP 1	LR / HP 0
0	HR / MP 1	MR / MP 0	LR / MP -1
-1	HR / LP 0	MR / LP -1	LR / LP -2

Both categories -1 to +1

Method 1

Table D2: Scoring Model 2

Pain scale	Reward scale 3	2	1
3	HR / HP 6	MR / HP 5	LR / HP 4
2	HR / MP 5	MR / MP 4	LR / MP 3
1	HR / LP 4	MR / LP 3	LR / LP 2

Both categories +1 to +3 scale

Method 2

Table D3: Scoring Model 3

Pain scale		Reward scale		
		3	2	1
	-3	HR / HP 0	MR / HP -1	LR / HP -2
	-2	HR / MP 1	MR / MP 0	LR / MP -1
	-1	HR / LP 2	MR / LP 1	LR / LP 0

Positive reward, negative pain scale

Method 3

APPENDIX E

Qualtrics Javascript

The following Javascript will be added to each AAP and AEQ question to capture reaction times:

```
Qualtrics.SurveyEngine.addOnload(function()
{
var starttime = new Date().getTime();
$('NextButton').hide();


this.questionclick = function(event,element){
    if (element.type == 'radio') {
            var endtime = new Date().getTime();
            var RT = (endtime - starttime)/1000;
            var EmData = Qualtrics.SurveyEngine.getEmbeddedData('reactiontime');
            var Holder = [];
        if (EmData == null){
            Holder += "RT1:";
            Holder += RT;
            Qualtrics.SurveyEngine.setEmbeddedData('reactiontime', Holder);
        }
        if (EmData != null){
            Holder += EmData;
            Holder +=  ", ";
            Holder += "RT1:";
            Holder += RT;
```

```
            Qualtrics.SurveyEngine.setEmbeddedData('reactiontime', Holder);
        }
            $('NextButton').click();
        }
    }
});
```

APPENDIX F

Figures and Tables

Figure 1

Prior and Posterior for AEQ correlation with AAP

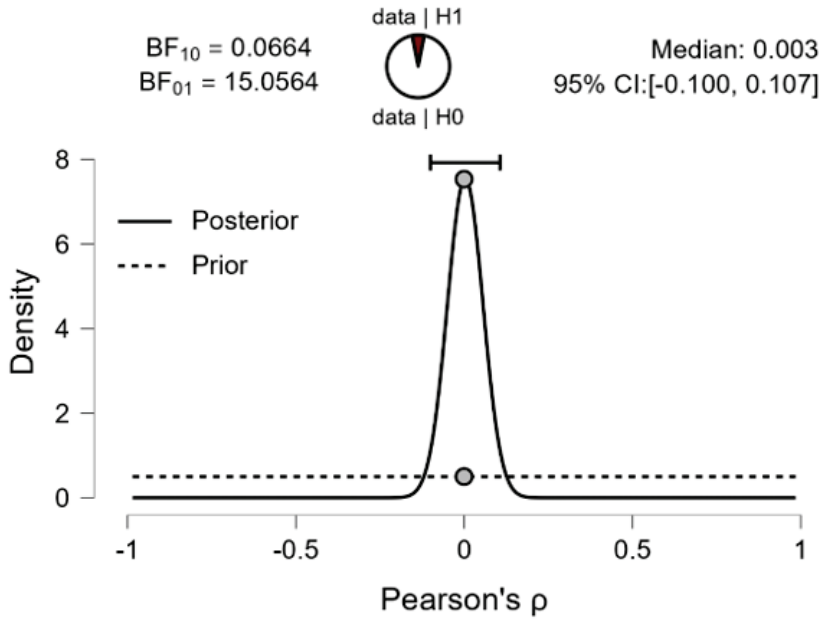


TABLE 1

Participant Demographics & Chi Square Comparisons Split by Chronic Pain Status

Variable	Sample (n = 357)		Chronic Pain (n = 197, 55.18%)			No Chronic Pain (n = 160, 44.82%)				
	n	%	n	% of Vaccinated	% of Sample	n	% of Unvaccinated	% of Sample	$\chi 2$	*p*
Age									**13.544**	**.259**
18-19 years	49	13.73%	32	16.24%	8.96%	17	10.63%	4.76%		
20-24 years	126	35.29%	68	34.52%	19.05%	58	36.25%	16.25%		
25-29 years	50	14.01%	28	14.21%	7.84%	22	13.75%	6.16%		
30-34 years	36	10.08%	14	7.11%	3.92%	22	13.75%	6.16%		
35-39 years	21	5.88%	10	5.08%	2.80%	11	6.88%	3.08%		
40-44 years	35	9.80%	19	9.64%	5.32%	16	10.00%	4.48%		
45-49 years	8	2.24%	5	2.54%	1.40%	3	1.88%	0.84%		
50-54 years	11	3.08%	6	3.05%	1.68%	5	3.13%	1.40%		
55-59 years	11	3.08%	9	4.57%	2.52%	2	1.25%	0.56%		
60-34 years	6	1.68%	3	1.52%	0.84%	3	1.88%	0.84%		
65-69 years	3	0.84%	3	1.52%	0.84%	0	0.00%	0.00%		
70-74 years	1	0.28%	0	0.00%	0.00%	1	0.63%	0.28%		
Gender									**6.094**	**.413**
Male	76	21.29%	33	16.75%	9.24%	32	20.00%	8.96%		
Female	289	80.95%	158	80.20%	44.26%	125	78.13%	35.01%		
Demigirl	1	0.28%	0	0.00%	0.00%	1	0.63%	0.28%		
Gender Fluid	1	0.28%	1	0.51%	0.28%	0	0.00%	0.00%		
Gender Non-Comforming	1	0.28%	0	0.00%	0.00%	1	0.63%	0.28%		
Non-Binary	4	1.12%	3	1.52%	0.84%	1	0.63%	0.28%		
Transgender	2	0.56%	2	1.02%	0.56%	0	0.00%	0.00%		
Country									**39.384**	**.206**
United States	356	99.72%	197	100.00%	55.18%	159	99.38%	44.54%		
Ghana	1	0.28%	0	0.00%	0.00%	1	0.63%	0.28%		

Table 2

AAP Reliability Statistics

AAP Stimuli	Cronbach's α	Lower 95%	Upper 95%
Total	0.924	0.914	0.935
High Reward / High Pain	0.949	0.941	0.957
High Reward / Medium Pain	0.914	0.901	0.928
High Reward / Low Pain	0.864	0.841	0.885
Medium Reward / High Pain	0.915	0.901	0.929
Medium Reward / Medium Pain	0.937	0.926	0.947
Medium Reward / Low Pain	0.821	0.791	0.849
Low Reward / High Pain	0.840	0.813	0.867
Low Reward / Medium Pain	0.905	0.889	0.919
Low Reward / Low Pain	0.902	0.886	0.918

Table 3

Group Differences by Threat Level (Bayes)

						95% Credible Interval	
	Group	N	Mean	SD	SE	Lower	Upper
Low Threat	Non-Pain	160	17.650	2.692	0.213	17.230	18.070
	Chronic Pain	197	18.122	3.262	0.232	17.664	18.580
High Threat	Non-Pain	160	26.688	3.617	0.286	26.123	27.252
	Chronic Pain	197	27.066	3.507	0.250	26.573	27.559
AAP Composite	Non-Pain	160	66.688	8.046	0.636	65.431	67.944
	Chronic Pain	197	67.766	8.411	0.599	66.585	68.948

Table 4

Frequentist Correlations of Study Measures Across Dimensions

Variable		High Reward	Low Reward	Low Threat	High Threat	AAP Comp	ASA	APA	PP	AEQ Comp
1. High Reward	Pearson's r	—								
	p-value	—								
2. Low Reward	Pearson's r	-0.033	—							
	p-value	0.535	—							
3. Low Threat	Pearson's r	0.673 ***	0.014	—						
	p-value	< .001	0.798	—						
4. High Threat	Pearson's r	0.186 ***	0.749 ***	0.108 *	—					
	p-value	< .001	< .001	0.042	—					
5. AAP Comp	Pearson's r	0.605 ***	0.590 ***	0.618 ***	0.775 ***	—				
	p-value	< .001	< .001	< .001	< .001	—				
6. ASA	Pearson's r	0.120 *	-0.063	0.076	-0.031	0.019	—			
	p-value	0.024	0.235	0.150	0.557	0.726	—			
7. APA	Pearson's r	-0.011	-0.021	-0.008	0.118 *	0.029	0.322 ***	—		
	p-value	0.831	0.698	0.874	0.026	0.588	< .001	—		
8. PP	Pearson's r	-0.084	-0.053	-0.107 *	-0.071	-0.130 *	-0.077	0.064	—	
	p-value	0.112	0.317	0.044	0.184	0.014	0.149	0.226	—	
9. AEQ Comp	Pearson's r	0.025	-0.070	-0.008	0.017	-0.030	0.709 ***	0.758 ***	0.424 ***	—
	p-value	0.638	0.188	0.886	0.755	0.574	< .001	< .001	< .001	—

Note. Conditioned on variables: Chronic Pain.
* p < .05, ** p < .01, *** p < .001

Table 5

Bayesian Correlations of Study Measures Across Dimensions

Variable		Low Threat	High Threat	AAP Comp	ASA	APA	PP	AEQ Comp
1. Low Threat	Pearson's r	—						
	BF_{10}	—						
2. High Threat	Pearson's r	0.112	—					
	BF_{10}	0.607	—					
3. AAP Composite	Pearson's r	0.620	0.776	—				
	BF_{10}	1.058e+36	2.250e+69	—				
4. ASA	Pearson's r	0.094	-0.016	0.035	—			
	BF_{10}	0.314	0.070	0.082	—			
5. APA	Pearson's r	0.022	0.129	0.051	0.385	—		
	BF_{10}	0.072	1.288	0.106	1.364e+11	—		
6. PP	Pearson's r	-0.077	-0.051	-0.103	0.009	0.174	—	
	BF_{10}	0.191	0.104	0.442	0.067	14.881	—	
7. AEQ Composite	Pearson's r	0.029	0.039	0.003	0.727	0.797	0.500	—
	BF_{10}	0.077	0.087	0.066	2.424e+56	1.827e+76	7.821e+20	—

Table 6

Alternate Scoring Model 1 Correlations Between AAP and AEQ Scales

Variable		High Reward	Low Reward	High Threat	Low Threat	AAP Composite
	BF_{10}	5.536e+25	1.929e+23	6.244e+139	1.943e+9	—
ASA	Pearson's r	0.010	0.036	-0.012	0.088	-0.018
	BF_{10}	0.068	0.084	0.068	0.263	0.070
APA	Pearson's r	0.013	-0.014	-0.170	0.036	-0.145
	BF_{10}	0.068	0.069	11.415	0.084	2.848
PP	Pearson's r	0.052	0.011	0.060	0.091	0.077
	BF_{10}	0.106	0.068	0.125	0.292	0.189
AEQ Composite	Pearson's r	0.033	0.016	-0.072	0.102	-0.055
	BF_{10}	0.081	0.069	0.165	0.418	0.112

Table 7

Alternate Scoring Model 2 Correlations Between AAP and AEQ Scales

Variable		High Reward	Low Reward	High Threat	Low Threat	AAP Composite
	BF_{10}	4.360e+37	7.906e+33	5.867e+100	1.665e+18	—
ASA	Pearson's r	-0.141	0.060	0.009	-0.117	-0.036
	BF_{10}	2.241	0.126	0.067	0.756	0.083
APA	Pearson's r	-0.036	0.013	-0.142	-0.032	-0.077
	BF_{10}	0.084	0.068	2.358	0.080	0.187
PP	Pearson's r	0.043	0.042	0.054	0.056	0.091
	BF_{10}	0.092	0.091	0.110	0.115	0.290
AEQ Composite	Pearson's r	-0.075	0.055	-0.048	-0.055	-0.022
	BF_{10}	0.179	0.114	0.100	0.114	0.072

Table 8

Alternate Scoring Model 3 Correlations Between AAP and AEQ Scales

Variable		High Reward	Low Reward	High Threat	Low Threat	AAP Composite
	BF_{10}	2.047e+68	5.114e+58	3.688e+52	2.149e+73	—
ASA	Pearson's r	-0.148	-0.071	-0.073	-0.145	-0.147
	BF_{10}	3.240	0.163	0.171	2.826	3.062
APA	Pearson's r	-0.043	-0.021	6.988e-4	-0.050	-0.043
	BF_{10}	0.092	0.072	0.066	0.103	0.092
PP	Pearson's r	0.026	-0.047	-0.015	-0.005	-0.013
	BF_{10}	0.075	0.099	0.069	0.067	0.068
AEQ Composite	Pearson's r	-0.089	-0.067	-0.044	-0.104	-0.104
	BF_{10}	0.272	0.147	0.093	0.451	0.454

Figure 2

Correlations of High Threat and APA subscale across scoring methods

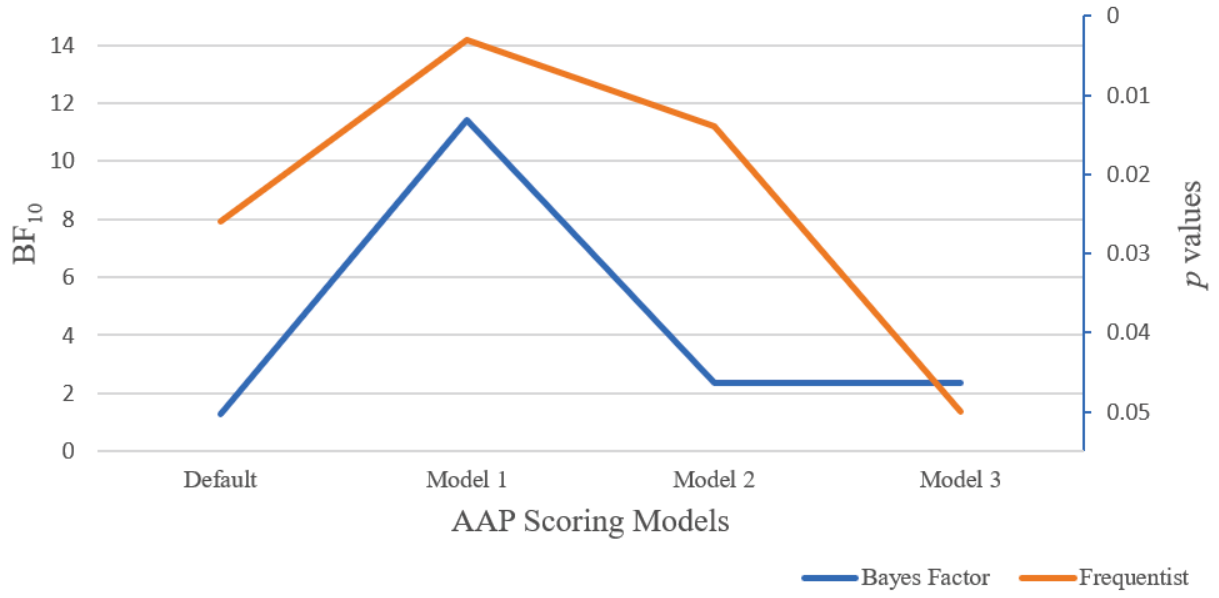


Figure 3

Correlations of High Reward and ASA subscale