INVESTIGATING THE ROLE OF AUDITORY CUES ON PAIN CATASTROPHIZING

A Thesis

by

COLTON WAYNE SIMS

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Chair of Committee,	Amber Bozer, PhD
Committee Members,	Jennifer Dias, PhD
	Trina Geye, PhD
Head of Department,	Thomas Faulkenberry, PhD
Acting Graduate Dean,	Nathan Heller, PhD

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ABSTRACT

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Pain catastrophizing has been shown to lower quality of life in individuals suffering from chronic pain. Individuals suffering from chronic pain that are high in pain catastrophizing have been shown to have impairments in accuracy tasks and reaction time tasks regarding visual stimuli in the form of facial expressions. This led to the prediction that individuals with pain catastrophizing would also have impairments in accuracy regarding auditory stimuli in the form of verbal cues. Participants included 100 individuals divided into either a chronic low back pain group (n = 47) or a no chronic low back pain group (n = 53). Participants completed the Pain Catastrophizing Scale (PCS) and a 15 item verbal cue task. A point biserial correlation revealed a positive relationship between PCS scores and errors on the verbal cue task, which indicates that individuals with more severe pain catastrophizing will make more errors on verbal cue tasks. This information can help provide vision-impaired individuals suffering from chronic pain with pain catastrophizing the same opportunity for therapy as individuals who do not have vision impairment.

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Chapter I

Introduction

"Pain catastrophizing is a maladaptive cognitive and affective reaction to pain characterized by magnification, helplessness, and rumination" (Mun et al., 2019, p. 2234). Pain catastrophizing can be applied to either pain that is currently being experienced or pain that is being anticipated and can also influence functional outcomes and recovery after surgery (Nwankwo et al., 2021). Research has shown that individuals with high levels of preoperative pain catastrophizing report having less function after following total knee arthroplasty (Nwankwo et al., 2021). Ranjbar et al. (2020) investigated the interaction between pain catastrophizing and attentional bias in terms of pain-related facial expressions. The study's objective was to determine whether attentional control could be used to block pain catastrophizing tendencies in participants exposed to visual stimuli in the form of pain-related faces. Participants with high pain catastrophizing had significantly higher error rates in antisaccade trials which indicated difficulty in disinhibiting attention to painful faces. Ranjbar et al. (2020) used the Pain Catastrophizing Scale (PCS), Fear of Pain Questionnaire III (FPQ III), and administered antisaccade and prosaccade tasks to participants to track eye movements. The present study was based on the study conducted by Ranjbar et al. (2020), except that visual stimuli were replaced by auditory stimuli.

Tan et al. (2020) researched the role of pain catastrophizing in individuals experiencing chronic post-hysterectomy pain. Chronic pain is pain that lasts for 12 weeks or longer regardless of treatment or medication. The pathogenesis of different forms of chronic pain involves a combination of psychological vulnerability (pain

catastrophizing), vulnerability to pain, genetic predisposition, and sociodemographic factors (Tan et al., 2020). Pain catastrophizing can be linked to the development of affective disorders, pain-related disabilities, and poor response to pain interventions. Tan et al. (2020) also used the PCS in their study and used the scores from the PCS to assess the preoperative catastrophizing in participants. High PCS scores were associated with the development of chronic post-hysterectomy pain (Tan et al., 2020).

According to Marshall et al. (2017), chronic low back pain has the greatest worldwide burden of disease and is a large economic cost to society. Marshall et al. (2017) used the Pain Catastrophizing Scale in combination with the Fear Avoidance Beliefs Questionnaire and the Hospital Anxiety and Depression Scale to determine the relationship between chronic back pain, pain catastrophizing, and anxiety and depression. The relationship between pain and disability was significantly mediated by fear, with depression however, catastrophizing only had a mediating effect when physical activity was reported weekly. Marshall et al. (2017) stated that fear and depression should be targeted in individuals with low back pain to reduce the disability related to low back pain.

Mun et al. (2019) designed a study to find the association between pain catastrophizing and pain acceptance, and pain severity and pain interference among individuals involved in methadone maintenance treatment. According to Mun et al. (2019), patients with chronic pain that entered the methadone maintenance treatment program reported using illicit substances to manage their pain. Patients with chronic pain in the methadone maintenance treatment program are at a significantly higher risk of having complex psychiatric conditions than patients in the program who do not have

chronic pain (Mun et al., 2019). The role that pain catastrophizing plays in the development of pain-related disabilities, poor response to pain interventions, and development of affective disorders could explain why the patients with chronic pain are at higher risk for complex psychiatric conditions than the patients without chronic pain. To investigate this, Mun et al. (2019) used the Pain Catastrophizing Scale in their study to determine the connection between pain catastrophizing and acceptance in patients in the methadone maintenance treatment program. It was found that individuals with higher levels of pain catastrophizing and lower levels of pain acceptance reported higher pain severity (Mun et al., 2019).

Terradas-Monllor et al. (2020) designed a study to assess the postoperative health functioning of individuals after knee arthroplasty concerning pain catastrophizing. Participants were recruited from a domiciliary physiotherapy service and then divided into two groups based on their scores on the Pain Catastrophizing Scale. Terradas-Monllor et al. (2020) measured quality of life, walking speed, physical performance, range of motion, and pain. The outcome measures were taken one week postoperatively and at follow-ups for one, three, and six months postoperatively. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used as an index for the primary outcome measure. Participants with higher degrees of pain catastrophizing had higher WOMAC scores during each follow-up, indicating a poorer quality of life, poorer health functioning, and poorer physical performance (Terradas-Monllor et al., 2020).

Sciruicchio et al. (2019) designed an observational study to evaluate the pain catastrophizing in children with chronic and episodic migraines. Participants completed the Child version of the Pain Catastrophizing Scale (PCS-C), the disability scale for

migraine (PedMIDAS), the general quality of life estimated by children (PedsQL), and parents (PedsQL-P), anxiety and depression (SAFA-A; SAFA-D) scales. Headache frequency was evaluated along with the presence and severity of pain from stimuli that are not normally painful. Sciruicchio et al. (2019) discovered no difference between chronic and episodic migraine groups for their pain catastrophizing scores. According to Sciruicchio et al. (2019), pain catastrophizing can be described as a mental characteristic of a clinical phenotype in which psychopathological traits are present and central sensitization symptoms have a more pronounced expression. Sciruicchio et al. (2019) found that pain catastrophizing was not correlated with disabilities linked to migraines, but instead found that it was positively correlated with decreased quality of life. Sciruicchio et al. (2019) proposed that this is due to the positive association between depression and anxiety levels.

According to Dismore et al. (2020), pain catastrophizing is a cognitive-emotional process that can cause heightened emotional stress and is a key predictor of postoperative pain intensity, delayed recovery, poorer quality of life, and perceived disability. Dismore et al. (2020) designed a study to determine whether pain catastrophizing has an effect on pain, quality of life, and functionality following joint replacement surgery. The results indicated that individuals with high levels of pain catastrophizing had more symptoms post-surgery, claimed to experience greater pain, and gave a rating of dissatisfaction. Individuals classified as being catastrophizers tend to believe that they are unable to control pain while also claiming to have issues with mobility and typical daily activities (Drismore et al., 2020).

Ysidron et al. (2021) designed a study to determine the relationship between pain catastrophizing and pain resilience regarding short-term memory tasks. Ysidron et al. (2021) recruited 121 healthy participants and had them complete four trials of a Corsi block tapping task. During the second and fourth trials of the task, participants were exposed to painful stimuli. Ysidron et al. (2021) discovered that participants with high pain resilience and low pain catastrophizing were more likely to have better scores than participants with low pain resilience and high pain catastrophizing. Ysidron et al. (2021) discovered that resilience and catastrophizing interact to influence an individual's performance during pain by using both the Pain Resilience and the Pain Catastrophizing Scales.

The study conducted by Ranjbar et al. (2020) used visual stimuli and eye-tracking programs to determine the interaction between pain catastrophizing and attentional bias. The goal of the present study is to replicate the results from the study conducted by Ranjbar et al. (2020) while using auditory stimuli instead of visual stimuli. The results from their study indicate that visual stimuli can help identify relationships between pain catastrophizing and attentional bias. This would be impossible with individuals who are legally blind or have a visual impairment with a high enough severity that they cannot see facial expressions.

In these individuals, auditory stimuli would have to be used to identify the relationship between pain catastrophizing and attentional bias. The study conducted by Ranjbar, et al. (2020) used facial expressions such as happy, angry, or painful as visual stimuli for their participants. The present study used recordings of pre-read math equations as auditory stimuli. It was hypothesized that individuals with higher levels of

pain catastrophizing (as measured by the Pain Catastrophizing Scale) will make more errors on a verbal cue accuracy task than individuals with lower levels of pain catastrophizing, similar to the study conducted by Ranjbar et al. (2020).

Chapter II

Methods

Participants

Participants 18 years or older were recruited through the SONA system and links sent via email, flyers and social media. Data was collected remotely using Qualtrics as there could not be in-person trials due to the COVID-19 pandemic. A total of 132 participants responded to the survey, and 32 of them were excluded from the study either for not completing the survey or if they had chronic pain other than chronic low back pain. Participants consisted of 74 females and 26 males. Participants were asked to complete a survey on Qualtrics in which they were presented with a consent form and asked to report whether they had been experiencing chronic low back pain for 12 weeks or longer. A total of 53 participants (35 female, 18 male) reported that they did not have chronic pain. A total of 47 participants (39 female, 8 male) reported having chronic low back pain for 12 weeks or longer.

Materials and Design

Qualtrics was used to collect data (Appendix A) and design the present study. First, participants were presented with a consent form indicating that they would be allowed to stop the study at any point if they chose to do so. Participants were presented with demographics questions (age and gender) upon giving consent to participate. Participants were presented with questions asking if they had chronic low back pain for 12 weeks or longer and if they had any other form of chronic pain. Next, participants were instructed to complete the PCS, a 13-item questionnaire that uses a 5-point Likert scale (0 = not at all to 4 = always) to measure the frequency of pain catastrophizing. The

maximum possible score of the PCS is 52. The PCS is divided into 3 subscales: Rumination, Magnification, and Helplessness. The subscale score ranges are Rumination (0-16), Magnification (0-12), and Helplessness (0-24). A total score of 30 or above is considered to be clinically relevant. Lastly, participants were presented with verbal cue tasks after completing the PCS. The verbal cues presented to participants were in the form of simple math problems (e.g. one plus one equals two) in which the participant replied by selecting true or false. Instead of being presented with a picture of a face with an expression on it, participants were presented with verbal instruction. The key differences between the present study and the study conducted by Ranjbar et al. (2020) are that the present study uses verbal cue tasks (auditory stimuli) instead of antisaccade and prosaccade tasks to track eye movement paired with pictures of faces (visual stimuli).

Data Analyses

Data was exported from Qualtrics into Microsoft Excel for management. JASP (Version 0.14.1; JASP team, 2020) and IBM SPSS v. 27 were used for descriptive and inferential statistics. To minimize other variables, participants were excluded from the study if they had types of diagnosed pain conditions other than chronic low back pain (n = 10) and did not complete the survey (n = 22), leaving 100 participants for analysis. Participants were placed into the chronic low back pain group if they indicated that they had chronic low back pain for 12 weeks or longer on the survey (n = 47), and the no chronic low back pain group if they did not (n = 53).

To compare gender across pain groups, a Chi-square test was run. An independent samples t-test was run to compare age across pain groups. To investigate differences in pain catastrophizing across groups, an independent samples t-test was run to compare

PCS scores by group (low back pain/no low back pain). A Bayesian independent samples t-test was run to determine if PCS scores between groups (low back pain/no low back pain) are significantly different. It was hypothesized that individuals with high levels of pain catastrophizing (as measured by the Pain Catastrophizing Scale) would make more errors on a verbal cue accuracy task than individuals with lower levels of pain catastrophizing. Answers on the verbal cue task were coded as correct (0) or incorrect (1), and a sum of errors was computed for each participant. A point biserial correlation was run to investigate the relationship between pain catastrophizing and verbal cue accuracy errors.

Results

A Chi-square analysis was run to compare gender across pain groups. There were no significant differences across pain groups in gender, $p = .054$. Of the 53 participants not reporting pain, there were 35 females (66%) and 18 males (34%). Of the 47 participants reporting chronic low back pain, 39 were female (83%), and 8 were male (17%). An independent samples t-test was run to compare age across pain groups. There was no significant difference in age between pain groups, $t(98) = -0.60$, $p = .550$.

There was a significant difference in PCS scores between pain groups, $t(98) = -6.13$, $p < .001$. Participants reported various pain conditions including: arthritis (n = 6), bulging discs (n = 2), degenerative disc disease (n = 3), endometriosis (n = 1), fibromyalgia (n = 3), functional short leg (n = 1), pinched nerve (n = 2), spinal stenosis (n = 2), back pain caused by pregnancy (n = 1), hip impingement causing back pain (n = 1), sciatica (n = 1), herniated disc (n = 2), torn hamstring (n = 1), polycystic ovaries (n = 1), osteoporosis (n = 1), ankylosing spondylitis (n - 1), scoliosis (n = 1), and

spondylolisthesis (n =1). An independent samples t-test was run to compare PCS scores across pain groups.

To investigate differences in pain catastrophizing across groups, an independent samples t-test was run to compare PCS scores by group (low back pain/no low back pain). The independent samples t-test indicated a significant difference in pain catastrophizing across pain groups, $t(98) = -6.13$, $p < .001$. The group with chronic low back pain had significantly higher PCS scores ($M = 13.83$, $SD = 9.5$) than the group without chronic low back pain ($M = 3.53$, $SD = 7.25$). The Bayesian independent samples t-test revealed that the data were 1,670e -9:1 in favor of the alternative hypothesis, or it is 565062 times more likely that individuals in the pain group will have higher PCS scores.

It was hypothesized that individuals with high levels of pain catastrophizing (as measured by the Pain Catastrophizing Scale) would make more errors on a verbal cue accuracy task than individuals with lower levels of pain catastrophizing. A point biserial correlation was run to investigate the relationship between pain catastrophizing and verbal cue accuracy errors. There was a significant positive relationship between levels of pain catastrophizing and errors on the verbal cue task, $r = .209$, $p = .037$.

Chapter III

Discussion

The purpose of the present study was to replicate the study conducted by Ranjbar et al. (2020) while using auditory stimuli instead of visual stimuli, thus discovering the nature of the relationship between pain catastrophizing and verbal cues. The present study addressed the lack of pain catastrophizing studies focusing on auditory stimuli. The present study results support the hypothesis that individuals with chronic pain and high levels of pain catastrophizing will make more errors on a verbal cue accuracy task than individuals without chronic pain.

The Bayesian independent samples t-test was run to compare PCS scores between pain groups. As expected, participants without chronic low back pain did not have high PCS scores, as indicated by the Bayes factor. Because individuals in the no back pain group have such low PCS scores and are being compared to the chronic low back pain group with high PCS scores, it is possible to get a Bayes factor of this magnitude. If individuals in the no chronic back pain group had high PCS scores, they would have to be excluded from the study due to other underlying factors causing them to catastrophize without chronic pain. The Chi-square test revealed no differences between gender among pain groups.

In the study conducted by Ranjbar et al. (2020), evidence suggested a relationship between pain catastrophizing and attentional bias regarding facial expressions (visual stimuli). Attentional bias refers to how individuals' perception is affected by specific recurring thoughts. High PCS scores for individuals with chronic pain are a strong indicator that they have recurring thoughts about their pain. In the

present study, facial expressions were substituted with verbal cues, and similar results were found. Results from the present study indicate a positive relationship between PCS scores and the number of errors made on the verbal cue task. The point biserial correlation revealed that participants with higher PCS scores also made more errors, which supports the evidence from previous pain catastrophizing studies. Given these findings, it can be concluded that there is also a relationship between pain catastrophizing and attentional bias regarding verbal cues (auditory stimuli).

Limitations

One of the main limitations of the present study is that there was not a reliable method of recording reaction time remotely for the verbal cue task with the resources at hand. Recording reaction time alongside PCS scores and accuracy could help provide valuable information on the strength of the relationship between verbal cues and pain catastrophizing. The present study was conducted during the COVID 19 pandemic. Therefore in-person trials were not possible during the beginning of this study. Having in-person trials could yield more accurate results and present a way of measuring reaction time.

Conclusion

Pain catastrophizing can inhibit daily functioning for individuals suffering from chronic pain. This is supported by the present study, which reveals that pain catastrophizing shares a positive relationship with auditory stimuli and visual stimuli in individuals suffering from chronic pain. Visual tests can be performed in conjunction with the PCS to determine the severity of pain catastrophizing in individuals suffering from chronic pain without vision impairment or blindness. These tests will not be

applicable if an individual with chronic pain has a vision impairment. Now that the connection has been made between pain catastrophizing and verbal cues, vision-impaired individuals can have the same opportunity for therapy, such as physical and psychosocial therapy, to help with their pain catastrophizing tendencies and teach them coping mechanisms.

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Appendix A

Consent Form

You are being invited to participate in a research project conducted by Colton Wayne Sims, graduate student in the Masters program for Applied Psychology. This study is about chronic pain. You will be asked to answer several questions concerning pain and listen to sound clips of someone reading basic math problems which you will answer as quickly and accurately as possible. The potential risks associated with this study are time and reporting past events. The survey specifically asks about chronic pain and emotions and wellbeing associated with it, which could be stressful for some participants. Should you have any emotional or physical distress from this survey, please contact a counselor. The university that you attend provides free counseling services to students, and can be reached at 254-968-9044. The benefits of this study are for the greater good; meaning that the results from this study will help the researchers identify information regarding differences in individuals with and without chronic pain. The paper may be published in literature that will help scientists understand the effects of chronic pain and pain catastrophizing on auditory perception. No one will have access to your information. We will not ask that you leave your name. If you have decided to participate in this research, please understand that your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time during the process with no penalty. You also have the right to refuse to answer any question(s) for any reason with no penalty. In addition, your individual privacy will be maintained in all publications or presentations resulting from this study. You will not be giving any personal identifying information in the survey. The information provided will be coded using a number,

without any identifying information that could be traced back to you. The data obtained from this process will be protected to the best ability under the researchers personal computer file with a protected password. Students may contact the researcher at colton.sims@go.tarleton.edu for information regarding the results of the study. If you have any questions about the research or about your rights as a subject, we want you to ask. If you have questions later, or if you wish to report a research-related injury (in addition to notifying the investigator), you may call the Chairman of the Institutional Review Board during office hours at (254) 968-9463. A copy of this consent form will be provided to you prior to the interview, but one can also be provided to you by contacting colton.sims@go.tarleton.edu. I understand the above information and voluntarily consent to participate in the research. I further attest that I am at least 18 years of age. By selecting yes, you agree to give consent to participate. By selecting no, your survey will end and you will not be able to answer the questions.

Demographics

1. Gender
2. Age
3. Have you had chronic low back pain for 12 weeks or longer?
4. Do you have a diagnosed pain condition? If so, please name it if you can.

Pain Catastrophizing Score (PCS) Questions

1. I worry all the time about whether the pain will end.
    - 0- not at all
    - 1- to a slight degree
    - 2- to a moderate degree

- 3- to a great degree
- 4- all the time

2. I feel I can't go on.
    - 0- not at all
    - 1- to a slight degree
    - 2- to a moderate degree
    - 3- to a great degree
    - 4- all the time
3. It's terrible and I think it's never going to get any better.
    - 0- not at all
    - 1- to a slight degree
    - 2- to a moderate degree
    - 3- to a great degree
    - 4- all the time
4. It's awful and I feel that it overwhelms me.
    - 0- not at all
    - 1- to a slight degree
    - 2- to a moderate degree
    - 3- to a great degree
    - 4- all the time
5. I feel I can't stand it anymore.
    - 0- not at all
    - 1- to a slight degree

- 2- to a moderate degree
- 3- to a great degree
- 4- all the time

6. I become afraid that the pain will get worse.
    - 0- not at all
    - 1- to a slight degree
    - 2- to a moderate degree
    - 3- to a great degree
    - 4- all the time
7. I keep thinking of other painful events.
    - 0- not at all
    - 1- to a slight degree
    - 2- to a moderate degree
    - 3- to a great degree
    - 4- all the time
8. I anxiously want the pain to go away.
    - 0- not at all
    - 1- to a slight degree
    - 2- to a moderate degree
    - 3- to a great degree
    - 4- all the time
9. I can't seem to keep it out of my mind.
    - 0- not at all

- 1- to a slight degree
- 2- to a moderate degree
- 3- to a great degree
- 4- all the time

10. I keep thinking about how much it hurts.

- 0- not at all
- 1- to a slight degree
- 2- to a moderate degree
- 3- to a great degree
- 4- all the time

11. I keep thinking about how badly I want the pain to stop.

- 0- not at all
- 1- to a slight degree
- 2- to a moderate degree
- 3- to a great degree
- 4- all the time

12. There's nothing I can do to reduce the intensity of the pain.

- 0- not at all
- 1- to a slight degree
- 2- to a moderate degree
- 3- to a great degree
- 4- all the time

13. I wonder whether something serious may happen.

- 0- not at all
- 1- to a slight degree
- 2- to a moderate degree
- 3- to a great degree
- 4- all the time