PAIN INTENSITY RATINGS ARE ALTERED BY PRIOR EXPOSURE TO AN UNRELATED NUMERIC ANCHOR

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A THESIS SUBMITTED TO

THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF ARTS

GRADUATE PROGRAM IN

CLINICAL PSYCHOLOGY

YORK UNIVERSITY

TORONTO, ONTARIO

JULY 2019

Abstract

Numeric anchoring occurs when exposure to a numeric quantity biases a person's subsequent judgment involving other quantities. This could be applicable to the evaluation of pain, where exposure to an unrelated number prior to evaluation of pain could influence pain ratings. This study aimed to determine whether exposure to a random numeric anchor influences subsequent pain intensity ratings of a hypothetical patient. In this study, 385 participants read a vignette describing a patient with chronic pain before being randomly assigned to one of four groups. Groups 1 and 2 spun an 11-wedge number wheel (0-10) that was, unbeknownst to the participants, programmed to stop on a high number ('8') or a low number ('2'), respectively. Group 3 spun a similar letter wheel (A-K) that stopped on 'C' or 'I' (Control 1). Group 4 did not spin a wheel (Control 2). Participants were then asked to rate the patient's pain intensity using a 0-10 numeric rating scale. The high-number group rated the patient's pain (*Median* ± *IQR* = 8 ± 2) significantly higher than the letter wheel control (*Median* ± *IQR = 7* ± *2*, $p < .05$) and the low-number group (*Median* ± *IQR* = 6 ± 2, $p < .001$). The low-number group rated the pain significantly lower than Control 1 and 2 (*Median* ± *IQR = 7* ± *2*) (both $p < .05$). Pain ratings were influenced by prior exposure to a random number with no relevant information about the patient's pain, indicating anchoring had occurred. However, contrary to the traditional definition of anchoring where anchoring occurs even when participants are unaware of the anchor's influence, in this study the anchoring effect was seen only in participants who believed that they had been influenced by the anchor. Future studies should evaluate the role of influence in anchoring effects, specifically determining the conditions under which awareness of the anchor occurs. Further studies should also evaluate the role of anchoring effects in health care provider's judgments of patient's pain.

Acknowledgements

First and foremost, I would like to extend my deepest thanks to my supervisor, Dr. Joel Katz. Joel has been an endless source of support and understanding throughout my master's degree, and I feel incredibly fortunate to be mentored by him. Thank you for allowing me the opportunity to grow professionally and personally in this program, and under your leadership.

To Dr. Karen Fergus, thank you for your invaluable mentorship, knowledge, and encouragement on my thesis project. I would like to also thank my other committee members, Dr. Paul Ritvo and Dr. Christo El Morr, for taking the time out of their summer to be a part of my examining committee, and for their feedback and mentorship on this project.

To Keisha, Sarah, Alison, Dana, Julia, Karin, and Veerpal, I am thankful to have been a part of the most supportive and encouraging cohort I could have imagined.

Thank you to M. Gail Rudakewich of Synapse Visuals, for creating the Adobe Flash animation spinning wheels used in the present study.

To my fiancé Mitch, parents, Tom and Sharon, my siblings, Ryan, Eric, and Shaun, my sister-in-law, Isabelle, my grandparents, Lyon, Doreen, Anatol and Angelina, and all of my cousins, aunts, and uncles, thank you for being my biggest cheerleaders, giving me constant advice and encouragement, and for always being available to help me when I needed additional guidance.

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Background and Introduction

Chronic pain is prevalent in 18.9% of Canadian adults, and almost half of those who have chronic pain have suffered for over ten years (Schopflocher, Taenzer, & Jovey, 2011). With both the prevalence and longevity of chronic pain, the burden of chronic pain on the Canadian healthcare system is not surprising. In health care alone, chronic pain is shown to have an incremental cost that is 51% higher than a propensity-matched cohort, totaling to approximately $7.2 billion in 2014 (Hogan, Taddio, Katz, Shah, & Krahn, 2016). Chronic pain has also been shown to cost Canadian health care an additional $37 billion lost due to sick days and unemployment each year (Schopflocher et al., 2011). In addition to the societal costs of chronic pain, those who suffer from chronic pain are also at a higher risk of sleep disturbances (Morin, Gibson, & Wade, 1998), depression (Bair, Robinson, Katon, & Kroenke, 2003; Fishbain, Cutler, Rosomoff, & Rosomoff, 1997), anxiety (Lerman, Rudich, Brill, Shalev, & Shahar, 2015), decreased quality of life (Hunfeld et al., 2001), and overall decreased physical functioning (Ullrich, Askay, & Patterson, 2009). In fact, among those with chronic diseases, individuals with chronic pain have been found to have the lowest health-related quality of life with all of its associated consequences when compared with similar cohorts with heart disease, diabetes, and chronic obstructive pulmonary disease (Hogan, Taddio, Katz, Shah, & Krahn, 2017).

Given the significant impact that chronic pain has on both a personal and societal level, it is therefore important to also understand how inferences are made as to another person's pain experience as it can affect their course of treatment, including how and when their treatment is received. This is particularly important when also considering that early intervention has been shown to reduce chronic pain disability and medication use (Gatchel et al., 2003), making it all the more vital that pain is assessed as accurately and quickly as possible by the patient's healthcare team. Healthcare providers are often required to assess and treat pain; however, it is recognized that healthcare provider ratings of a patient's pain intensity may be biased and inaccurate (Tait, Chibnall, & Kalauokalani, 2009). Patient, healthcare provider, and environmental or situational factors contribute to the providers' perception and interpretation of a patient's pain intensity. Examples of factors that have been shown to be associated with biased provider ratings include past work experience (Choinière, Melzack, Girard, Rondeau, & Paquin, 1990), physician gender (Weisse, Sorum, & Dominguez, 2003), and availability of medical evidence (Chibnall, Tait, & Ross, 1997). In these circumstances, provider ratings often do not align with patient ratings and instead tend to over- or under-estimate patient self-report (Chibnall et al., 1997; Choinière et al., 1990; Marquie et al., 2003). It is therefore important to consider the processes by which situational factors contribute to biased provider ratings. (Riva, Rusconi, Montali, & Cherubini, 2011).

The aim of this research project is to explore whether the exposure to a random number could influence how a patient's pain intensity is inferred, using the concept of *numerical anchoring*. Numerical anchoring represents a cognitive bias where prior exposure to a numeric value influences subsequent numerical decisions. It has been studied extensively in a number of settings (Blankenship, Wegener, Petty, Detweiler-Bedell, & Macy, 2008; Furnham & Boo, 2011; Kahneman, 2013; Wegener, Petty, Detweiler-Bedell, & Jarvis, 2001), but has rarely been studied in the context of pain. Given that pain is most often rated on a numeric pain scale (Hawker, Mian, Kendzerska, & French, 2011), it is important to determine how anchoring may play a role in how a person's subjective pain experience is inferred.

Chronic Pain Definition

Pain is defined by the International Association for the Study of Pain (IASP) as "an unpleasant sensory and emotional experience with actual or potential tissue damage, or described in terms of such damage" (IASP, 2017). Chronic pain in particular was previously defined as "pain that persists past normal healing time, and hence lacks acute warning function of physiological nociception" (Treede et al., 2019). In other words, the pain no longer holds the function of warning the body that tissue damage is impending, or occurring. This definition was later expanded upon to give the distinction that chronic pain is pain that persists longer than three months (Schopflocher et al., 2011; Treede et al., 2019). However, IASP has recently updated the definition of chronic pain to differentiate between chronic pain that is not a symptom of any other chronic pain condition (*chronic primary pain*) versus chronic pain that is a symptom of a different underlying condition (*chronic secondary pain*) such as chronic cancer-related pain or chronic post-surgical pain (Treede et al., 2019). In chronic secondary pain, the pain is typically predated by some injury or insult to the underlying tissue. Despite treatment, the pain persists beyond the normal recovery time, or continues even once the original diagnosis is no longer relevant (Treede et al., 2019). Conversely, chronic primary pain can be seen as a health condition on its own, and does not require any other chronic condition to meet diagnostic criteria. This new definition better captures certain conditions such as fibromyalgia, complex regional pain syndrome, chronic primary headache, and or nonspecific low-back pain, where there is often no clear cause or injury preceding the chronic pain (Treede et al., 2019).

Pain Assessment

Given the uniquely subjective experience of pain, it is important that the methods used for pain assessment are both reliable and valid. Pain assessment is not only valuable for guiding the patient's treatment, but also for diagnostic purposes as well as tracking a patient's pain over time (Fillingim, Loeser, Baron, & Edwards, 2016). However, given that pain is such a personal experience, the gold standard method for pain assessment is through self-report. Self-reported pain assessment covers several domains to ensure that the healthcare provider is given a comprehensive overview of the patient's pain. These domains include where the pain is located, how long the pain has been present, how the pain feels to the patient, and what factors improve or worsen the pain. However, the most renowned domain of pain assessment is that of pain intensity, which measures the "strength" of the pain (Fillingim et al., 2016). Pain intensity is most commonly measured using a numeric rating scale, whereby the patient rates their pain intensity on a 0 (no pain) to 10 (worst pain imaginable) scale (Nicholas et al., 2019). Often, the patient may also be asked to assess their pain retrospectively by using a numeric rating scale to rate their average pain intensity over the past week (Treede et al., 2019). The numeric rating scale is used with the majority of patients, and has been found to be easy for patients to use and understand as well as statistically useful for healthcare providers to track the patient's pain (Fillingim et al., 2016).

Despite the fact that numeric rating scales have been shown to be reliable and valid for pain assessment in most populations, there are still a number of factors that can influence how a person's pain is inferred. A number of studies have shown that healthcare providers pain ratings often do not align with the patient's, and instead tend to over- or under-estimate patient self-report (Chibnall et al., 1997; Choinière et al., 1990; Marquie et al., 2003).

For example, length of time in practice is one factor that has been shown to influence health care professionals' ratings of a patient's pain. Choiniere et al (1990) showed that nurses who had been frequently exposed to burn patients in extreme pain tended to under-estimate the patient's pain, while newer nurses tended to over-estimate their pain. It is possible that nurses who are more frequently exposed to burn patients become desensitized to these extreme pain complaints, or find the treatments to be routine, thus allowing them to perceive their patient's pain experience as being less intense, while those who are less experienced become overwhelmed and more emotionally affected by the patient's pain (Choinière et al., 1990).

Gender may also contribute to how a patient's pain is perceived by both healthcare workers as well as non-medical professionals. Firstly, the gender of the patient has been shown to influence how their pain is rated by health care professionals, with male patients' pain being rated as significantly lower than females (Robinson & Wise, 2003; Weisse et al., 2003). As well, the gender of the rater can influence how they rate the patient's pain, as it has been found that female raters tend to judge the patient's pain as higher than male raters, regardless of the patient's gender (Robinson & Wise, 2003).

Availability of medical evidence has also been shown to influence how a patient's pain intensity is inferred by healthcare professionals. In a study conducted by Chibnall et al. (1997), medical students were asked to read vignettes of a hypothetical patient where the patient reported their pain intensity as being low (corresponding to a 3/10 pain intensity rating on a 0-10 numeric rating scale), moderate (5/10 pain intensity rating), high (7/10 pain intensity rating), or very high (9/10 pain intensity rating). In each pain intensity category, one of two vignettes was shown to participants. In half of the vignettes, medical evidence for the patient's pain, such as objective medical test results, was present. For the other half, medical evidence was not provided. The results of this study demonstrated that both availability of medical evidence as well as the pain intensity levels, had an influence on how the hypothetical patient's pain was perceived. In particular, higher pain ratings tended to be discounted by the medical students, while lower pain ratings were seen as more accurate depictions of the patient's pain. As well, when the medical students had medical evidence available, their pain and disability ratings of the hypothetical patients were higher than those in the no medical evidence condition.

It is important to consider the processes by which situational factors contribute to biased provider ratings (Riva et al., 2011). The factors listed above are only some of the situational factors that can influence how a patient's pain is perceived; however, there is still a need to continue exploring different sources of bias to determine how inferences are made about a patient's pain experience. In many of these factors listed above, perceptions of the patient's experiences are distorted through cognitive biases.

Cognitive biases

A cognitive bias influences how stimuli in the environment are attended to, remembered, and processed (Pincus & Morley, 2001). Morewedge and Kahneman (2010) further expand on this definition by explaining that cognitive biases are a function of a dual-system model of reasoning. In this model, "System 1" uses an intuitive or heuristic, cognitive system to make judgments in an automatic and fast manner. "System 2" on the other hand, allows us to make more calculated decisions by being a slower and more conscious system. A cognitive bias under the dual-system model is therefore seen as the joint failure of both systems. Namely, System 1 creates an initial biased impression, and then System 2 fails to correct the biased impression. Devine (1989) studied dual-processing in the form of stereotypes. Caucasian participants were recruited and asked to write down common labels of African Americans, and their personal thoughts towards the racial group before being asked to complete the Modern Racism Scale which measures a person's prejudice level towards a certain group. The researchers found that despite high- and low- prejudiced participants having equal knowledge of the common stereotypes associated with African-Americans, those who were low in prejudice tended to inhibit stereotype-congruent thoughts, and instead replaced them with thoughts of equality or reasons why the stereotypes are false. In the low-prejudice group, we see dual-activation of Systems 1 and 2. Though the stereotyped thoughts were equally present (System 1), those in the low-prejudice group were able to effectively use System 2 to inhibit the stereotypical thoughts.

Using the dual-system approach, heuristics, an aspect of System 1, will be evaluated further in this study. Heuristics themselves are not cognitive biases and more often than not, they are helpful in allowing mental shortcuts in an effective and efficient manner; however, they may occasionally lead to bias when the heuristic is relied upon too heavily. According to Tversky and Kahneman (1973), heuristics can be further categorized into representativeness, availability, and anchoring.

Heuristics definition. Although heuristics themselves are not cognitive biases, they may occasionally lead to cognitive biases. An individual's capacity for information processing is limited, and often time-sensitive. As a result, the human brain often makes shortcuts, or "rules of thumb" to be able to process information more efficiently (Haselton, Nettle, & Murray, 2015). These shortcuts are automatic, and often individuals are not aware of the biases that governed their thought processes or decisions (Tversky & Kahneman, 1974).

Representativeness definition. Representativeness refers to the probability that an object or person can be accurately categorized in a certain way (Tversky & Kahneman, 1974). In a study conducted by Tversky and Kahneman (1974), participants were given brief personality descriptions of a number of individuals before being asked to rate the probability that each individual worked as an engineer or as a lawyer. The researchers found that regardless of the actual probability of each occupation, participants tended to categorize the hypothetical workers based on their preconceived notions of what the personality of a lawyer or engineer would be.

Availability definition. Availability uses prior experience to process information and make judgments regarding frequency or probability. The more often a particular event has been experienced, the more easily it will be brought to mind, and vice versa (Tversky & Kahneman, 1974). For example, for a healthcare professional working in a hospital, the sound of sirens might have them automatically assume the sound comes from an ambulance, rather than from a police vehicle or fire truck. The classic study of availability was conducted by Tversky and Kahneman (1973), where participants were asked whether there were more words in the English language that began with the letter K, or had K as its third letter. Participants were asked the same question with a number of different letters. In all letters, the participants judged the first position to be more common than the letter being placed in the third position. This is likely due to the availability heuristic- it is much easier to think of words that begin with the letter K than it is to think of words that have K as its third letter, despite the fact that in each case given to participants, it was more common to have the letter in the third position.

Anchoring definition. Anchoring, as mentioned previously, is a cognitive bias where the prior exposure to a numeric value influences subsequent decisions. In other words, when individuals are given an initial value, further estimates are made using that initial value as a starting point for their judgments. It has been suggested that anchoring effects occur when the first information that comes to mind ultimately influences the individual to use that information in their decision making processes (Epley, 2004).

Anchoring

Anchoring was initially defined and studied by Tversky and Kahneman (1974). In their classic anchoring study, the researchers asked participants to estimate the number of African countries in the United Nations (UN) before they spun a rigged wheel with numbers between 0-100. The wheel was designed to stop at the number 10 or 65. After spinning the wheel, participants were asked to indicate whether the number they spun was too high or too low of an estimate, before being asked to estimate the actual number of African countries in the UN. Participants who spun the number 10 estimated that there were 25 African countries in the United Nations whereas those who spun 65 estimated that there were 45. Thus, exposure to a prior number anchored participants to a lower or higher value and influenced their response to a later unrelated question.

Selective accessibility model. Mussweiler and Strack (1999) explain the anchoring effect through the *Selective Accessibility Model*, also known as *assimilation anchoring.* The selective accessibility model breaks anchoring down into two subsequent steps. First, participants engage in a comparative task, where they are asked to compare the anchor to a target (in the example above, Strack and Mussweiler (1997)state that the target would be the number of African countries in the UN, and the comparative task is asking participants whether the number they spun is higher, lower, or equal to the number of African countries in the UN). Participants are then asked to engage in an absolute task, where they are asked to give an estimate or judgment (in the example above, Mussweiler and Strack (1999) state that the absolute task would be asking the participants to estimate how many African countries are in the UN) (Mussweiler & Strack, 1999).

In the selective accessibility model, anchoring effects are explained by a *selectivity hypothesis* and an *accessibility hypothesis*. That is, participants selectively use semantic knowledge to help them conclude that the target value is equal to the anchor. For example, Northcraft and Neale (1987) recruited both real estate agents (expert subjects), as well as undergraduate students (amateur subjects) to determine if anchoring effects could influence the perceived value of a property for sale. Participants were given a packet containing a summary of a property for sale, which had an appraisal value of $74,900. Each group (amateur and expert) was randomized into one of two conditions, each of which gave a false appraisal value of ±12% ($65, 900 and $83,900, respectively, for both the amateur and expert subjects) from the true appraisal value ($74,900), and asked to generate a suggested listing price for the property. The researchers found a significant anchoring effect in both expert and amateur subjects, where those who had been given a higher appraisal were more likely to generate a higher listing price, and vice versa. In this case, the appraisal value acted as an anchor for the participants, to compare to their target value of their generated listing price. In this case, it is clear that the appraisal values given (anchors) and the listing price (target) are semantically related, especially considering that the appraisal value is typically used to generate a listing price in most real estate situations. The selective accessibility model suggests that as the participants form these semantic connections, the accessibility of the anchor increases, thus allowing the participant to use the numerical anchor to create their final judgments (Mussweiler & Strack, 1999).

A number of studies have demonstrated the anchoring effect using similar two-step procedures outlined by Tversky and Kahneman (1974), where participants are asked to first compare the anchor to the target, before being asked to provide an estimation. Anchoring effects have been found using both numeric anchors that are related to the target, such as real estate estimates (Northcraft, Neale, & processes, 1987), and legal judgments (Enough & Mussweiler, 2001), as well as numeric anchors that are unrelated to the target. Similar to the study above where the numeric anchor may be completely unrelated to the target, anchoring effects have also been found in studies using irrelevant anchors that influence participants' judgment regarding general knowledge or factual questions (Strack & Mussweiler, 1997), or estimates of self-efficacy (Peake & Cervone, 1989).

What makes the results of Tversky and Kahneman (1974) especially interesting is that given the situational context of a 'random' spinning wheel, the numeric anchor was totally unrelated to the estimation task. The anchor could not possibly provide any useful information about the estimation task and yet it clearly influenced the participants' responses. With this in mind, anchoring effects in the context of random numerical anchoring especially hold the implicit assumption that any anchoring effects are operating through cognitive processes that are outside of awareness.

However, despite the selective accessibility model holding merit in the cases where the numeric anchor is semantically related to the target, in the case of Tversky and Kahneman (1974)'s study on random numerical anchoring, and in any case of random numerical anchoring, it seems unlikely that anchoring effects can be completely attributed to the selective accessibility model, given that the anchor provides the participants with no semantic knowledge on which they can base their decisions. In the case of random numerical anchoring, Strack and Mussweiler (1997) instead have proposed that anchoring effects may instead be due to numeric priming. Specifically, random numerical anchoring occurs simply because the number that the participant has been exposed to is more accessible to the participant, which subsequently influences their decisions (Strack & Mussweiler, 1997). Therefore, it is generally accepted that while numeric anchoring typically relies on the semantic relationship between the target and the anchor, random numerical anchoring relies instead on the anchor's accessibility to the participant, and typically occurs outside of the participant's awareness (Strack & Mussweiler, 1997). Interestingly, despite the implicit assumption that anchoring effects, arising from a "random", unrelated anchor, are outside the participant's awareness, only one previous study has looked at how participants' awareness of the anchor influenced their subsequent decisions. Only two studies have examined if anchoring effects could be negated by warning the participants of the anchoring effect (Chapman & Johnson, 1999; Quattrone, 1982). In a series of experiments, Wilson, Houston, Etling, and Brekke (1996) found that anchoring effects were pervasive, even if participants were warned of the anchor's influence, or were asked whether they believed they had been influenced by the anchor. Notably, anchoring effects were found even in those who indicated they had not been influenced by the anchor, though the anchoring effects were found to be larger the more informative the anchor was perceived to be. These relevant anchors are in contrast to the original anchoring study conducted by Tversky and Kahneman (1974) where the spinning wheel produced an anchor that held no relevant or useful information for the subsequent decisions.

In line with the studies conducted by Wilson et al. (1996) using relevant, informative anchors, anchoring effects have also been studied extensively where the numeric anchor is directly relevant or related to the target value. Of particular interest, anchoring effects have also been studied in the healthcare context. Brewer, Chapman, Schwartz, and Bergus (2007) conducted a study where physicians were given a vignette of a hypothetical patient. The physicians were then asked to indicate the probability that the patient had a pulmonary embolism, which is known in the medical community to be very difficult to diagnose, and therefore diagnoses are often made with a fair amount of uncertainty. Participants were then randomized to be exposed to a "high" numerical anchor, or "low" numerical anchor, asking if they believed that the chance of a pulmonary embolism was greater than, or less than, 90% or 1%, respectively, before being asked to give their absolute judgment of the probability. Similar to previous anchoring studies, the physicians who were exposed to the low numerical anchor tended to rate the probability of the patient having a pulmonary embolism as being lower (23%) than those in the high numerical anchoring group (53%).

Anchoring effects have also been studied in relation to pain but to a much lesser extent. Riva and colleagues (2011) demonstrated that there may be an anchoring bias in healthcare professionals' perceptions of patient pain. The researchers recruited 423 health care professionals who read vignettes describing a patient presenting with a headache. Participants randomized to the experimental arm were asked to rate the patient's level of pain immediately after reading the vignette and again after learning of the patient's pain rating, while control group participants were asked to rate the patient's level of pain only after learning of the patient's self-reported pain level. Healthcare professionals in the experimental condition tended to maintain their original pain rating, or, did not sufficiently alter it, after hearing the patient's subjective pain rating. In contrast, those in the control condition tended to agree with the patient's subjective pain rating. The results of the experimental condition indicate that once an initial judgment of pain had been made by the healthcare professionals, the patient's self-reported pain rating did not influence the professionals' final decision of the patient's pain intensity (Riva et al., 2011). On the other hand, under the appropriate groups, the presence of a pain-related numeric anchor in the form of a patient's pain rating may unintentionally influence a healthcare provider's evaluation of a patient's pain.

Anchoring in the context of pain can also occur if physicians make an initial probability estimate of a certain diagnosis (Bravata, 2000). Once an initial probability estimate has been established, the physician has effectively set an anchor, and subsequently uses tests to confirm this likelihood. In some cases, this may lead to correct diagnoses; however, this anchor may also lead to poor judgment or incorrect diagnoses (Bravata, 2000). Given the importance of early intervention for chronic pain patients, it is all the more important to understand whether anchoring effects influence how a patient's pain is perceived.

The Present Study

Pain-related numeric anchors appear to influence a healthcare provider's perception of patient pain (Riva et al., 2011). However, it remains to be seen whether a 'random' numeric anchor, with no relevance to the subsequent estimation task, can influence an individual's perception of someone else's pain. This has relevance to healthcare providers, as it would indicate that numeric quantities unrelated to the patient may influence how a healthcare provider evaluates the patient's pain. It would also demonstrate a novel situational factor that operates through a cognitive bias to unwittingly influence the health care provider's estimate of the patient's pain. The present study aimed to provide a preliminary assessment of whether exposure to a 'random' numeric anchor influences subsequent estimates of a hypothetical patient's pain intensity ratings.

Hypotheses

Based on the literature reviewed above, the following hypotheses were made:

1. Participants who are exposed to a numerical anchor will be influenced by that anchor, with the median pain rating of participants who were exposed to a high numerical anchor being significantly higher than the median pain rating of those who are exposed to a low numerical anchor.

2. Median pain ratings of those who are not exposed to an anchor will be higher than those who are exposed to the low anchor, but lower than the median pain rating of those who are exposed to the high-anchor.
3. The median pain ratings of the two groups that are not exposed to a numerical anchor will not differ from one another.
4. Participants who are originally not exposed to a numerical anchor will anchor to their original pain ratings when asked to re-rate the patient's pain, even if they are subsequently exposed to a high anchor. That is, median pain ratings of those who are originally not exposed to a numerical anchor will remain unchanged even after the subsequent exposure to the high numerical anchor.
5. The median pain ratings of those who believe that they were influenced by the anchor within each group will not be significantly different from those who do not believe they were influenced.

Methods

Participants

A total of 516 participants were recruited through Mechanical Turk (Amazon.com, Inc. Seattle, WA), an online study recruitment website that has millions of users world-wide who participate in Human Intelligence Tasks in exchange for money (Goodman, Cryder, & Cheema, 2013). The only inclusion criterion was that participants be fluent in English. Of the 516 participants, 385 (223 males, 162 females, M_{age}= 35.85, SD= 10.96, range= 19-72) were included in the final analysis. Figure 1 shows the flow chart depicting participant recruitment.

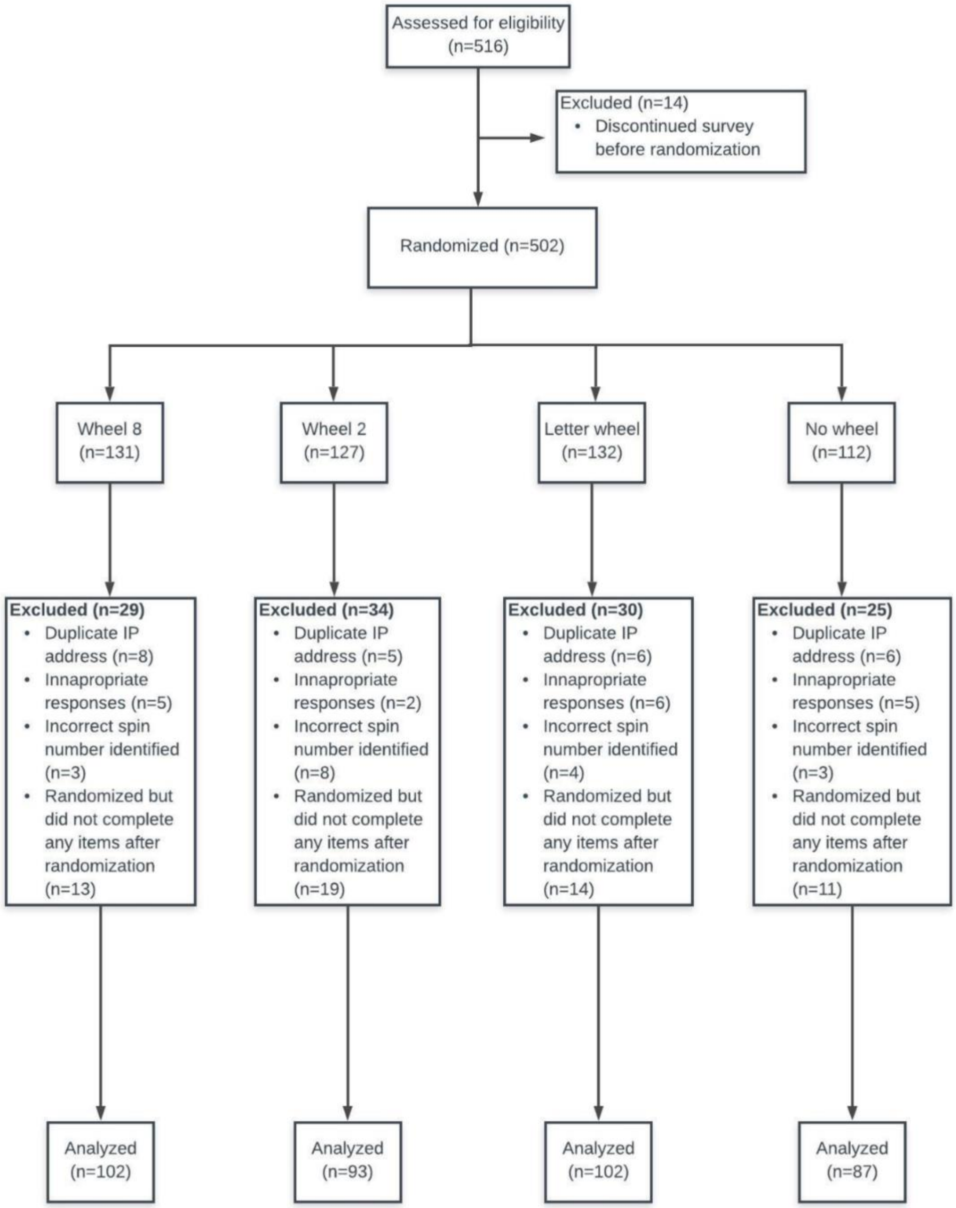

Figure 1: Flow chart of participant recruitment.

Procedures

This study was reviewed and approved by the York University Research Ethics Board (Human Participants Review Committee certificate #e2018-017). Informed consent to participate was obtained prior to the start of the study, and participants were compensated $1 USD for their time. The study was administered using Qualtrics software (Version May 2018, Provo, UT, USA), an online survey management system. Participants were directed to the Qualtrics website, where they provided informed consent to participate and completed demographic questions, including questions regarding their history of pain. Participants were then randomized into one of four groups using the randomizer available through Qualtrics. Each group was asked to read the following vignette which describes the journey of a hypothetical person from injury, post-injury chronic pain, to rehabilitation:

> *"Steve lives in a modest house on a quiet, tree-lined street very close to a major highway. Last year, as Steve was driving to work one morning, he was involved in a serious collision that nearly cost him his life. He spent months in the hospital and underwent multiple surgeries to repair his leg which was shattered in the crash. After many more months of physical rehabilitation, Steve is left with chronic leg pain and requires a cane to walk especially when the pain acts up. Steve sees his physical therapist once a week for treatment and despite the increased pain he has after each session, he feels the therapy is helping."*

Virtual spinning wheels comprised of 11 wedges each were created using Adobe Flash animation for the purposes of the present study. Unbeknownst to the participants, these virtual spinning wheels were programmed online to stop at a pre-determined value. Participants in Groups 1 (n = 102) and 2 (n = 93) spun an online wheel containing the numbers 0 to 10, that was programmed to stop on either a high number (8) or a low number (2), respectively. To control for viewing numeric values, participants in Group 3 (n=102) spun a similar wheel containing the letters A-K that was programmed to stop on either the letter "C" or "I". To control for the spinning of the wheel itself, participants in Group 4 (*n* = 87) read the vignette and initially did not spin a wheel. Figure 2 illustrates the wheels used for Groups 1, 2, and 3.

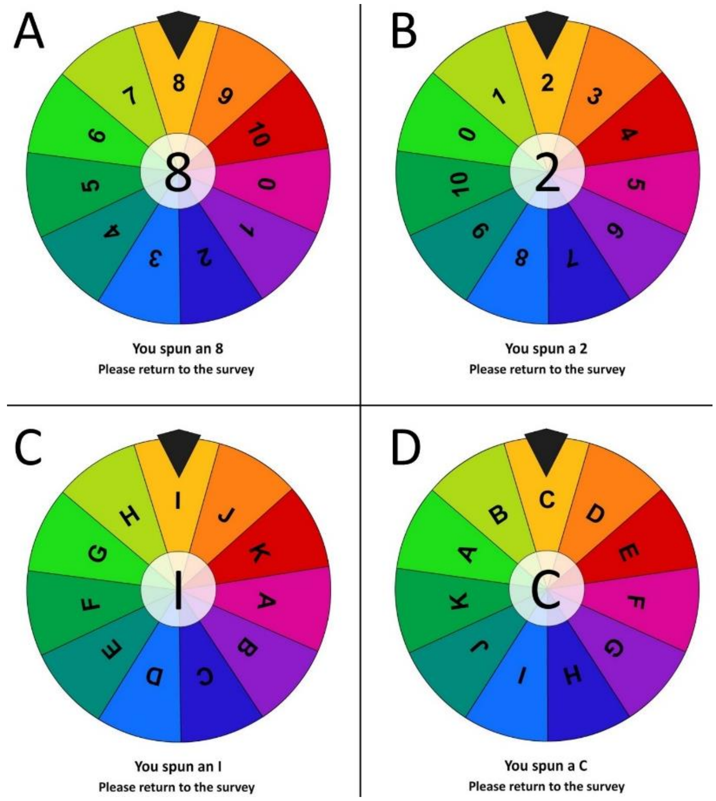

Figure 2. Spinning wheels used for Group 1 (A), Group 2 (B), and Group 3 (C and D)

Immediately after spinning the wheel, participants in Groups 1 and 2 were asked to recall the number they saw on the wheel, and to indicate if they thought the number was higher, lower, or equal to the intensity of pain that the patient in the vignette experiences on a typical day. Those in Group 3 were only asked to recall the letter they saw on the wheel spin. Participants in Groups 1-3 were then asked to estimate the patient's pain intensity on a typical day using a 0 ("no pain") to 10 ("worst possible pain") numeric rating scale (NRS). Subsequent questions were completed to ascertain whether participants in Groups 1-3 believed that the anchor had influenced their pain intensity rating of the patient, and if so, in what way.

Participants in Group 4 were asked to provide a NRS pain rating immediately after reading the vignette. Upon providing a pain rating, participants in Group 4, who initially did not spin a wheel, were asked to re-read the vignette, spin the high-anchor wheel (set to stop on the number 8), and re-rate the patient's pain. This was done to determine whether participants in Group 4 would anchor to their own original pain rating, or if they would be influenced by the numerical anchor.

After completing the experimental task, all participants completed the Pain Catastrophizing Scale (PCS) and the Hospital Anxiety and Depression Scale (HADS) as previous studies have indicated that both pain catastrophizing and anxiety or depression are associated with pain ratings (Gerrits, van Marwijk, van Oppen, van der Horst, & Penninx, 2015; Quartana, Campbell, & Edwards, 2009; Snaith, 2003; M. J. Sullivan, Bishop, & Pivik, 1995). Of particular interest, individuals high on pain catastrophizing scales have also been shown to infer more intense pain in others (M. Sullivan, Martel, Tripp, Savard, & Crombez, 2006). As such, it is important to ensure that anchoring effects are not confounded by pain catastrophization.

Measures

Hospital Anxiety and Depression Scale (HADS). The HADS measures symptoms of anxiety and depression, and has been widely used among both clinical and non-clinical populations (Bjelland, Dahl, Haug, & Neckelmann, 2002). It contains 14 items, consisting of two subscales. Seven items comprise the anxiety subscale, and seven items comprise the depression subscale. Each item is rated on a 0-3 Likert scale. Higher scores are associated with a higher severity of anxiety or depressive symptoms (Bjelland et al., 2002). Subscale scores range from 0-21, where scores equal to or below seven indicate no clinically relevant findings of depression or anxiety ("normal"). Scores between eight and ten are suggestive of a possible mood disorder ("borderline abnormal"), and scores between 11-21 are suggestive of the probable presence of a mood disorder ("abnormal") (Snaith, 2003) The HADS has been found to be reliable in detecting states of anxiety and depression and their associated severity. It has good internal consistency (α= .82), and has been very well-validated in a number of settings (Bjelland et al., 2002). The internal consistency of the HADS for the present study was .91.

Pain Catastrophizing Scale (PCS). The PCS measures the extent to which an individual experiences pain-related catastrophic thinking, including how much they think and worry about pain, magnify the amount of pain experienced, and feel helpless towards painful experiences. It consists of 13 items, each rated on a five-point Likert scale, with scores ranging from 0-52. Scores above 30 are considered to be clinically relevant for catastrophizing. (M. J. Sullivan et al., 1995) Individuals who score higher on the PCS also tend to report more intense pain experiences as well as heightened anxiety and depression symptoms (M. J. Sullivan et al., 1995). These individuals also tend to use more analgesic medication, have longer hospitalizations, and tend to demonstrate an increase in pain behaviours and pain-related disabilities (M. J. Sullivan et al., 1995). The PCS has demonstrated good internal consistency (α= .87), and has been well validated in both clinical and non-clinical samples (M. J. Sullivan et al., 1995). In the present study, the internal consistency of the PCS was .96.

Sample Size Estimation

Sample size estimation using G*Power (v3.1.9.4, University of Düsseldorf, Germany; Faul et al., 2009) indicated that 400 participants (n=100 per group) are required for ANOVA with alpha = .05, power = .95 and an effect size of .25.

Data analysis

Data analyses were conducted with a significance level of $\alpha = .05$. Chi-square tests of independence were conducted to determine any significant demographic group differences. A Kruskal-Wallis test was used to determine whether the groups differed in age.

Hypothesis 1 was analyzed using a non-parametric Kruskal-Wallis test, as initial screening of the data revealed a non-normal distribution, necessitating a non-parametric approach to data analysis (see Results). The medians of the four groups were compared to determine whether the high and low numerical groups (Groups 1 and 2) significantly differed, and to determine whether the median pain ratings of both Groups 3 and 4 were higher than the median pain ratings of Group 2 and lower than Group 1.

Hypothesis 2, that the median pain ratings of those who are not exposed to an anchor will be higher than those who are exposed to the low numerical anchor, but lower than the median pain rating of those who are exposed to the high numerical anchor, was analyzed using a Kruskal-Wallis test.

Hypothesis 3, that the median pain ratings of the two control groups (Group 3 and 4) would not significantly differ from one another, was analyzed using a Kruskal-Wallis test.

Hypothesis 4, that participants in Group 4 would anchor to their original pain ratings rather than be influenced by the high numerical anchor, was analyzed using a Friedman test. Hypothesis 5, that the median pain ratings between participants who believed they had been influenced, and participants who believed they had not been influenced by the numerical anchor would not differ, was first analyzed using a chi-square test of independence to determine whether the proportion of participants being influenced by the anchor differed by group. A Kruskal-Wallis test was used to determine if pain intensity ratings were significantly different across groups for those participants who reported they had not been influenced by the anchor, and those who felt they had been influenced by the anchor.

Results

Demographics

Table 1 shows the demographic variables for the sample of participants. The majority of participants self-reported their ethnicity to be Caucasian (*n*=226, 57.9%) or South Asian (*n*=97, 25.2%). The sample was relatively well-educated with 89.4% (*n*=344) of participants having at least some post-secondary education. 62.6% (*n*=241) of participants endorsed currently experiencing an ongoing pain problem, with 32.2% (*n*=124) reporting they had been diagnosed with chronic pain by a physician. Of the 330 participants on whom longitude and latitude was reported, the majority were located in North America (*n*=214, 57.1%) or India (*n*=95, 25.3%), with the remaining 21 (5.6%) being from South America (*n*=8, 2.1%), Asia (*n*=5, 1.3%), Europe (*n*=6, 1.6%), and Africa (*n*=2, 0.5%).

Table 1

Demographic information for the four groups

	Group 1 (***n*= 102)**	**Group 2** (***n*= 92)**	**Group 3** (***n*= 102)**	**Group 4** (***n*= 87)**	**X(df)**	***p***
Age (years) (SD)	35.06 (10.11)	34.80 (9.47)	37.13 (11.63)	39.34 (11.84)		
Sex *n* (%)						
Male	64 (62.7%)	53 (57%)	50 (49%)	55 (63.2%)	5.319(3)	.150
Female	38 (37.3%)	40 (43%)	52 (51%)	32 (36.8%)		
Education *n* (%)						
High School	4 (3.9%)	12 (12.9%)	15 (14.7%)	10 (11.5%)	16.456(9)	.058
Some post-secondary	33 (32.4%)	18 (19.4%)	17 (16.7%)	22 (25.3%)		
Post-secondary	41 (40.2%)	49 (52.7%)	47 (46.1%)	38 (43.7%)		
Graduate degree	24 (23.5%)	14 (15.1%)	23 (22.5%)	17 (19.5%)		
Ethnicity *n* (%)						
White	62 (60.8%)	51 (54.8%)	62 (60.8%)	51 (58.6%)	9.044(12)	.699
South Asian	23 (22.5%)	27 (29%)	26 (25.5%)	21 (24.1%)		

African Descent	5 (4.9%)	5 (5.4%)	6 (5.9%)	10 (11.5%)		
Other	11 (10.8%)	10 (10.8%)	7 (6.9%)	5 (5.7%)		
Ongoing Pain *n* (%)						
Yes	63 (61.8%)	56 (60.2%)	72 (70.6%)	49 (56.3%)	8.030(6)	.236
No	39 (38.2%)	35 (37.6%)	30 (29.4%)	37 (42.5%)		
Pain Duration *n* (%)						
< 3 months	9 (8.8%)	5 (5.4%)	10 (9.8%)	6 (6.9%)	12.869(12)	.379
3-6 months	6 (5.9%)	12 (12.9%)	14 (13.7%)	2 (2.3%)		
6-12 months	9 (8.8%)	10 (10.8%)	8 (7.8%)	6 (6.9%)		
>1 year	38 (37.3%)	30 (32.3%)	40 (39.2%)	35 (40.2%)		
Pain longer than 3 months *n* (%)						
Yes	39 (38.2%)	42 (45.2%)	32 (31.4%)	38 (43.7%)	5.989(6)	.424
No	63 (61.8%)	50 (53.8%)	69 (67.6%)	48 (55.2%)		
Chronic Pain *n* (%)						
Yes	29 (28.4%)	32 (34.4%)	33 (32.4%)	29 (33.3%)	2.023(6)	.918
No	72 (70.6%)	59 (63.4%)	68 (66.7%)	56 (64.4%)		

Classification of HADS Depression Scores *n* (%)						
Normal	70 (68.6%)	65 (69.9%)	66 (64.7%)	53 (60.9%)	5.679(6)	.450
Borderline	25 (24.5%)	21 (22.6%)	31 (30.4%)	31 (35.6%)		
Abnormal	7 (6.9%)	7 (7.5%)	5 (4.9%)	3 (3.4%)		
Classification of HADS Anxiety Scores *n* (%)						
Normal	48 (47.1%)	48 (51.6%)	49 (48%)	55 (63.2%)	7.755(6)	.257
Borderline	24 (23.5%)	17 (18.3%)	26 (25.5%)	12 (13.8%)		
Abnormal	30 (29.4%)	28 (30.1%)	27 (26.5%)	20 (23%)		

Note. * indicates significance at the α=.05 level. *SD*= Standard Deviation

Group characteristics

Chi-square tests of independence demonstrated no significant differences between groups in gender, ethnicity, education, or pain history. (see Table 1). Chi-square tests also show that between groups, there were no significant differences in the number of participants who scored above or below the clinical cut-off on the PCS (p= .257) or for the HADS in the depression (p= .511) or anxiety (p= .302) subscales, or in self-reported chronic pain (p=.918). A Kruskal-Wallis test demonstrated that there was no significant difference in groups for age, $H(3)= 4.779$ p= .189.

Hypothesis 1: Effects of numerical anchoring on pain scores

Table 2 shows NRS pain intensity ratings for the four groups.

Table 2

Median (Interquartile Range) numeric rating scale (NRS) pain intensity scores for the four groups

	Group 1 (*n*= 102)	**Group 2 (*n*= 92)**	**Group 3 (*n*= 102)**	**Group 4 (*n*= 87)**
Pain intensity rating *Median (IQR)*	8 (2)	6 (2)	7 (2)	7 (2)
Pain Intensity Rating after spinning the wheel (Group 4 only) *Median (IQR)*	---	---	---	7 (2)

Note. IQR= Interquartile Range; *NRS*= Numeric Rating Scale.

A visual inspection of the histograms shown in Figure 3 indicated a non-normal distribution of the pain intensity ratings, particularly for Group 1. This was confirmed by the Shapiro-Wilk test (p<.05). Figure 4 shows the box plots of pain scores for the four groups.

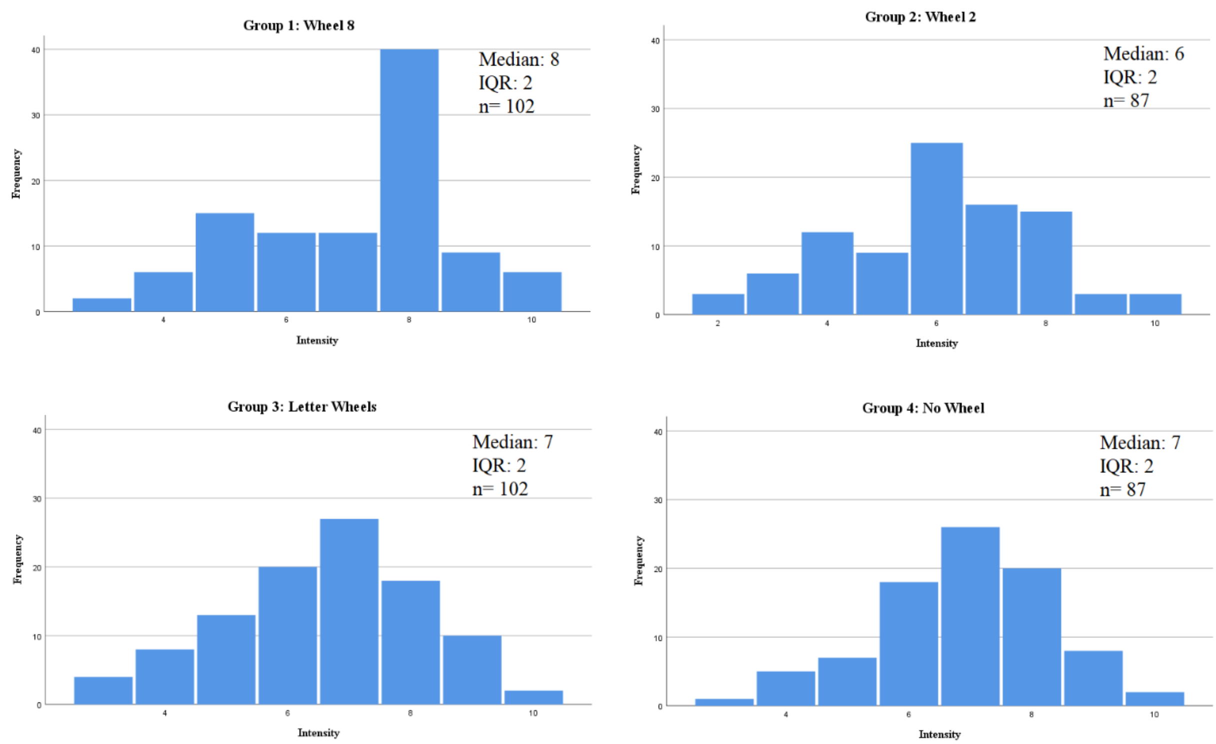

Figure 3. Frequency distributions of pain intensity ratings for Groups 1-4.

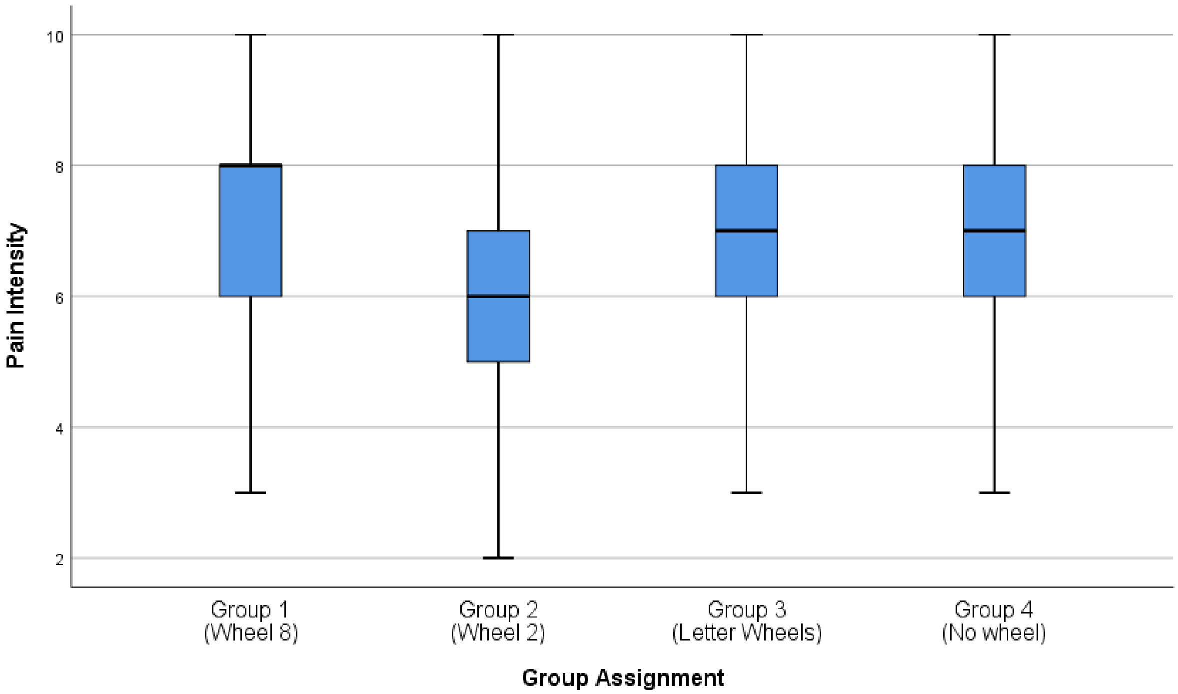

Figure 4. Boxplots of pain intensity ratings for Groups 1-4. In each box, the bolded line represents the median pain rating for each group. The interquartile range (IQR) is a measure of variability that is more resistant to outliers than the range or standard deviation. It represents the difference between the highest and lowest scores within the middle 50% of a set of scores. In the boxplot, the IQR is the difference between the upper quartile (the highest portion of the box), and the lower quartile (the lowest portion of the box). For example, the IQR for Group 1 would be the difference between the highest portion (8) and the lowest portion (6). Therefore, the IQR for Group 1 is IQR= 8 ± 2. The whiskers extending from the box indicate the group's most and least extreme scores (Field, 2009).

Kruskal-Wallis tests showed a significant difference between the mean ranks of at least one pair of groups in their pain intensity ratings, $H(3)= 19.529$, $p < .001$. Dunn's pairwise tests revealed that the high-wheel group (*Median* ± *IQR* =8 ± 2*)* rated the patient's pain significantly higher than the low-wheel group (*Median* ± *IQR*= 6 ± 2, $p < .001$)

Hypothesis 2- Median pain ratings of groups not exposed to the numerical anchor

The Kruskal-Wallis test above, $H(3)= 19.529$, $p < .001$, indicated that there was a significant difference between the mean ranks of at least one pair of groups in their pain intensity ratings.

Dunn's pairwise tests revealed that the high-wheel group (Group 1) (*Median* ± *IQR* =8 ± 2) rated the patient's pain as being significantly higher than the letter wheel group (Group 3) (*Median* ± *IQR* = 7 ± 2, p= .023). There were no significant differences in pain rating between the high-wheel group and Group 4 who initially did not spin a wheel (p= .325). The low wheel group rated the patient's pain significantly lower than both the letter-wheel group (p = .045) as well as Group 4, which did not spin a wheel (*Median* ± *IQR* = 7 ± 2, p= .045).

Hypothesis 3- Median pain ratings of control groups

There were no significant differences in pain ratings between Groups 3 and 4 (p = .230)

Hypothesis 4 - Anchoring after an initial judgment had been made

A Friedman's test indicated that there were no significant differences in pain ratings for Group 4 between Time 1, initially after reading the vignette, (M_{rank}= 1.55) and Time 2, after re-reading the vignette and spinning the high-anchor wheel. (M_{rank}= 1.45), $\chi^2(1)$= 3.2, p=.074. Among those who believed they had been influenced by the anchor, there were no significant differences in pain ratings between Time 1 (M_{rank}= 1.56) and Time 2 (M_{rank}= 1.44), $\chi^2(1)$ = 0.50, p=.480.

Hypothesis 5 - Influence of the numerical anchor

A chi-square test of independence demonstrated that there were significant differences between groups in the proportion of participants who believed that their pain intensity rating of the patient had been influenced by the number they spun, χ^2 (3) = 11.025, p= .012. Table 3 demonstrates these results.

Table 3

Participants' perception of whether they were influenced by the anchor that they were exposed to.

Influence	Group 1 *n*(%)	Group 2 *n*(%)	Group 3 *n*(%)	Group 4 *n*(%)	χ^2 (df)	*p*
Yes	36 (35.3%)	19 (20.4%)	17 (16.7%)	19 (21.8%)	11.025(3)	.012*
No	66 (64.7%)	74 (79.6%)	85 (83.3%)	67 (77%)		

Note. * indicates significance at the α= .05 level.

In particular, participants in Group 1 were significantly more likely to believe that they had been influenced by the anchor, while participants in Group 3 were significantly more likely to believe that they had not been influenced by the anchor. In Group 1, 35.3% (*n*=36) of participants endorsed being influenced, in comparison to 20.4% (*n*=19) in Group 2, 16.7% (*n*=17) in Group 3, and 21.8% (*n*=19) in Group 4 after these participants had spun the high anchor wheel.

A Kruskal-Wallis test indicated that among participants who indicated they were not influenced by the anchor, there were no significant differences between groups in pain intensity ratings, $H(3)= 7.214$, $p= .065$. In contrast, there were significant differences in pain intensity ratings across groups among those participants who indicated they had been influenced by the anchor, $H(3)= 13.644$, $p= .003$. Dunn's pairwise tests indicated that participants in Group 2 (*Median* ± *IQR =6 ± 5)*, who spun the low-anchor wheel, rated the patient's pain significantly lower than participants in Group 1 (*Median ± IQR =8 ± 1),* who spun the high-anchor wheel (*p*= .003), as well as participants in Group 4 (*Median ± IQR =8 ± 2)*, who initially did not spin a wheel, but later spun the high-anchor wheel (*p*= .026). Participants in Group 1 who indicated they had been influenced by the anchor reported significantly higher pain intensity ratings than participants in Group 3 (*Median ± IQR =7 ± 2),* who spun a wheel containing letters (*p*= .006). Finally, among those who believed they had been influenced by the anchor, participants in group 4 rated the patient's pain significantly higher than participants in group 3 (*p*=.046). In addition, a Kruskal-Wallis test indicated that after participants in Group 4 had spun the high-anchor wheel and re-rated the patient's pain, those who indicated that they had been influenced by the anchor tended to rate the patient's pain as being significantly higher than those who believed they had not been influenced by the anchor, $H(1)= 5.881$, $p= .015$.

Discussion

This study examined whether prior exposure to a pain-unrelated, random numerical anchor would influence participant's ratings of a hypothetical patient' pain intensity. This was done by asking participants to read a vignette depicting a hypothetical patient who lives with chronic pain, before asking the participants to spin a wheel programmed to land on a high numerical anchor (8), a low numerical anchor (2), or a letter (C or I). A fourth group served as a control condition and did not spin a wheel initially before rating the patient's pain intensity, but were later asked to spin the high-anchor wheel and re-rate the patient's pain.

At first glance, the findings appear to support the main hypothesis, that exposure to a numerical anchor would influence participant's estimations of a hypothetical patient's pain intensity. Participants who spun a high numerical anchor estimated that the hypothetical patient experienced a much higher pain intensity than did the other three groups. Additionally, participants in the low numerical anchor condition had the lowest estimation of pain intensity for the hypothetical patient. The second hypothesis, that participants in the letter-wheel group as well as the control group who originally did not spin a wheel, would have median pain ratings that were lower than participants who spun a high-anchor wheel, but higher than participants who spun a low-anchor wheel, were only partially supported. Participants in the letter-wheel condition were found to have this result; however, those in the control group that did not initially spin a wheel did not have a median pain rating that was significantly lower than the high-wheel group, but the median pain rating of the no-wheel group was significantly higher than the low-wheel group. Importantly, there was no difference in pain intensity ratings between participants who spun a wheel containing a letter and the control group that did not spin a wheel (Hypothesis 3), indicating that the spinning of the wheel itself had no effect on pain intensity ratings. These results are in line with a number of studies that have also used a spinning wheel or similar devices to anchor their participants to a random numerical anchor (Mussweiler, Englich, & Strack, 2004; Tversky & Kahneman, 1974).

Given that the no-wheel group's median pain intensity rating was not significantly lower than the high-anchor group's rating, and given that there were no significant differences between the letter-wheel and no-wheel control groups, these results may suggest that regardless of the presence of an anchor or not, the pain intensity that was depicted within the vignette may have been in line with a higher pain intensity. The anchoring effect is still demonstrated in this study in that there were significant differences between the median pain ratings of the high- and low-anchor conditions; however, that there were no significant differences between the high-anchor group and the no-wheel control group's median pain intensity rating indicates that the vignette itself may have been a confounding factor.

The fourth hypothesis, that those participants who were originally not exposed to an anchor would anchor to their original pain rating when asked to re-rate the patient's pain, even when subsequently exposed to the high-anchor, was supported. Participants did not adjust their second pain ratings when asked to re-rate the patient's pain. This was expected, given the results of Riva et al. (2011), who similarly found that health care providers did not significantly adjust their results when asked to re-rate a patient's pain, even when given additional information about the patient's subjective pain rating.

The fifth hypothesis, that the median pain ratings in each group would not differ between those who did and did not believe they had been influenced by the anchor, was unsupported. In the high-anchor group, those participants who believed they had been influenced had a significantly higher median pain rating than those who did not believe they had been influenced.

Similarly, in the low-anchor group, those participants who believed they had been influenced had a significantly lower median pain rating than those who did not believe they had been influenced. While the majority of participants in all four groups indicated that they were not influenced by the anchor, those participants who spun a high anchor were also more likely than any other group to indicate that they had been influenced by the anchor. This may relate to the suggestion above. The vignette may have depicted a higher pain rating, and after spinning the wheel and rating the patient's pain as higher, the participants may then have inferred that they must have been influenced. This is discussed in more depth below.

The results also demonstrate that when participants acknowledged the anchor's influence on their pain rating, they do seem to have actually been influenced. Among the participants who reported they had been influenced by the anchor, the results were very similar to the overall study findings in that participants who spun a high anchor wheel rated the patient's pain as being more intense than all other groups, while those who spun a low anchor wheel rated the patient's pain as being less intense than all other groups. In contrast, the median pain ratings for all four groups were not significantly different among those participants who indicated they had not been influenced by the anchor. In other words, the anchoring effect was seen only in participants who reported that the anchor influenced their decision making. These results deviate from previous studies that have examined the role influence on anchoring effects. Although only one study has looked directly at whether participants believed they had been influenced or not (Wilson et al., 1996), both Chapman and Johnson (1999) and Quattrone (1982) investigated whether being warned would inhibit the anchoring effect. In all three studies, the anchoring effect was present in all participants who were exposed to the anchor, but anchoring effects were consistently stronger in cases where the anchor was relevant or informative to the target. However, in none of the three studies were the anchors completely random as they were in the current study, despite being uninformative. In the study conducted by Chapman and Johnson (1999), participants were anchored to a random dollar amount before being asked target questions about whether they would sell a lottery ticket for that dollar amount. Therefore, though the anchor was random and uninformative, it was not irrelevant to the task at hand. In the current study, the anchors used were both irrelevant, as well as random. As such, the results of the previous studies by Chapman and Johnson (1999), as well as Wilson et al. (1996) and Quattrone (1982) do not provide a concrete description of the role of influence on random numerical anchoring effects.

The effect of influence that was seen in the three anchoring conditions was also seen in participants in Group 4, who initially did not spin a wheel. After re-reading the vignette, the participants were asked to spin the high-anchor wheel and re-rate the patient's pain. Overall, the participants did not change their pain intensity rating after re-rating the pain, which was expected. Riva et al. (2011) found similar results in that their participants did not change their pain rating when asked to re-evaluate a patient's pain, and instead anchored to their original rating. In the current study however, after spinning the high-anchor wheel, participants in Group 4 were also asked whether they believed the number they spun had influenced their response. This result may be due in part to cognitive dissonance theory- in particular, *selective exposure.* Selective exposure explains that individuals are more likely to be attuned to information that is congruent with their previous beliefs, attitudes, or opinions (Sears & Freedman, 1967). In the current study, participants were asked to form an opinion of the hypothetical patient's pain intensity; however, the participants were then exposed to new information (the spinning wheel containing a high anchor). It may be that participants remained consistent with their original response because changing their response would also require them to re-evaluate their perception of the patient's pain. Despite this, cognitive dissonance theory does not explain why, similar to the other three groups in the current study, the anchoring effect was seen only in participants who indicated they had been influenced by the anchor, while those who indicated they were not influenced tended to evaluate the patient's pain as being less intense and remain consistent with their original pain rating.

Taking in the entirety of the sample, the results initially suggest that anchoring has occurred. However, when also taking into consideration the effect of influence, anchoring only appears to have occurred in those who reported that they were influenced. These findings are contradictory to the traditional definition of anchoring where anchoring is proposed to occur independent of the participant's knowledge or lack thereof, of the anchor's influence on their subsequent decisions.

The effect of influence rarely has been evaluated in studies examining anchoring effects. Given the traditional anchoring paradigm as designed by Tversky and Kahneman (1974), where influence is not explored, the majority of anchoring researchers typically have not included a question aimed at determining the role of influence on participants' decision making (Chapman & Johnson, 2002). However, Wilson et al. (1996) did explore the role of influence on anchoring. In a series of two studies, participants were asked to rate how much they believed their answers had been influenced by the anchor. Similar to our study, the majority of their participants believed that the anchor had no influence on their response, and higher anchor values were associated with more belief of the anchor's influence. However, in both of the studies conducted by Wilson et al (1996), anchoring effects were found even in those who did not acknowledge the anchor's influence. In contrast, the results of the present study showed that there were no significant differences in pain intensity ratings among those who believed they had not been influenced by the anchor. One possible explanation for these results relates back to the selective accessibility model. Although the spinning wheel provided no actual semantic value, it may be that those participants who believed that they were influenced were the ones who were able to successfully integrate the vignette with the number they spun, thus adjusting their pain intensity rating to be closer to the anchor. Alternatively, these participants may be ones who spent more time focusing on the anchor, thus rendering it more accessible and therefore allowing them to recognize the anchor's influence on their pain rating.

The selective accessibility model is one explanation for these influence effects. It may also be that these influence effects seen across groups are due to a confirmatory search mechanism, as proposed by Chapman and Johnson (1999), in that after being exposed to a numerical anchor, participants then focused on reasons why that number is consistent with the hypothetical patient's pain, rather than on reasons why the anchor may be inconsistent with the patient's pain intensity. In this way, the numerical anchor may have influenced their decision-making. It is interesting, however, that some participants (16.7%) in Group 3 who spun a letter, indicated that they had been influenced by the anchor, despite the anchor being a letter value rather than a numeric one and therefore holding no possible relevant information for a numeric rating scale. This finding may be due to a demand effect (Grice, Cole, & Morgan, 1975; Schwarz, 1994), where participants may have inferred that they would not have been asked to spin a letter or had their attention subsequently drawn to it through the questions asked of them if the letter was not relevant or informative in some way. Finally, as noted by Nisbett and Ross (1980), these influence effects do not necessarily indicate that those who believed they were influenced actually were influenced. Rather, it may be that after being exposed to the anchor, the 16.7% of participants in the letter wheel group who believed that they had been influenced by the anchor inferred that their judgment must have been influenced, based on the response that they gave (Wilson et al., 1996).

That participants in the letter-wheel group believed they had been influenced by the letter they spun may also be indicative of a baseline percentage of participants who would believe they were influenced. Further studies should also seek to establish a baseline of what proportion of a sample will believe that they had been influenced.

Limitations

The current study has a number of limitations that are important to consider. Given that the study was completed online, it is possible that participants were not able to fully attend to the vignette, wheel, or the subsequent questions. As a result, the anchoring effects and influence effects seen may be due instead to the fact that the participants had very recently been exposed to a number rather than true anchoring effects. That is, if participants were not attending fully, they may have rated the participant's pain according to the numerical anchor they were exposed to simply due to the availability of the anchor in their memory rather than because that is the pain intensity rating they believe the patient experiences, or because of anchoring effects. These same participants might subsequently indicate that they had been influenced by the anchor as their response was based on the number they had been exposed to. Previous studies have demonstrated that data collected through Mechanical Turk is as reliable as data collected in a laboratory setting, with the exception of attention paid to the study itself (Gabrielle Paolacci & Chandler, 2014; Gabriele Paolacci, Chandler, & Ipeirotis, 2010). Typically this limitation is overcome through the use of validity questions to ensure that the participant is attending to the study (Gabriele Paolacci et al., 2010). The current study did contain validity questions, such as asking the participants which number or letter they spun; however, it is possible that additional validity questions regarding the vignette would have helped to more effectively screen out inattention.

A second limitation is that the current study has no pilot data on the vignette that was used to give a description of the hypothetical patient. As a result, it is unknown what the patient's baseline pain intensity would be rated as. This information would help to ensure that the vignette itself was not a confounding variable. For instance, if the vignette was shown to depict a pain intensity that is higher without the presence of a numerical anchor, it is possible that the influence effect that was seen in the high-anchor group may have been due to participants inferring that they had been influenced given the pain intensity rating that they had given.

Finally, the current study is limited by the fact that it is one of the first anchoring studies to look at the effect of influence on anchoring effects. As such, the questions regarding influence had not been previously tested, and may not have been valid, or may have unwittingly created biased responses.

Strengths

Despite the above-mentioned limitations, the study also has a number of strengths. Firstly, with a relatively large sample size of participants that were recruited globally, it is likely that the data is not only reliable but also cross-culturally validated. Participants were diverse in their age, education, ethnicity, and pain history which also helps to ensure that the data is valid and generalizable. In order to ensure that the results would be generalizable, Mechanical Turk was chosen as the primary recruitment method for this study, as previous studies have shown that the data collected through Mechanical is as reliable as data gathered from undergraduate participants (Buhrmester, Kwang, & Gosling, 2011).

Secondly, the current study is strengthened by the presence of two control conditions. In this way, both the effect of spinning a wheel as well as the effect of having the wheel land on a number, could be controlled. This helps to ensure that the anchoring effects seen are in fact due to anchoring effects, as opposed to being due to a confounding variable.

Finally, this study is one of the only studies to have looked at the effect of influence and found that anchoring effects were contingent upon the participant's belief that they had been influenced. Anchoring research has been very robust and well-established, but there has been very little research on the effect of influence on anchoring, and what these findings mean for the definition of anchoring itself. This study's results may help to better understand anchoring effects as a whole, as well as its underlying cognitive pathways.

Future directions

Future studies should attempt to clarify the role of influence on numerical anchoring. Namely, attempts should be made to replicate anchoring studies while also considering participant's perception of influence. It may be that the current definition of anchoring is not suitable if the effects of influence are reliably seen across studies, given that the current definition implies that participants are not aware of the anchor's influence on their judgment. Future studies should also expand on the current research about how random numerical anchoring might affect the pain response. In particular, it would be interesting to determine whether these same random numerical anchors could affect a participant's judgment of their own pain experience in both acute and chronic pain experiences. The current study has demonstrated that anchoring effects can influence how a hypothetical patient's pain is inferred. However, this study did not investigate how random numerical anchoring may influence how a patient's pain is perceived or treated. As such, future studies may also look at how numerical anchoring may be evident in the health care context in relation to how random numerical anchors may influence a health care provider's judgment and treatment of a chronic pain patient's experience.

Conclusion

The results of this study are consistent with previous studies of numerical anchoring. Exposure to a high numerical anchor influenced participants' subsequent rating of a hypothetical patient's pain to be higher, while exposure to a low numerical anchor influenced participants to rate the patient's pain as lower. However, while the majority of participants across groups did not believe they were influenced by the anchor, the anchoring effect was seen only in participants who did indicate that the anchor had influenced their judgments. Further research is necessary to determine the role of influence on anchoring effects, and the applicability of anchoring effects in the healthcare context.

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Appendix A: Informed Consent Form

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Informed Consent Form- Pain Vignette Study

Purpose of the Research: The ability of humans to accurately identify pain in others is crucial to the appropriate provision of aid. In this study, we are interested in your ratings of a person's pain after reading a hypothetical vignette.

What You Will Be Asked to do in the Research: You will be asked to complete a few demographic and other questions. You will then be asked to read a short vignette of a hypothetical patient and rate their pain. You will then be asked to answer some computer-based questionnaires. The study will take approximately 10-15 minutes to complete.

Benefits of the Research and Benefits to You: There are no major benefits that may reasonably be expected to result from this study, except the knowledge that you are contributing to graduate education and the advancement of science.

Voluntary Participation: Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision not to volunteer will not influence your relationship with York U, the researchers, or any other group associated with the project.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. If you decide to stop participating, you will still be eligible to receive the promised credit for agreeing to be in the project. Your decision to stop participating, or refusal to answer particular questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event you withdraw from the study and you do not wish the investigators to use your data, please let them know and the data will be destroyed.

Risks: There are no known risks associated with participating in this study. Should you feel any distress as a result of participating in the present study you may contact the York University Personal Counselling Services at 416-736-5297.

Confidentiality: All information you supply during the research will be held in confidence. . Your name or any other identifying information will not appear in any report or publication of the research. All data collected will be anonymized (will not contain personal identifying information).

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Katz either by telephone at [redacted] or by e-mail [redacted]. This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Legal Rights and Signatures:

I_______________________, consent to participate in the study "Pain Vignette Study" conducted by Dr. Joel Katz and Rebecca Lewinson. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by consenting to this statement. My selection below indicates my consent.

Signature_________________________ **Date**_____________________

Participant

Signature_________________________ **Date**_____________________

Person obtaining consent

Appendix B: Demographic Questions

1. How old are you? (text box)
2. What is your gender? (Multiple choice)
   a. Male
   b. Female
   c. Other: ______
3. How do you self-identify regarding your ethnicity? (multiple-choice with other option)
   a. Aboriginal
   b. African-Caribbean
   c. African-American
   d. East Asian (e.g. Hong Kong, China, Vietnam, Korea)
   e. Hispanic/Latino/a
   f. Middle-Eastern or North African (e.g. Iran, Israel, Egypt, Morocco)
   g. South Asian (e.g. India, Pakistan, Sri Lanka)
   h. White
   i. Other: ____
4. What is your highest level of education?
   a. Some high school
   b. High school diploma
   c. Some college/university
   d. College diploma
   e. University degree
   f. Master's degree
   g. Doctoral degree
   h. Other:____
5. If you are attending, or have attended post-secondary education, what is your major field of study? _____
6. Do you have any ongoing pain problems?
   a. Yes
   b. No
7. If you have ongoing pain problems, list diagnosis or type of pain and location (text box)
8. If you have ongoing pain problems, how long have you had the pain?
   a. Less than 3 months
   b. 3 months- 6 months
   c. 6 months- 1 year
   d. More than 1 year
9. Have you ever been diagnosed by a doctor with a chronic pain problem? If yes, indicate the diagnosis and location (text box)

Appendix C: Anchoring Questions

1. What number/letter did you spin*?
2. Using the above scale, do you think Steve's pain intensity on a typical day is higher than, lower than, or equal to the number you just spun? **/***
    a. Higher
    b. Lower
    c. Equal
3. Using the 0-10 scale above, how intense do you think Steve's pain is on a typical day?
    a. Why did you choose that number?
4. Do you think that the number/letter you spun influenced your rating of Steve's pain? */***
    a. Why do you think the number/letter influenced your rating of Steve's pain?
    b. Why do you think the number/letter you spun did not influence your rating of Steve's pain?
5. If a health-care professional were to rate Steve's pain, how intense do you think they would rate it to be?
    a. What made you choose that number?
6. Please re-read the vignette.

    Steve lives in a modest house on a quiet, tree-lined street very close to a major highway. Last year, as Steve was driving to work one morning, he was involved in a serious collision that nearly cost him his life. He spent months in the hospital and underwent multiple surgeries to repair his leg which was shattered in the crash. After many more months of physical rehabilitation, Steve is left with chronic leg pain and requires a cane to walk especially when the pain acts up. Steve sees his physical therapist once a week for treatment and despite the increased pain he has after each session, he feels the therapy is helping.

Now imagine you hadn't spun the wheel. Please use the 0-10 scale shown above to rate how intense you think Steve's pain is on a typical day.

**** This item was customized to say "number" or "letter" depending on group assignment.**

**** indicates an item that was asked only for Groups 1 and 2**

***** Indicates an item that was not asked for Group 4**

Appendix D: Hospital Anxiety and Depression Scale

Q43

Read each item below and click the box beside the reply which comes closest to how you have been feeling in the past week.

Q25

I feel tense or "wound up"

- Most of the time
- A lot of the time
- From time to time
- Not at all

Q26

I still enjoy the things I used to enjoy

- Definitely as much
- Not quite so much
- Only a little
- Hardly at all

Q27

I get a sort of frightened feeling as if something awful is about to happen

- Very definitely and quite badly
- Yes, but not too badly
- A little, but it doesn't worry me
- Not at all

Q29

I can laugh and see the funny side of things

- As much as I always could
- Not quite so much now
- Definitely not so much now
- Not at all

Q30

Worrying thoughts go through my mind

- A great deal of the time
- A lot of the time
- Not too often
- Very little

Q31

I feel cheerful

- Never
- Not often
- Sometimes
- Most of the time

Q32

I can sit at ease and feel relaxed

- Definitely
- Usually
- Not often
- Not at all

Q33

I feel as if I am slowed down

- Nearly all the time
- Very often
- Sometimes
- Not at all

Q34

I get a sort of frightened feeling like "butterflies" in the stomach

- Not at all
- Occasionally
- Quite often
- Very often

Q35

I have lost interest in my appearance

- Definitely
- I don't take as much care as I should
- I may not take quite much care
- I take just as much care as ever

Q36

I feel restless as if I have to be on the move

- Very much indeed
- Quite a lot
- Not very much
- Not at all

Q37

I look forward with enjoyment to things

- As much as I ever did
- Rather less than I used to
- Definitely less than I used to
- Hardly at all

Q38

I get a sudden feeling of panic

- Very often indeed
- Quite often
- Not very often
- Not at all

Q39

I can enjoy a good book or radio or television program

- Often
- Sometimes
- Not often
- Very seldom

Appendix E: Pain Catastrophizing Scale

Q40

Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures, or surgery.

We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

Q44

When I'm in pain...

	Not at all	To a slight degree	To a moderate degree	To a great degree	All the time
I worry all the time about whether the pain will end	○	○	○	○	○
I feel I can't go on	○	○	○	○	○
It's terrible and I think it's never going to get any better	○	○	○	○	○
It's awful and I feel that it overwhelms me	○	○	○	○	○
I feel I can't stand it anymore	○	○	○	○	○
I become afraid that the pain will get worse	○	○	○	○	○
I keep thinking of other painful events	○	○	○	○	○
I anxiously want the pain to go away	○	○	○	○	○
I can't seem to keep it out of my mind	○	○	○	○	○
I keep thinking about how much it hurts	○	○	○	○	○
I keep thinking about how badly I want the pain to stop	○	○	○	○	○
There's nothing I can do to reduce the intensity of the pain	○	○	○	○	○
I wonder whether something serious may happen.	○	○	○	○	○

Appendix F: Debrief Form

Debrief form: The effect of unconscious numerical anchoring on participants' rating of others' pain- Study 2

Numerical anchoring is a type of cognitive bias that influences people's ratings of quantities of objects by presenting them with a number before asking for their estimate. A good example of this would be if we showed one group of people the number **650** and another group the number **75** before asking them to guess the number of subway stations in the underground system in London, England. Those shown the higher number would produce higher estimates than those shown the lower number (the actual number is **270**).

The purpose of this study was to determine the effect of unconscious numerical anchoring on ratings of a hypothetical patient's pain. In this study, there were 4 groups of participants. Each group read the same vignette about Steve but two groups spun a wheel that contained numbers. One of these groups spun a high number, and the other group spun a low number. The third group spun a wheel that contained letters rather than numbers. Finally, the last group did not spin a wheel at all. The purpose of this study was to determine whether the number that was spun influenced participants' rating of the hypothetical patient's pain.

Because cognitive biases like the anchoring effect can be partly counter-acted by thinking carefully about the question you've been asked especially if you know someone is attempting to influence you, we could not tell you the purpose of the study in advance.

We would like to ask that you keep the true nature of this study confidential, and not discuss it with your peers. If any other participants know that the study assesses anchoring prior to their participation, their results will not be able to be used as it can change the responses they would give.

If you have any questions, comments, or concerns about this research, please feel free to contact Dr. Joel Katz at [redacted], or [redacted]. If you have any ethical concerns regarding this study, please contact the Coordinator, Research Ethics Review, Office of Research Ethics, at ext. 55201 or at ore@yorku.ca.

If you have general interest in numerical anchoring, you may wish to consult the following references:

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Kahneman, D. (2013). Thinking, fast and slow. Toronto, ON: Anchor, Canada.

Thank you very much for your participation! We greatly appreciate the time you have taken to participate in this study, and the effort that you have put forth.

I, ______________________________, consent to the use of my data in the study “The effect of unconscious numerical anchoring on participants’ rating of others’ pain- Study 2” conducted by Dr. Joel Katz & Rebecca Lewinson. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by consenting to this statement. My selection below indicates my consent.

Participant Signature Date

Signature of Person Obtaining Consent Date