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The Multifaceted Interaction of Pain Perception in Collegiate Athletes

by

Kristen Leigh Bartiss

A Plan B Research Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

MASTER OF SCIENCE

in

Health, Physical Education, and Recreation

Approved:

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Logan, Utah

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Participation in intercollegiate athletics exposes individuals to physically demanding tasks, often resulting in injury and the subsequent perception of pain. Pain is described as a multidimensional experience, defined by unpleasant sensory and emotional experiences associated with actual or potential tissue damage (Addison, Kremer, & Bell, 1998; Garland, 2012) and characterized by patterns of nerve impulses generated by a widely distributed neural network (Melzack, 2001). Importantly, the subjective experience of pain has been linked to multiple social, behavioral, and psychological factors (Mayhew, Hylands-White, Porcaro, Derbyshire, & Bagshaw, 2013; Ogino, Nemoto, Inui, Saito, Kakigi, & et al., 2007; Puentedura & Louw, 2012). In addition to concrete tissue damage encountered from injury, the perception of pain can also be influenced by various psychological, social, cultural, and neurological factors (Linton & Shaw, 2001; Melzack, 2001; & Puentedura & Louw, 2011). Consequently, extensive literature has been devoted to understanding pain tolerance and threshold, coping strategies, and the neurological processing pathways (Addison, Kremer, & Bell, 1998; Raudenbush, Canter, Corley, Grayhem, Koon, & et al., 2012; Ryan & Kovacic, 1966; & Sharma, Sandhu, & Shenoy, 2011). Despite these efforts, a sense of confusion remains regarding the individual differences that may contribute to the multidimensional experience of pain. In particular, factors such as the desire to fulfill an athletic role, the presence of interconnected pathways within the brain, and evidence of previous injuries could meaningfully link to one's perception of pain. Examining the relationships among these variables is imperative to further our understanding of the factors that influence how pain activates the brain. Such understanding would allow researchers to establish the salience of individualistic perceptions, tolerances, and response levels to pain in collegiate athletes.

Deepening the present understanding of the multidimensional nature of athlete perceptions of pain requires attention to three specific gaps. First, the field currently lacks fundamental knowledge regarding the relationship between an individual's athletic identity and the role of the brain in deciphering and responding to painful stimuli. Because athletes view injury as a potential loss of identity and thus a significant part of themselves (International Olympic Committee, n.d.), the severity they ascribe to pain is both conceptually and practically relevant. Second, the field has yet to fully explore the specific areas of the brain associated with subsequent functional connectivity as it relates to pain perception. Due to the increased activation of the brain's neuromatrix during painful experiences (Peltz, Seifert, DeCol, Dorfler, Schwab, & et al., 2011), it is critical to highlight the specific areas and connections within the brain that are activated during painful events. Such activation patterns are referred to in the literature as functional connectivity. Third, the field has yet to document the potential impact of an individual's past injury experiences on their perceptions of pain, thereby influencing future injury experiences. Because injury is commonplace in elite athletics (Sharma et al., 2011), it is important to examine how athletes subjectively perceive and react to the pain that accompanies an objective physical injury event.

To address these gaps, focusing on the total impact of injury among athletic individuals is beneficial. Intercollegiate athletes participating in contact sports are exposed to a host of physical stressors that predispose them to injury (Raudenbush, Canter, Corley, Grayhem, Kool & et. al., 2012). At this level of competition, athletes have gained enough experience and been provided with sufficient opportunity to actively acknowledge and cope with injury and the resultant pain that follows. Indeed, contact sport student-athletes, when compared to age-matched non-contact sport student-athletes, have demonstrated increased pain tolerances and thresholds, as well as willingness to continue participating despite the presence of pain and affliction (Raudenbush, Canter, Corley, Grayhem, Kool & et. al., 2012). Anecdotally, athletes are also known for possessing a strong mental psyche, potentially enabling them to diminish the impact of unpleasant stimuli (Sharma, Sandhu, & Shenoy, 2010). Examining the effects of collegiate athletes' athletic identity, mapping of brain pathways, and previous history of injury on painful physiological stimuli could be a fruitful step toward achieving a more integrated understanding of individual differences in perceptions of pain.

Informed by the extant sport and medical literatures, as well as the aforementioned theories of pain, the purpose of the present research was to investigate the individual and interactive effects of athletic identity, functional connectivity, and history of previous injury on intercollegiate athletes' perceptions of pain. Athletic identity has been defined as, the way athletes perceive their sporting role, and is informed by goals, values, thoughts, and sensations related to sport participation (International Olympic Committee, n.d.). In the present study, we operationalize athletic identity according to five classifications offered by Anderson (2004) (a) physical appearance, (b) athletic competence, (c) commitment to importance of exercise, sport, and physical activity, (d) environmental surroundings, and (e) amount of social support received for athletic participation. For a majority of athletes, athletic identity involves a full-body commitment exacerbated by social, cognitive, psychological, emotional, and behavioral factors (Anderson; Martin et al., 1997; Weinberg et al., 2013). Functional connectivity has been defined as the spatiotemporal correlations that exist between spatially dependent regions of the brain. Specifically, functional connectivity offers researchers a tool to understand brain activity under a certain condition and within a specific period of time (Peltier & Shah, 2011, p. 267). This allows the pathways and connections that have been created through previous experiences such as memories, images, and emotions to be seen objectively. Previous injury was defined as sustaining an athletic-related injury during one's high school and/or collegiate athletic career. Types, frequencies, locations, and severities were recorded for each individual injury that was sustained.

The present research was designed to examine the pain perceptions of individual athletes that have a distinct athletic identity, established functional connectivity patterns, and a history of previous injury. It was hypothesized that athletes involved in contact sports would have a higher pain tolerance and lower perception of pain than those involved in non-contact sports, with male contact athletes having the highest pain tolerances and lowest pain perceptions (see Figure 1).

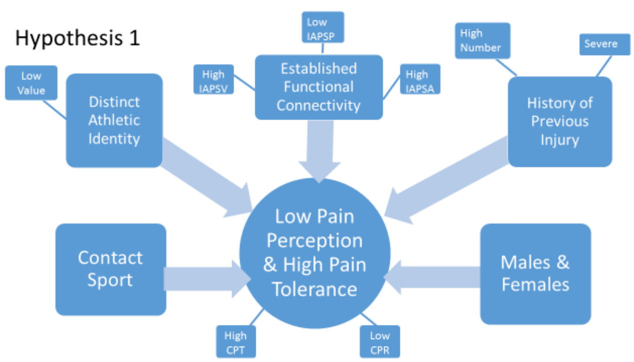

Figure 1. Hypothesis that athletes participating in contact sports will have a higher pain tolerance and lower perception of pain than those involved in non-contact sports.

It was also hypothesized that injury would lead to a decreased and more positive perception of pain in contact sport student-athletes than it would in an age-matched sample of non-contact sport student-athletes (see Figure 2).

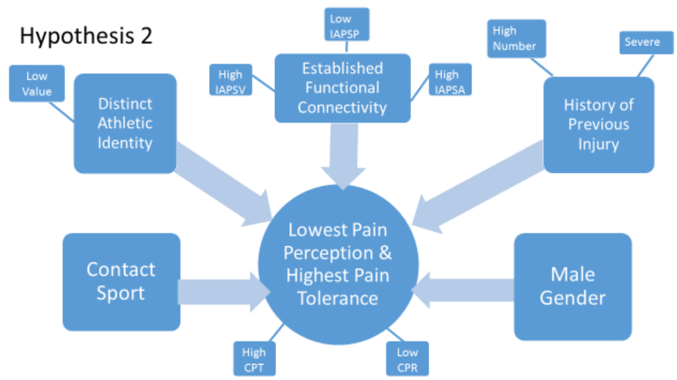

Figure 2. Hypothesis that male contact student-athletes will possess the lowest pain perception and highest pain tolerance.

METHODS

Participants

Participants were 84 NCAA Division I student-athletes, aged 18 to 24 years (M = 20.20, SD = 1.56) from a large university in the western United States who were selected for this study. Participants were comprised of male (n = 40) and female (n = 44) student-athletes participating in four contact sports: women's soccer (n = 14), women's basketball (n = 4), men's basketball (n = 4), and men's football (n = 20); and seven non-contact sports: women's tennis (n = 4), women's volleyball (n = 4), women's softball (n = 4), women's gymnastics (n = 2), women's track and field (n = 12), men's tennis (n = 4), and men's track and field (n = 12). Differentiation among contact and non-contact sports was conducted in accordance with the 2000 NATA Recommendations and Guidelines for Appropriate Medical Coverage of Intercollegiate Athletics. Forty-nine participants identified as first string (starters), 26 as second-string (substitutes), and nine as practice players. Forty-two participants reported being on a full athletic scholarship, 29 on a partial scholarship, and 13 on no scholarship.

Procedures

Participants were recruited for the study by email and word of mouth. Contact information was obtained via ATS software, which provides demographics for each student-athlete at the university. All participants provided informed consent prior to participating in the study. All measurements were conducted by the first author. Participants were then instructed to sit at a vacant desk in the university athletic training room, open the internet browser and click a series of two links leading to the separate survey instruments. Prior to completing each instrument, participants read the directions found at the top of the monitor and were offered an opportunity to ask questions of the researcher prior to survey completion. Participants were allotted 5 minutes to complete the first instrument and 15 minutes to complete the second instrument. Subsequent to completion of the first two instruments, participants were administered a third paper-and-pencil survey. Completion of the paper-and-pencil instrument took approximately 15 minutes.

Subsequent to survey completion, a desk chair was placed parallel to an athletic treatment table, with an armrest arranged at a comfortable height. Each participant was asked to sit in the chair and rest his/her arm comfortably while placing his/her dominant hand and forearm into a cold tub of water. Participants were instructed to keep their hands in the tub until they could no longer tolerate the resultant pain from the temperature of the water. If no such pain was experienced, the trial was terminated after three minutes of immersion. Participants alternated between a cold immersion and a warm immersion intended to re-warm the hand and forearm to a normal body temperature. Completion of this protocol took approximately 15 minutes. Full completion of the study lasted approximately 50 minutes.

Measures

Athletic Identity. The multidimensional AIMS questionnaire (see Appendix A) was used to assess participants' athletic identity. The instrument consisted of 10 statements based on four components of athletic identity: (a) self-identity, (b) social identity, (c) exclusivity, and (d) negative affectivity. Participants were asked to rate the extent to which they agree or disagree with each of the 10 listed statements. A 7-point scale ranked from 1 (strongly disagree) to 7 (strongly agree), with a median score of 4 (I don't know) was used to assess the extent to which participants agreed or disagreed with the statement.

Previous Injury. The study-designed previous injury questionnaire (see Appendix B) was utilized to assess the number, type, location, and severity of participants' past injuries. The instrument was also designed to track demographics, treatment and coping strategies experienced during injury, as well as the level of various emotional states felt after sustaining an injury. Differentiations among acute and chronic injury and high school and collegiate sustained injuries were also made. The measure consisted of 11 fill-in-the-blank, 10 yes/no, and 14 scaled (1-10) questions.

Pain Perception. A series of fifteen images retrieved from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) and Google search engine were utilized to assess athlete pain perceptions (see Appendices C and D). Images ranged from surgical procedures to athletic injuries sustained on a variety of playing fields. The images were then rated based on the level of pleasure and arousal experienced by viewing the image. Ratings for each image were measured using the self-assessment manikin (SAM; Lang, 1980) tool. This 9-point rating scale utilizes five graphical figures that range from smiling and happy to frowning and unhappy faces. Participants were provided specific instructions to feel and rate their own pain as if they were in the situation displayed in the image. Participants are asked to view the same 15 images for a duration of 10 seconds per image, and a 10-point numerical rating scale is utilized for participant ratings. A 5 second period of time between each image viewing is utilized to allow participants to briefly clear their eyes and minds of the previous image. In addition to these hypothetical ratings, the cold pressor test was administered to elicit more tangible ratings of participants' pain perceptions.

Participants are asked to immerse their dominant arm in cold water (37.4 degrees Fahrenheit, 3 degrees Celsius) for up to three minutes while constantly rating their level of pain using a 0-10 numerical rating scale, with 0 representing no pain and 10 the worst pain they have ever felt (see Appendix E). Ratings are reviewed at the culmination of the three trials, and averages on pain ratings and immersion time are recorded for each individual.

Statistical Analysis

Descriptive statistics were calculated for each participant in accordance with the recommendations of Tabachnick and Fidell (2007). SPSS version 21 was utilized to assess the relationships between athletic identity, previous injury, and functional connectivity on individual pain perception. Independent sample t-tests were implemented to assess responses from the AIMS questionnaire. Tests that compare males vs. females and contact vs. non-contact sports were assessed. A two-way ANOVA was also utilized to assess results from the AIMS questionnaire. The differences between gender and contact level of the sport were identified. Descriptive statistics were used to compare results from the previous injury questionnaire. Differentiations between males and females as well as contact and non-contact sports in their injury histories and perceptions of pain were also assessed.

RESULTS

Descriptive Statistics

Means and standard deviations for all student-athlete participants' previous injury reports appear in Table 1. Overall, 81 participants reported sustaining at least one athletic injury prior to or during their collegiate athletic career (*M* = 1.85, *SD* = 1.81). Of these participants, 79 sustained one or more acute injuries (*M* = 1.19, SD = 1.04) and 78 sustained one or more chronic injuries (*M* = .64, *SD* = .897). The most common injury locations were to the ankle, (n = 55), knee (n = 41), and shoulder (n = 38). The type of injuries sustained prior to college participation consisted of mostly sprains (n = 31), tears (n = 22), and fractures (n = 21), while those sustained during college were sprains (n = 27), strains (n =23), and inflammation (n = 18). Overall, the amount of pain sustained as a result of injury did not seem to affect athletes' physical, mental, or emotional states in regards to participation in their respective sports. On a scale of 1-7, the amount of pain resulting from injury had relatively little impact on athletes' physical (*M* = 4.11, *SD* = 1.88) or mental (*M* = 3.54, *SD* = 2.23) readiness to return to participation in sports. Similar results were found when assessing athletes' willingness to continue sport participation despite the presence of pain (*M* = 3.33, *SD* = 2.31) and despite the presence of injury (*M* = 3.29, *SD* = 2.31).

To address the effects of previous injury on pain perception, various physical, mental, and emotional variables were examined. Bivariate correlations, means, and standard deviations for all study variables are displayed via a correlational matrix in Table 1. Coefficients in the reliability diagonal are consistently the highest in the matrix. Results highlighted a definite relationship between possessing a history of previous injury and one's subsequent response to pain and various other variables. Statistically significant correlations were seen between the amount of pain felt after an injury and athletes' confidence $r = .49$ and physical readiness to return to play $r = .33$ at $p < .01$, as well as mental readiness to return to play $r = .25$ at $p < .05$. This shows that as the amount of pain experienced due to injury increased, athletes' confidence and physical and mental readiness to participate increased as well. Significant correlations were also seen with willingness to return to play despite the presence of pain and athletes' confidence $r = .18$, physical readiness $r = .33$, mental readiness $r = .35$, and motivation $r = .64$ at $p < .01$. This shows that one's athletic identity, as predicted by willingness and motivation to return to play despite being in pain, overrides the effects of the pain on individuals' decisions to participate in sport. Correlations between athletes' ability to block pain and motivation $r = .53$, willingness to return to play despite presence of pain $r = .52$, willingness to return to play despite presence of injury $r = .56$, ability to participate in sport $r = .48$, and ability to cope with future pain and injury $r = .44$ were also statistically significant. This suggests that athletes' ability to block out the effects of pain has a positive effect on motivation and deters restrictions on current and future sport participation.

Table 1

Previous Injury Correlation Matrix.

	Confidence	Phys Read	Ment Read	Motivate	Pressure	RTP	Disappnt.	Depress	Relief	Hopeless	Axiety	Phys Pain	Happiness	RTP Pain	RTP Inj.	Able Play	ADL	Cope Fut.	Bloc Pain
Confidence																			
Physical Ready	.63**																		
Mental Ready	.66**	.62**																	
Motivation	.51**	.50**	.43**																
Pressure	.41**	.39**	.44**	.53**															
Willing to RTP	.44**	.47**	.51**	.68**	.58**														
Disappointment	.48**	.42**	.28	.33**	.37**	.25*													
Depression	.23*	.18	.15	.17	.14	.17	.58**												
Relief	.04	.05	.16	.11	.24*	.29*	.05	.12											
Hopelessness	.13	.28*	.16	.17	.23*	.18	.50**	.70**	.28*										
Anxiety	.11	.29*	.24*	.14	.29*	.23*	.37**	.42**	.20	.48**									
Physical Pain	.49**	.33**	.25*	.27**	.32**	.16	.51**	.34**	.09	.31**	.40**								
Happiness	.28*	.34**	.30**	.18	.15	-.29*	.19	.24*	.18	.14	.06	.08							
RTP w/ Pain	.18**	.33**	.35**	.64**	.51**	.68**	.17	.06	.12	.09	-.03	.12	.06						
RTP w/ Injury	.31**	.38**	.36**	.58**	.47**	.70**	.22	.04	.20	.15	.11	.09	.08	.84**					
Ability to Play	.35**	.43**	.43**	.39**	.47**	.57**	.30**	.26*	.15	.20	.29**	.22	.40**	.25*	.32**				
Cope w/ Injury	.48**	.47**	.48**	.54**	.50**	.70**	.20	.17	.13	.11	.14	.17	.31**	.55**	.55**	.56**			
Affect ADLs	.45**	.43**	.47**	.42**	.37**	.47**	.31**	.15	.01	.06	.07	.34**	.41**	.43**	.19**	.50**	.50**		
Cope in Future	.49**	.50**	.51**	.49**	.44**	.62**	.24*	.12	.12	.12	.26	.15	.34**	.47**	.54**	.44**	.69**	.52**	

Block Pain	.40**	.45**	.43**	.53**	.49**	.60**	.30**	.16	.14	.14	-.19	.18	.34**	.52**	-.56**	.48**	.61**	.44**	.71**

Primary Analyses

Primary analyses were conducted in accordance with stated hypotheses. Collectively, results provide evidence for relationships between athletic identity, functional connectivity, and history of previous injury on athlete pain perception. Specific findings demonstrate the presence of a statistically significant interaction between gender and type of sport when predicting pain perception F (3, 78) = 3.43, p <.05; Wilks' λ = .78. A significant main effect was seen with type of sport and pain perception F (3, 78) = 2.80, p <.05; Wilks' λ = .90 (see Figure 3).

Figure 3. Results demonstrating a statistically significant relationship among sport type and sport and gender with pain perception and pain tolerance.

Overall, individuals participating in non-contact sports were seen to possess a higher pain tolerance and lower pain perception than those in contact sports. Individuals in both contact and non-contact sports who possessed a history of injuries in their collegiate athletic careers showed a lower pain perception than those who were injury-free. Interestingly, when total athletic identity scores from all participants were averaged, results showed that non-contact sport athletes possessed a slightly higher athletic identity than those in contact sports (*M* = 2.79, *SD* = 0.73; *M* = 2.76, *SD* = 0.80). Male athletes (*M* = 2.78, *SD* = 0.80) were seen to possess a slightly higher athletic identity than females (*M* = 2.27, *SD* = 0.73).

A MANOVA was used to address the relationship between type of sport, gender and athletic identity, addressing the subsequent effect on pain perception. The concept of athletic identity resulted in no statistically significant main effects or interactions. When compared to type of sport, there were no significant differences between athletic identity with contact and non-contact sport athletes and their perceptions of pain F (1,78) = .004, p = .95. Independent samples *t*-tests t (82) = -.17, p = .58 showed no statistically significant differences between contact athletes (*M* = 2.76, *SD* = .80) and non-contact athletes (*M* = 2.79, *SD* = .73). Between-subjects effects also showed no statistically significant relationship between gender and athletic identity on pain perception F(1,78) = .04, p = .85. Independent samples t-tests were also insignificant t (82) = .14, p = .71 for athletic identity among males (*M* = 2.78, *SD* = .80) and females (*M* = 2.78, *SD* = .73). Between-subjects effects of the interaction between type of sport and gender were also insignificant F (1,78) = .03, p = .87.

Relationships between athletic identity and history of previous injury were also examined. Results demonstrate that non-contact sport athletes who sustained the highest number of total injuries in their collegiate careers (n = 82, *SD* = 1.62), played nearly as many games (n = 58, *SD* = 0.49) when compared to athletes in contact sports who sustained less injuries (n = 75, *SD* = 2.20) and only participated in one more game (n = 59, *SD* = 0.58). The same non-contact sport athletes also possessed very similar athletic identity values (*M*= 5.57, *SD* = .01) when compared to contact sport athletes (*M* = 5.52, *SD* = 0.01). This was also true for female athletes, who sustained more injuries (n = 79, *SD* = 1.93) yet missed fewer athletic competitions (n = 56, *SD* = 0.54) than their male counterparts who sustained less injuries (n = 74, *SD* = 1.98) and sat our more games (n = 59, *SD* = 0.51) However, males in this case possessed a slightly higher athletic identity (*M* = 5.55, *SD* = 0.01) than females (*M* = 5.54, *SD* = 0.03).

A follow-up multivariate analysis of variance (MANOVA) showed a statistically significant relationship between sport and gender, indicating men participated more in contact sports and women participated more in non-contact sports. Additionally, there was a significant gender effect for number of games missed due to injury F (1, 78) = 5.70, p <.05. There was no statistically significant relationship between previous injury and type of sport F (1, 78) = .01, p = .93) or gender F (1, 78) = 1.53, p = .22).

Results showed no statistically significant relationships for gender and previous injury F (3,53) = .95, p = .45, type of sport and previous injury F (3,53) = .98, p = .80, nor the combination of gender and type of sport and previous injury F (3,53) = .91, p = .18. Examination of between-subject effects demonstrated some statistically significant relationships in regards to the number of acute, chronic, and total injuries sustained by contact and non-contact athletes. The combination of gender and playing status had an effect on the total number of collegiate injuries F (1,76) = 4.29, p <.05). Playing status and type of sport had an effect on total number of acute injuries F (1,55) = 3.78, p <.05. An overall effect was seen with total number of collegiate injuries F (1,76), = 13.87, p < .01.

Differences between gender, type of sport, and number of injuries sustained were also evident. A significant difference was seen between type of sport and number of collegiate injuries sustained in all athletes. Female contact sport athletes reported a total of 29 injuries, resulting in a total of 26 missed athletic competitions, while female non-contact athletes sustained 56 total injuries and missed 32 competitions. Male contact athletes sustained 47 total injuries in their collegiate careers with 33 missed competitions, whereas male non-contact athletes sustained only 27 injuries and refrained from participating in 26 competitions. Between subjects effects were seen with following variables: total number of college injuries, number of acute injuries, number of chronic injuries, and the combination of gender and playing status with total number of injury.

Analysis of Wilks' Lambda demonstrated no statistically significant interactions between gender and type of sport F (20,25) = .66, p = .85. There were also no significant effects for gender F (20,25) = .55, p = .46, or type of sport F (20,25) = .54, p = .43.

Specific interactions were noted among the variables found within the pain correlation matrix. Among them, playing status was correlated with relief F (2,44) = 3.19, p < .05, happiness F (2,44) = 3.41, p < .05, and willingness to participate in sport-specific activity F (2,44) = 3.56, p < .05. Type of sport was correlated with pain F (1,44) = 4.11, p < .05, scholarship status with relief F (1,44) = 3.58, p < .05, the combination of playing status and scholarship status with pain F (3,44) = 3.21, p < .05, and the combination of gender and scholarship status with motivation F (2,44) = 3.14, p < .05.

A MANOVA was used to address the relationship between sport type and gender and its subsequent effect on pain perception. Results showed that there was a statistically significant difference in pain perception depending on whether the sport the athlete participated in was considered to be contact or non-contact, F (3, 78) = 2.80, p <.05; Wilks' λ = .90. Non-contact athletes demonstrated a lower pain perception than contact athletes, thereby contradicting my initial hypothesis. An additional multivariate relationship was seen with the combination of both sport type and gender on athlete pain perception, F (3, 78) = 3.43, p <.05; Wilks' λ = .88. Female non-contact athletes were found to have the lowest pain perception. Between-subjects effects showed a statistically significant effect of sport type on the amount of time spent in the cold-water immersion during the cold pressor test, F (1, 80) = 8.21, $p < .01$. Non-contact athletes collectively spent a greater amount of time in the cold water immersion (M = 162.1 sec, SD = 30.3) than contact athletes (*M* = 134.7 sec, *SD* = 52.9). Females (*M* = 154.7 sec, *SD* = 34.5) maintained their hands in the cold water for longer periods of time than their male counterparts (*M* = 141.5 sec, *SD* = 53.9).

A similar effect was also seen with gender and sport type on time spent in cold water immersion, F (1, 80) = 4.91, $p < .05$. When analyzed simultaneously, female non-contact athletes spent the longest amount of time immersed in the cold water (*M* = 316.8 sec, *SD* = 64.8), when compared to male contact athletes (*M* = 276.2 sec, *SD* = 106.8), therefore refuting my hypothesis.

Neither the cold pressor pain rating F (1, 78) = 1.90, $p = .17$, nor the IAPS pain rating F (1, 78) = .03, $p = .85$ were seen to be statistically significant for type of sport in this study. The same was true for the cold pressor pain rating F (1, 78) = .02, $p = .89$, and IAPS rating F (1, 78) = 2.05, $p = .16$ for gender, and finally for the cold pressor rating F (1, 78) = .02, $p = .88$, and IAPS rating F (1, 78) = 2.55, $p = .12$, and the combination of gender and sport. Although not statistically significant, males were seen to rate higher on the cold pressure pain scale (*M* = 54.3, *SD* = 23.5) than females (*M* = 53.7, *SD* = 23.4). Similarly, contact sport athletes rated higher pain scores (*M* = 57.6, *SD* = 25.5) than non-contact sport athletes (*M* = 50.4, *SD* = 20.5). Also of insignificance, results from the IAPS pain ratings showed that males (*M* = 7.0, *SD* = .9) scored higher than females (*M* = 6.6, *SD* = 1.2). Both contact (*M* = 6.8, *SD* = 1.2) and non-contact (*M* = 6.8, *SD* = .9) sport athletes reported similar pain ratings after viewing the image slideshow.

Analysis of athletes' functional connectivity required review of the IAPS valence and arousal scores. A MANOVA revealed a statistically significant relationship between the IAPS valence score and the combination of sport and gender F (1, 78) = 6.21, $p < .05$. However, there were no statistically significant relationships between the IAPS valence scores and athlete pain perception for sport F (1, 78) = .77, p = .38 or gender F (1, 78) = 1.53, p = .22. There was also no statistically significant relationships between the IAPS arousal scores and athlete pain perception for sport F (1, 78) = .36, p = .55, gender F (1, 78) = .13, p = .72, or the combination of sport and gender F (1, 78) = .45, p = .50.

When assessed across all variables, independent samples *t*-tests showed no statistically significant relationships for the IAPS valence scores t (82) = -1.09, p = .12, nor for the IAPS arousal scores t (82) = .20, p = .24. Independent *t*-tests also showed no statistical significance for IAPS valence among contact sport athletes (M = 3.05, SD = .88), or non-contact sport athletes (M = 2.91, SD = .12), nor among males (M = 2.87, SD = .15) or females (M = 3.07, SD = .11). IAPS arousal scores were insignificant for contact sports (M = 4.29, SD = .24) and non-contact sports (M = 4.45, SD = .25), as well as for males (M = 4.40, SD = .27) and females (M = 4.33, SD = .23) (see Figure 4).

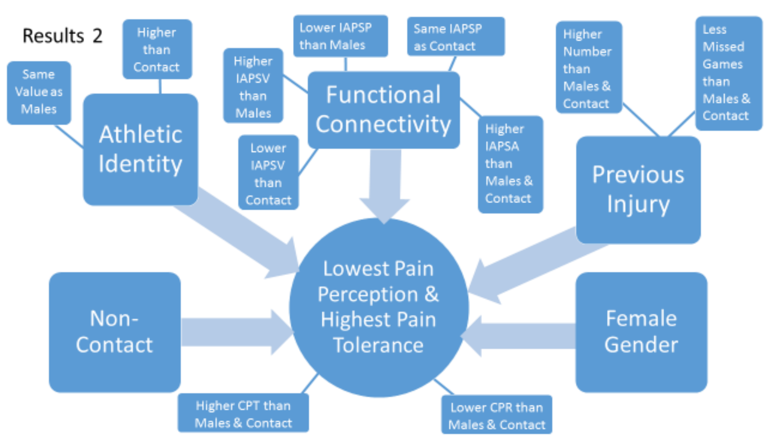

Figure 4. Results demonstrating that female non-contact athletes possess lowest pain perception and highest pain tolerance.

DISCUSSION

The present study investigated the effects of athletic identity, functional connectivity, and history of previous injury on pain perception in male and female contact and non-contact collegiate student-athletes. In response to the wide spectrum of factors that contribute to athlete pain perceptions, numerous theories have offered to explain this complex, subjective topic. Among those cited most frequently are the biopsychosocial model, gate control theory, and the neuromatrix theory.

According to the biopsychosocial model, the components of anatomy, biomechanics, tissue pathology, pain mechanics, the neuromatrix, evolutionary biology, and psychosocial issues all contribute to one’s perception of pain (Garland, 2012; Ogino et al., 2007; Puentedura & Louw, 2012). This model refers to pain as multidimensional, and highlights the potential impact that human biology, the human psyche, and social stigmas from the environment have on an individual’s response to and acceptance of pain.

Gate control theory (Melzack & Wall, 1965), uses the metaphor of a gate swinging open and closed to describe the way in which the nervous system controls the flow of noxious stimuli through the spinal cord and brain. The gate, representative of the pathway to the brain, remains closed when presented with normal somatosensory signals through the process of neural inhibition. Specifically, when pain receptors in the body’s periphery detect an electrical signal from a stimulus, the signal travels up the spinal cord to the brain, where it is deciphered and (a) accepted as noxious, thus resulting in the experience of pain, or (b) deemed non-threatening and blocked of all sensation (Addison, Kremer, & Bell, 1998; BMJ, 1978; Garland, 2012).

The Neuromatrix theory, an extension of the previously-established gate control theory, is contingent on a network of neurons that generates patterns, processes information, and ultimately establishes a whole-body processing a sense of self (Melzack, 2001). This network is comprised of intricate connections among various areas of the brain that intertwine to form a specific pattern, termed a neurosignature. The neurosignature results from several inputs, including previous experiences, values, emotions, social factors, behaviors, and sensory influences. It is these aforementioned patterns that become activated when the brain detects and processes painful stimuli. Although noxious stimuli are the only definitive source of painful input, the brain is still able to process other non-threatening inputs as seemingly painful.

In an attempt to understand the brain's pain processing methods, the concept of apperception has been studied. Apperception can be described as, a mental process of understanding and contextualizing new information relative to previous experiences (Straub, Martin, Williams, & Ramsey, 2003). More specifically, the concepts of pain tolerance and threshold, as well as their role in individualized pain perceptions, have been investigated. Pain tolerance can be interpreted as an individual's ability and willingness to cope with a painful stimulus, whereas threshold is the utmost limit that one can endure (Ryan & Kovacic, 1966). Ryan and Kovack (1966) found that when prompted with physically painful stimuli, athletes were seen to have increased pain tolerances and thresholds than their non-athlete counterparts. Specifically, athletes participating in contact sports were better able to cope with pain than those involved in non-contact sports. Males also had higher pain tolerances and lower thresholds than female athletes (Addison et al., 1998; Straub, Martin, Williams, & Ramsey, 2003; Weinberg, Vernau, & Horn, 2013).

Contrary to previous research, the results from my study refute these claims, demonstrating that female non-contact athletes possess higher pain tolerances and thresholds. This contradicts popular belief that society portrays males as dominant and tough athletes, while females are seen to be inferior and weak. The fact that contact sports generally result in greater risk of injury and severity due to the nature of the sport can play a role in why previous research has shown higher pain perceptions for contact athletes. On the same token, non-contact sports tend to suffer from more chronic, over-use type injuries that they are forced to deal with for extended periods of time. Due to the constant presence of such injuries and subsequent pain and ailments on a regular basis, non-contact athletes may in fact have higher pain tolerances in certain situations. These results provide a stepping-stone for changes in the public eye regarding gender and sport stereotypes.

Also of importance to the perception of pain is the concept of athletic identity. Consistent with my hypothesis that athletes possessing higher athletic identity values will have a greater pain tolerance and lower pain perception, similar findings were seen in previous research. Roderick and Waddington (2000) highlighted the concept of athletic identity and its involvement in individual pain perception and injury acceptance. Results indicated that soccer players who possessed high athletic identities played through pain and injury for fear of losing their roles on the team, to act more masculine and tough, and so that they would be able to participate in important games. Thomas and Rintala (1989) showed that athletes with high athletic identities were more willing to participate in athletics despite the presence of pain because they feared being alienated from their team and/or losing their sense of self as a particular type of athlete

(Weinberg et al., 2013). Young (1997) furthered this knowledge through his investigation of gender differences in athletic identity and pain perception, and found that males and females possessed nearly the same responses to injury, were willing to participate equally despite pain, and were quick to downgrade others for succumbing to similar injuries. Results from my study provide additional support to previous research, as seen with the similar and elevated level of athletic identity with both male and female contact athletes. This may be due to the overall nature of Division I student-athletes to associate themselves primarily athletes, or attributed to the overzealous amount of time and effort they place into their respected sports.

Although possessing a strong athletic identity may prove to be beneficial for sport performance, it is not viewed as an essential variable. It has been suggested that injured athletes who possess a high athletic identity are more likely to engage in an aggressive and excessive amount of rehabilitation, and return to participation more quickly and prematurely than those who don't clearly define themselves by their athletic roles (Podlog, Gao, Kamen, Kleinert, Granquist, & et al., 2013). They also found that athletes with increased athletic identities were affected more negatively and imposed more pressure on themselves more so than those who viewed themselves as more well-rounded. In interpreting the present findings, there is support for previous research on athletes' speedy return to play. Of all of the sports utilized in the present work, the only individual athletic teams were those non-contact in nature (tennis and track and field). It is plausible that since individual sports rely heavily on each athlete for high performance and success, the pressure and stigma associated with it could cause the athletes to return to play quicker. These teams also tend to have smaller rosters, therefore decreasing the number of alternative substitutes and increasing the pressure for injured athletes to play.

Additionally, males in general tend to possess a more macho and relentless personality, and may fear being denoted as weak or replaced by a fellow teammate.

When labeling oneself as an athlete, individuals often feel the need to participate in athletics at all costs, and that failing to do so might result in a loss of social identity and sense of self (Martin et al., 1997; Weinberg et al.). This brings to point the concept of athletic toughness that is evident throughout many contact sports. The inherent social stigma associated with failing to play due to injury often causes athletes to push through injury and ignore pain so as to continue participation, despite the possible severity of injury (Addison et al., 1998; Ogino et al., 2007). With that being said, athletes who have sustained injuries high in severity and number may have an altered interpretation and sense of pain than those who have not. Possessing a strong athletic identity causes one to label himself as an athlete first, and any other variable second. Therefore, it is deemed unacceptable for the athlete to be "out of commission" and refraining from sport participation. This is especially true for individual sport teams, whom rely solely on themselves for athletic performance. It is at this point that the athlete's passion for the sport, role on the team, and significance of their athletic identity come into a collective focus.

Although the influence of athletic identity on pain perception has been heavily studied, specific information regarding the intricacies of pain processing remains unknown. In attempts to illuminate the mechanisms of pain processing in the human brain, research has focused on functional connectivity and brain activation areas. Due to the high cost of fMRI machines, alternative methods for measuring functional connectivity patterns need to be established. Neurologists, behaviorists, and psychologists worldwide have utilized the International Affective Picture System (IAPS) in order to study individual emotional reactions and attentional focuses to a variety of stimuli. Through the use of over 1,000 photographs depicting a plethora of events and objects relating to everyday human existence, researchers have begun to unveil clues as to how humans emotionally respond to different stimuli (Bradley & Lang, 2007; Ogino et al., 2007; Wied & Verbaten, 2001).

One of the main purposes behind this study was to identify the presence of functional connectivity among male and female contact and non-contact student-athletes. Despite the lack of statistically significant findings in the present study, previous research has in fact revealed evidence of neurosignatures in the brain. Extant research offers evidence of brain activity in the frontal and midbrain (Martini et al., 2009; Ogino et al., 2007). A study by Oertel, Preibisch, Martin, Walker, Gamer, and colleagues (2012) incorporated the concept of pain threshold in the study of noxious stimuli, activation of the pain matrix, and pain perception in healthy individuals. Results indicated that stimuli ranked above one’s threshold propagated painful responses and activated brain regions located in the pain matrix. Specifically, the posterior insula was seen to have a direct relationship to the perception of pain.

Ohara and colleagues (2006), identified correlations between individual attentional focus and increased functional connectivity when subjected to painful stimuli. Increased synchrony between the primary somatosensory and medial frontal cortex was evident both pre and post stimulus, thus supporting the presence of cortical pain networks within the brain. Strong activation patterns within the pain neuromatrix were detected in the thalamus, primary and secondary somatosensory cortexes, anterior cingulate cortex, parietal cortex, insula, and forebrain (Garland, 2012; Peltz, Seifert, DeCol, Dorfler, Schwab, & et. al, 2011; Puentedura & Louw, 2012). According to Ogino and colleagues (2007), similar activation patterns were noted when participants were instructed to imagine oneself experiencing a painful stimulus. The lack of monetary funding and equipment availability prevented the use of fMRI for the purpose of this study, thereby eliminating the ability to generate claims for the presence of functional connectivity patterns within the brain.

Results of studies that have implemented the IAPS measurement tool highlight a strong correlation between SAM ratings and semantic differential scales, bolstering the reliability and validity of the IAPS in measuring pleasure and arousal levels. Inferences from pleasure and arousal statistics can also be made regarding an individual's response to pain. Success in measuring neural activity has also been noted, with increased activity in the amygdala, and fusiform, occipital, and parietal cortexes. Similar brain regions, in particular, the cortexes, have been stimulated when presented with a painful and threatening stimulus (Bradley & Lang; Garland; Ogino et al., 2007).

Although pain perception has not yet been specifically measured via the IAPS, researchers claim that new images can be added in order to study a specific emotion (Bradley & Lang, 2007). In line with this affordance, images depicting painful events and sports injuries can be added to the IAPS collection in order to assess pain perception in a more suitable athletic environment. If the newly added images were to accurately represent individuals' pain perceptions, viewing them might rekindle memories and emotions of previous experiences. These results would then support the common belief that previous emotions and memories may decrease one's sensitivity to pain.

Results from the present study showed no statistically significant relationships between the IAPS pain ratings and pain perception. In light of this, athlete pain perception doesn't appear to be affected by functional connectivity, as portrayed through viewing of painful images. However, this doesn't mean that functional connectivity lacks a role in the perception of pain. Instead, it could be the fact that the specific IAPS images or the IAPS system itself isn't a viable determinant of pain perception under these circumstances. Direct observation of athletes' reactions when utilizing the IAPS illustrated the fact that viewing the painful images elicited a painful response, thereby supporting the presence of functional connectivity within the brain. Although the ratings scales implemented in my study lacked the capability to portray brain activation, it is clear that the images did in fact create a painful reaction to the stimuli. It is also highly likely that such responses activated the various pre-established neurosignatures located in athletes' brains, thereby linking current viewing of painful images to past painful injuries, memories, and experiences.

Proper assessment of pain perception requires examination of both quantitative and qualitative data. This was achieved through analysis of the IAPS and cold pressor ratings. The cold pressor test has been used in scientific research for many years to assess pain tolerances and thresholds among a wide variety of subjects. This current study assessed the length of time that an athlete kept his/her hand immersed in cold water, as well as the level of pain sustained when doing so. Athletes that remained immersed for longer periods of time tended to report decreased feelings of pain and vice versa. Athletes with greater immersion times and lower pain ratings were said to have higher pain tolerances and lower pain perception than those who pulled their hands out quickly and portrayed more painful reactions.

A plausible explanation for the aforementioned claim is that the longer the athlete is able to immerse his/her hand in cold water immersions, the more likely he/she is to experience a numbing sensation in the hand. This occurs because nerve fibers and pain receptors in the hand are desensitized, therefore unable to detect pain as intensely or frequently. A sense of mental toughness also comes into play, because the athlete will experience pain until the numbness kicks in. Possessing the ability to "wait out" this painful time period signifies a higher pain tolerance and subsequent lower pain perception.

Results from the present study contradicted the initial hypothesis that contact sport student-athletes and male student-athletes would have a higher pain tolerance and lower pain perception than non-contact and female student-athletes. Data suggested that non-contact athletes remained with their hands in the cold water for a longer period of time and reported lower pain ratings than contact athletes. Females remained in the immersion for a longer period of time and also reported lower pain ratings while immersed than male athletes. Possible explanations to the aforementioned results can be attributed to the frequency that athletes engage in cold water immersion, the length of time spent in such immersions, the neural and bodily sensitivity unique to each individual, and the physical and mental toughness that they exhibit on a regular basis. Intensity, frequency, and duration of athletic participation also play a powerful role.

With participation in athletics comes exposure to exercise, injury, soreness, and recovery. Therefore, icing and cold tub immersions are very common in both male and female contact and non-contact athletes' daily regimes. With that being said, athletes that readily utilize a cold modality for extended periods of time are better able to cope with the discomfort from exposure to ice. As a result, their bodies experience a compensatory adaptation to nerve sensitization and activation, thereby decreasing nociceptor activation and painful stimuli sent to the brain. This will then decrease the number and frequency of nociceptive signals and result in fewer opportunities to accept and experience pain. In most cases, an individual immerses his entire body in the water, instead of one specific body part. On the same token, the hand itself is comprised of a higher number and sensitivity level of nerve and pain fibers than other parts of the body. As a result, immersing one's hand in the water can be a new experience to an athlete and can result in more frequent and stronger pain reactions.

In addition to the impact of painful experiences on one's perception of pain, so too is the influence of the severity and number of such events. Considering the relative frequency at which athletes sustain injuries, possessing a history of previous injuries may have some effect on perceptions of pain. Indeed, obtaining the ability to block out or minimize pain may be a congenital or acquired trait. Ogino and colleagues (2007) support this claim, stating that individuals have the ability to imagine pain from their past experiences with or without physical injury. Athletes that possess high IAPS ratings represent activation of neurosignatures that remind them of painful memories or experiences that they have encountered throughout their lifetimes. As the number and severity of injuries sustained by athletes increase, so too will the likelihood of them scoring high on the three IAPS variables. This is largely due to the fact that experiencing injury and subsequent healing process places severe physical, mental, and emotional strain on the brain and body. For extended periods of time after injury, athletes have claimed that they still visualize the injury mechanism and can even sense similar mental and bodily symptoms.

Those with a more prominent and frequent history of athletic injuries are taught to deal with the injury process from start to finish. One's initial injury always seems to be the worst, and causes the athlete to enter a state of shock, disbelief, fear, anxiety, and numerous other negative emotions. However, each subsequent one sustained thereafter generally decreases in reaction, and pain doesn't seem to play as big of a factor. This is especially true when athletes sustain a severe injury such as an ACL tear, and are forced to endure the lengthy recovery process before being cleared for sport participation. Once an athlete is exposed to a severe injury, future less severe injuries merely seem like a walk in the park. Greater adherence to physical therapy, more positive emotions regarding recovery time, and greater acceptance of the injury often result as well.

Possessing previous experience with injury also allows for proper injury assessment and ranking. This means that an athlete can differentiate between the type, severity, and duration of pain due to an ACL tear, a minor ankle sprain, and a miniscule laceration. Without prior exposure to injury, athletes will not be able to accurately relate to the painful repercussions associated with injury, which may cause them to either under or over report IAPS values. Examination of results from the present study demonstrated no significant relationships between previous injury and pain perception, thereby refuting my hypothesis. However, there was evidence of a gender effect on the number of games missed, with female non-contact athletes reporting the greatest number of injuries, yet male contact athletes missing the greatest number of competitions. Although there are a lack of evidence-based explanations as to why males sat out the most games, insight as to why females reported such significant injury rates is prevalent in the literature.

Previous research has shown that female athletes are more prone to lower extremity injury, especially involving the knee joint. This has been attributed to the fact that females have a 2-8 time greater tendency to tear their ACL than males, a risk which increase with participation in contact sports (Salci, Aslan, & Celik, 2014). However, most ACL tears are found to be caused by non-contact events and are largely due to biomechanical abnormalities and deficiencies. Among these are hormonal imbalances, intercondylar notch size, joint laxity, landing mechanics, limb alignment, neuromuscular activation patterns, ligament size, muscular strength and imbalances, nutrition, and sport and physical activity training level (Pettineo, Jestes, & Lehr, 2004). In addition to lower extremity incidence, females are also more susceptible to upper extremity shoulder injuries, in particular, multidirectional instability. This has been attributed to an increase in joint hyper-laxity and persistent overuse in overhead activity. Although direct trauma can cause this injury to arise, almost 50% of females with multidirectional instability have no previous history of trauma to the area (Cody & Strickland, 2014). Therefore, with the prevalence of female injuries so high, it is no surprise that they reported greater numbers. What remains unexplained, however, is how and why they were able to better cope with the injuries and pain and continue to participate in sport.

The explanation behind why females were seemingly better apt at coping with the pain associated with injury is beyond the scopes of this study. It may also be deemed unacceptable and unethical to characterize and/or stereotype gender with having a higher pain tolerance or vice versa, due to the lack of solid evidence to back up such claims. With that being said, differences in reactions and adaptations to pain are likely individualized and influenced by a plethora of factors.

Perceptions of pain might also be influenced by an individual's perceived or actual role on the team, their passion for the sport, and/or future plans regarding continued participation of the sport. Such factors may indeed affect the neurosignatures within the brain, thus playing a role in one's functional connectivity makeup. Therefore, due to the lack of evidence regarding the overall concept of pain, there is an indubitable lack of evidence regarding any interrelationships among the numerous factors that play a role in pain perception; the area is ripe for investigation. In order to address existing gaps and heighten our understanding of how intercollegiate athletes perceive pain, research on the effects of one's athletic identity, neural functional connectivity network, and prevalence of previous injury must be conducted.

Limitations

This study utilized a variety of measurement tools to assess athlete pain perception. The IAPS arousal and valence ratings, the AIMS questionnaire, and the cold pressor pain rating are all well-researched and utilized implements. However, the previous injury questionnaire and the IAPS pain ratings were designed specifically for this study, and don't have any statistical validity or reliability. This could have played a role in why results didn't show more significant relationships among the variables. Another limitation to this study is the fact that there were no depictions of individuals experiencing pain themselves. This means that all athletes were exposed to the same generic painful images, and may not have been able to connect with them on a personal level. As various areas of the brain are highlighted when viewing pain to oneself and pain to others, it is hard to differentiate whether the IAPS images utilized in the study adequately allowed for such functional connectivity patterns to occur. It is also possible that the athletes had previously viewed some of the images through the media and other sources, and subsequent exposure to it a second time could have diminished the extent of the painful reaction. Attention also needs to be placed to the fact that some athletes aren't affected or influenced by visual representations of pain, and instead require physical trauma or pain to one's own body in order to elicit a painful response.

Yet another limitation is the possibility of information sharing with other participants in the study. Although instructed not to share the details of the study with other individuals, I have no control over participants' actions, which may have skewed the data. I also have no control over the honesty with which the athletes reported their answers in the questionnaires nor on the reported pain scales. Possessing the need to act tougher or to fit a certain stigma should also be factored into the analysis of results. With that being said, further research should take all of these factors into consideration when re-creating the study. Emphasis should be placed on implementing more reliable and valid measurement tools for accurately recording pain perceptions. Also, additional and unique images should be utilized in the future to minimize the risk of prior exposure. Additional modifications include altering the temperature and/or body part inserted into the cold water, or requiring a specific amount of time spent immersed be met. These changes could possibly have an effect on pain reporting, and may also minimize the tolerance experienced by frequent cold-water immersion users. Lastly, delineating the population to solely those who have sustained an injury may cause alternate results and provide a more appropriate participant pool.

Future Research

It is recommended that additional research continues to explore the relationships between athletic identity, functional connectivity, and previous injury on pain perception in collegiate athletes. Future research on pain perception can further investigate individual pain tolerances and thresholds, as well as identify which sports elicited the greatest and lowest pain values. In terms of athletic identity, studies focusing on rationales behind athletic participation and athletic association could address the current gap in knowledge. In terms of gaining a greater understanding of functional connectivity, additional research utilizing the IAPS protocol in conjunction with fMRI imaging could provide insight into the number and type of neurosignatures present in the brain.

Although out of the scope of this study, it would be interesting to compare individual contact and non-contact sports against one another, and attempt to highlight why specific athletes or teams return to play quicker than others. Focused studies on athletes that have sustained a specific number or type of injury could also provide insight into how a history of injury truly influences one's perception of pain on a physical, mental, and emotional level. Supplemental research can then examine differences among coping strategies between male and female contact and non-contact student-athletes. Replication of the current study with utilization of different forms of painful stimuli, such as finger pricking, heat tolerance, and other physical interventions, may highlight new findings in regards to athlete pain perceptions.

CONCLUSIONS

Results from the present study provide preliminary evidence of some significant interactions among athletic identity, functional connectivity, and previous injury on pain perception in collegiate male and female student-athletes participating in contact and non-contact sports. Sport type, as defined by contact and non-contact sports, as well as the combination of sport type and gender were seen to have significant effects on student-athlete pain perceptions and pain tolerances. Specifically, the amount of time immersed in cold water during the cold pressor test and the valence score for the IAPS image screening demonstrated statistically significant findings. Overall, results showed that female non-contact student-athletes were seen to possess the lowest pain perception and highest pain tolerance when compared to female contact or male contact or non-contact student-athletes.

The information obtained from the present study is applicable to a variety of fields, namely sports psychology, athletic training, physical therapy, and exercise science. Due to the variegated nature of pain itself, understanding the variances and intricacies behind individual pain perception is paramount to proper evaluation and treatment of athletes. Acquiring sufficient recognition of the multitude of factors that encompass pain perception is paramount in differentiating between the significance of and manners with which athletes cope with painful stimuli. With that being said, additional research can extend the breadth of knowledge regarding the unique and complex concept of pain.

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Appendix A

Athletic Identity Measurement Scale

You will be asked to rate a few statements as they relate to your personal self-perceptions about being an athlete and playing your chosen sport. Please rate the extent to which you agree or disagree with each statement below based on how you would currently describe yourself.

	Strongly Agree	Agree	I Don't Know		Disagree		Strongly Disagree
1. I consider myself an athlete.	1	2	3	4	5	6	7
2. I have many goals related to sport.	1	2	3	4	5	6	7
3. Most of my friends are athletes.	1	2	3	4	5	6	7
4. Sport is the most important part of my life.	1	2	3	4	5	6	7
5. I spend more time thinking about sport than anything else.	1	2	3	4	5	6	7
6. I need to participate in sport to feel good about myself.	1	2	3	4	5	6	7
7. Other people see me mainly as an athlete.	1	2	3	4	5	6	7
8. I feel bad about myself when I do poorly in sport.	1	2	3	4	5	6	7
9. Sport is the only important thing in my life.	1	2	3	4	5	6	7

10. I would be very depressed if I were injured and could not compete in sport.

1 2 3 4 5 6 7

Appendix B

Previous Injury Assessment

Age: __________

Sex:___________

Sport (s) Played in College:
____

Perceived Role on Team: Starter Substitute Practice Player Never Play

Scholarship Status: None Partial Full

Injury is defined as: *Trauma to the body that resulted in loss of athletic participation for a minimum of 1 day and/or consultation by a medical professional.*

Please indicate which of the following injuries you have sustained ***prior to*** your collegiate athletic career.

Head Back Arm Hip Knee Hand Elbow

Neck Shoulder Forearm Leg Ankle Foot Other

Type of injury:

Sprain Contusion Tendinitis Tear Dislocation/Subluxation

Strain Inflammation Laceration Fracture Other

Please indicate which of the following injuries you have sustained ***during*** your collegiate athletic career.

Head Back Arm Hip Knee Hand Elbow

Neck Shoulder Forearm Leg Ankle Foot Other

Type of injury:

Sprain Contusion Tendinitis Tear Dislocation/Subluxation

Strain Inflammation Laceration Fracture Other

Date of **last** injury: ______________________

Total # of injuries in collegiate athletic career: ______________

of **Acute** injuries in college career: ______________________

of **Chronic** injuries in college career:______________________

Have you ever been held out of practice for an injury?

Yes No

Have you ever been held out of a game for an injury?

Yes No

Have you ever received surgery for an injury?

Yes No

Do you consider yourself a quick healer?

Yes No

Have you ever felt like you let yourself/team down because of an injury?

Yes No

Please answer the following questions utilizing the scale provided

(**1**= none **3**= minimal **5**= moderate **7**= severe **9**= unbearable)

The severity of the worst injury you have sustained in your collegiate career?

1 2 3 4 5 6 7 8 9

Your confidence level in returning to play?

1 2 3 4 5 6 7 8 9

Your physical readiness to return to play?

1 2 3 4 5 6 7 8 9

Your mental readiness to return to play?

1 2 3 4 5 6 7 8 9

The **overall** emotional disturbance (anger, sadness, fear, etc.) you felt due to that injury?

1 2 3 4 5 6 7 8 9

The presence of depression felt after injury?

1 2 3 4 5 6 7 8 9

The level of anxiety felt after injury?

1 2 3 4 5 6 7 8 9

The level of happiness felt after injury?

1 2 3 4 5 6 7 8 9

The sense of relief felt after injury?

1 2 3 4 5 6 7 8 9

The level of motivation felt to return to play after injury?

1 2 3 4 5 6 7 8 9

Amount of pressure felt by yourself/others to return to play?

1 2 3 4 5 6 7 8 9

Amount of physical pain felt after injury?

1 2 3 4 5 6 7 8 9

Level of disappointment felt after injury?

1 2 3 4 5 6 7 8 9

The sense of hopelessness felt after injury?

1 2 3 4 5 6 7 8 9

Have you ever sustained an injury and not told a coach or medical professional?

Yes No

Have you ever disregarded medical attention/recommendations for an injury?

Yes No

Have you ever received emotional support for your injuries?

Yes No

Have you ever felt pressured to return to play quicker than you felt ready?

Yes No

Have you ever returned to play earlier than recommended?

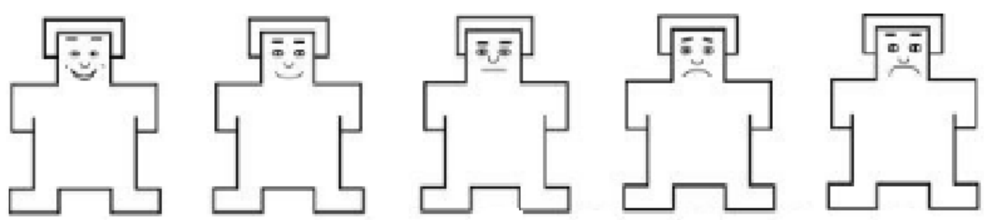
Yes No

Appendix C

IAPS SAM Scales for Valence and Arousal

SAM Scale for Valence

Please indicate the level of pleasantness that you experienced when viewing the previous image.

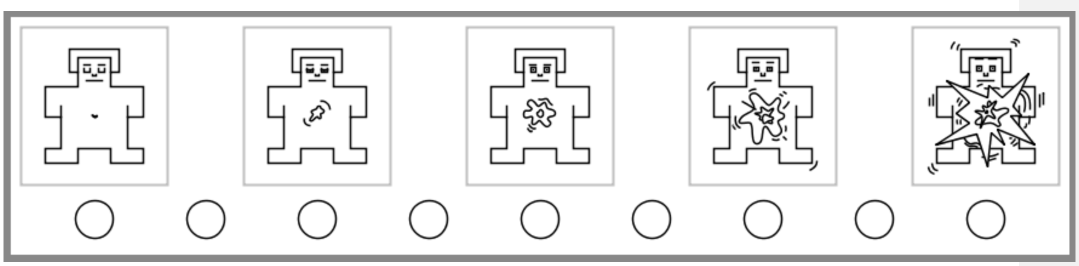


Most pleasant Neutral Unpleasant

9 8 7 6 5 4 3 2 1

SAM Scale for Arousal

Please indicate the level of arousal that you experienced when viewing the previous image.

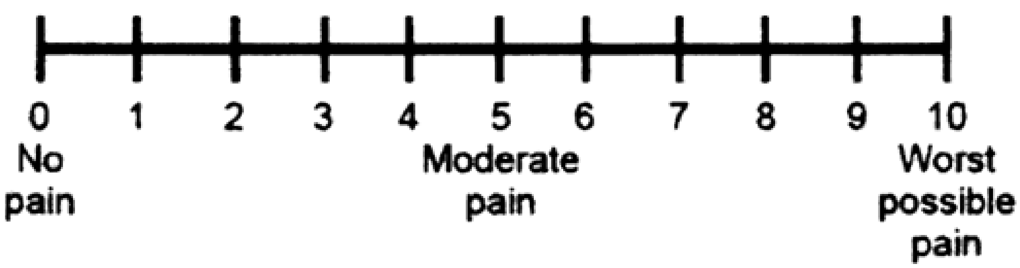


No arousal				Neutral				Maximum arousal
9	8	7	6	5	4	3	2	1

Appendix D

10- Point Numerical Rating Scale for Pain Experienced During IAPS Imaging

Please rate the level of pain that you are currently experiencing after viewing the previous image.



0 = No Pain

1-3 = Mild Pain

4-6 = Moderate Pain

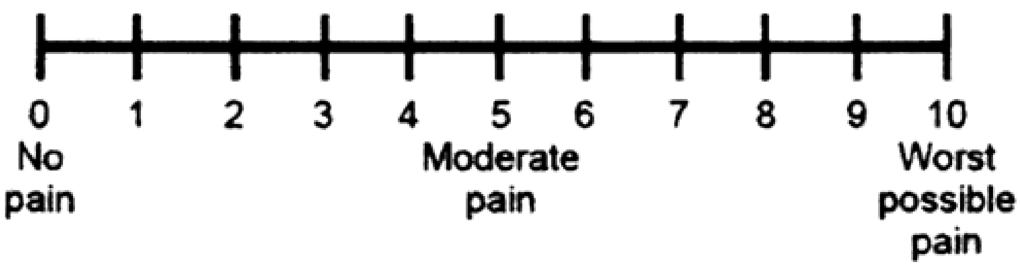
7-9 = Severe Pain

10 = Worst Possible Pain

Appendix E

10- Point Numerical Rating Scale for Pain Experienced During Cold Pressor Test

Please rate the level of pain that you are currently experiencing.



0 = No Pain

1-3 = Mild Pain

4-6 = Moderate Pain

7-9 = Severe Pain

10 = Worst Possible Pain

Appendix F Informed Consent Form

UtahState University
Department of HPER
7000 Old Main Hill
Logan UT 84322-7000
Telephone: (435) 797-1497

INFORMED CONSENT
The Multifaceted Interaction of Pain Perception Among Collegiate Athletes

Introduction/ Purpose: Dr. Richard D. Gordin in the Department of Health, Physical Education, and Recreation at Utah State University is conducting a research study on the effects of athletic identity, functional connectivity, and history of previous injury on pain perception in Division I collegiate athletes. He is interested in identifying how different athletes cope with injury and the subsequent pain and psychological distress that follow. You have been asked to take part in this study because you are a Division I student-athlete at Utah State University. There will be approximately 80 participants in this research, 40 of which are participants in contact sports and 40 in non-contact sports. Completion of this research study will take approximately 45 minutes. Kristen Bartiss, a graduate student in the Department of Health, Physical Education, and Recreation is conducting this research to meet the requirements of her degree.

Procedures: If you agree to be in this research study, you will be asked to complete two online questionnaires, an image screening examination, and a cold pressor test. Instructions as to proper completion of each component of the study will be provided in both written and oral form. After you are informed of the purpose and procedures of the research study you will be asked to read and sign the Informed Consent form. After the consent form has been signed, you will then be asked to begin the first portion of the study. The first questionnaire, referred to as the Athletic Identity Measurement Scale (AIMS), will investigate your degree of association with athletic identity. You will be asked to click on a link that will lead you to an online version of the AIMS on the Utah State University Qualtrics survey generator. Once the survey is loaded, you will then be asked to rate your level of agreement/disagreement to a set of 10 statements relative to athletic identity in your respected collegiate sport. Completion of the AIMS questionnaire should last approximately 5 minutes. Next, you will be asked to complete a questionnaire regarding your history of previous injuries regarding high school and collegiate athletic participation. Questions pertaining to demographics, athletic role on your respected team, athletic experience, and the number, location, type, and severity of your injuries will be assessed. Questions focusing on treatment and coping strategies as well as physical and emotional reactions to injury will also be examined. Completion of this questionnaire will take approximately 15 minutes. After completion of the questionnaires, you will then be asked to view a slideshow of 15 different pictures, all of which are related to pain and/or athletic injuries. After each image you will be instructed to rate the level of pain in which you are currently experiencing by vicariously observing the painful experience. A numerical pain rating scale and a graphical SAM scale will be utilized to track the amount of perceived pain felt at that point in time. Completion of this portion of the study will last approximately 15 minutes. For the final portion of the study you will be asked to complete the cold pressor test. You will be instructed to sit at a desk chair and place your dominant hand in a tub of cold water until either the water temperature becomes intolerable, or the maximum duration of three minutes subsides. After this time period you will be asked to rate your pain level on a numerical scale ranging from 1-10. You will then place your hand into a tub of warm water in order to return your skin back to room temperature. This process will be completed for a total of 3 trials. Completion of the research study in its entirety will require approximately 45 minutes.

Informed Consent Form

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INFORMED CONSENT
The Multifaceted Interaction of Pain Perception Among Collegiate Athletes

New Findings: During the course of this research study, you will be informed of any significant new findings (either good or bad), changes in the procedures, risks or benefits resulting from participation in the research, or new alternatives to participation that might cause you to change your mind about continuing in the study. If necessary, your consent to continue participating in this study will be obtained again.

Risks: Participation in this research study may involve some added risks or discomforts. These include the possibility of psychological discomfort, physical unease, or emotional trauma. The aforementioned side effects may be experienced when viewing the pain and athletic injury related images, some of which are moderately graphical in nature. Recollections of past painful experiences/injuries and experiencing a drastic change in the water temperature during the cold pressor test may also cause some discomfort. A loss of confidentiality is a minimal risk associated with participation in this study due to the careful steps that will be taken to decode all personal and demographic information.

Research-Related Injuries: If physical or psychological trauma should occur, appointments to meet with a sports psychologist or counselor will be arranged.

Benefits: There may or may not be any benefits associated with completion of this study. Findings will be made readily available to each participant in order to gain knowledge of one's personal scores in respects to athletic identity, functional connectivity, and previous injury. Insight as to how to improve one's coping with injury and subsequent pain may be derived from the conclusions of the study.

Explanation & offer to answer questions: Kristen Bartiss has explained this research study to you and answered your questions. If you have other questions or research-related problems, you may reach Kristen by email at kristenbartiss20@gmail.com or cellphone at (973) 800-8011.

Payment/Compensation: Upon completion of the research study, all participants will be entered into a random drawing to receive a $5 gift certificate to Twizzleberry frozen yogurt. There will be a total of 4 gift certificates placed in the drawing.

Voluntary nature of participation and right to withdraw without consequence: Participation in research is entirely voluntary. You may refuse to participate or withdraw at any time without consequence or loss of benefits. If at any time you feel uncomfortable or are unwilling to complete a portion of the study, you may withdraw without penalty. Failure to complete all portions of the study may result in elimination of your data without your consent.

Appendix F

Informed Consent Form

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INFORMED CONSENT
The Multifaceted Interaction of Pain Perception Among Collegiate Athletes

Confidentiality: Research records will be kept confidential, consistent with federal and state regulations. Only the investigator and her associated committee members will have access to the data which will be kept in a locked file cabinet or on a password protected computer in a locked room. To protect your privacy, personal, identifiable information will be removed from study documents and replaced with a study identifier. Identifying information will be stored separately from data and will be kept for a duration of one year, and will be properly discarded by September 2015.

IRB Approval Statement: The Institutional Review Board for the protection of human participants at Utah State University has approved this research study. If you have any questions or concerns about your rights or a research-related injury and would like to contact someone other than the research team, you may contact the IRB Administrator at (435) 797-0567 or email irb@usu.edu to obtain information or to offer input.

Copy of consent: You have been given two copies of this Informed Consent. Please sign both copies and keep one copy for your files.

Investigator Statement: "I certify that the research study has been explained to the individual, by me or my research staff, and that the individual understands the nature and purpose, the possible risks and benefits associated with taking part in this research study. Any questions that have been raised have been answered."

Signature of Researcher(s):

______________________________	______________________________
Richard D. Gordin, Principal Investigator (435) 797-1506; rich.gordin@usu.edu	Kristen Bartiss, Student Researcher (973) 800-8011; kristenbartiss20@gmail.com

Signature of Participant: By signing below, I agree to participate.

______________________________	______________________________
Participant's signature	Date