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A comparison of combined versus individual cognitive coping strategies for managing pain

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by Grant Douglas Pointon

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PUBLIC PRESENTATION

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Abstract

Several cognitive coping strategies for reducing pain sensation have been identified, but their effects have traditionally only been examined in isolation. The current investigation instead compared the effectiveness of traditional cognitive coping strategies based upon imagery and pain acknowledgement/attention against an "integrated" strategy (that required both strategies to be used in combination) within a cold pressor test (CPT). Participants ($N = 24$, $M_{age} = 19.46$, $SD = 1.47$) underwent a baseline condition followed by counterbalanced strategy trials: imagery, attention, & integrated condition. Tolerance times, pain ratings, and perceived control ratings were recorded. The imagery condition had lower pain ratings and higher perceived control ratings compared to the baseline and attention condition but did not statistically differentiate from the integrated condition on any measure. In contrast, pain ratings were higher, and perceived control ratings were lower, in the attention condition relative to baseline, a finding which was not predicted by previous research. This suggests that, at least in its current form, attending to pain could actually represent absence of a coping strategy. Additionally, performance levels in the integrated strategy were consistently between those observed with the imagery strategy and the remaining conditions, suggesting that while imagery in the integrated strategy did help to alleviate pain, unfamiliarity with the integrated approach may have limited the extent of its observed effectiveness. This possibility of further pain-reducing effects following training with the integrated strategy warrants further investigation.

Introduction

Whether originating from abrasions, bruises, or lacerations, one's perception of physical pain is a complex process involving several factors. Our inherent aversion towards pain, and desire to reduce its psychological impact, has driven research on various forms of analgesics (Alexa, Marza, Voloseniuc, Tamba 2015; Çelik & Khorshid, 2015; Chagas, Éckeli, Bigal, Silva, Speciali, 2015; Costa-Martins et al., 2014; Hagesawa et al., 2010). Drugs are a common method of pain reduction. However, drugs may not always be an available, feasible, or appropriate option during a painful experience. The current study will focus on a form of pain reduction readily available at any moment: cognitive coping strategies. Specifically, two previously identified cognitive coping strategies shown to successfully modulate physical pain will be combined with the hope of identifying a more effective way to alleviate pain.

The perceived intensity of a pain sensation is influenced by several cognitive factors that have either positive or negative effects. One of these cognitive factors is known as pain catastrophizing. Pain catastrophizing is an overactive negative response to harmful or unpleasant stimuli (Sullivan, Bishop, & Pivik, 1995). A pain catastrophizing scale was developed in which participants were asked to rate the degree to which a certain thought or feeling was experienced during a past painful experience on a 0 (not at all) to 4 (all the time) scale (Sullivan et al., 1995). Three components of pain catastrophizing were found to account for a majority of the variance within the results: rumination, magnification, and helplessness. The authors described rumination as "an inability to suppress or divert attention away from pain-related thoughts" magnification was defined as a focus on "exaggerat[ing] the threat value of painful stimuli". Helplessness was defined as a negative evaluation of one's "ability to deal effectively with painful stimuli".

Yet another cognitive factor influencing the perception of pain is fear. Evidence has been found that suggests a two-way interaction between fear and pain (Vowels, McNeil, Sorrell, & Lawrence, 2006). In this study, the amount of CO_2 (two conditions: 5% and 15%) a participant breathed in was manipulated in order to induce fear. The participants also reported pain ratings during a painful experience (pressure pain on a finger induced by weights) while inhaling the CO_2 enriched air. Significantly higher pain ratings were reported in the 5% CO_2 condition compared to the 15% CO_2 condition. The authors suggested the salience of the fearful stimulus (breathing in CO_2) relative to the painful experience was the cause of these incongruous results. In the 15% CO_2 condition, fear took precedent over the pain as it was considered more distressing leading to lower reported pain ratings whereas the opposite effect took place in the 5% CO_2 condition.

Unlike pain catastrophizing and fear, acceptance of pain has been shown to positively influence chronic pain patients in both long-term and acute painful experiences (Richardson, Ness, Doleys, Banos, & Cianfrini, 2010; Viane et al., 2003). Two groups of chronic pain patients reported that acceptance of pain (measured by questionnaires) predicted mental well-being more so than the intensity of their back pain or their tendency to catastrophize the pain (Viane et al., 2003). An extension of this research compared pain acceptance scores and one's performance on a cognitively demanding task during a painful experience (Richardson et al., 2010). Performance on the task was found to positively correlate with pain willingness (a component of the pain acceptance scale) scores. Thus, the ability to willingly accept pain sensations in the present moment may mediate performance on other unrelated cognitive tasks.

When conducting pain research, the method of pain induction is of critical importance. Pain induction must be consistent in intensity while remaining safe. Multiple pain induction

techniques exist, however the most common technique used in previous research has been the cold pressor test (CPT) (Alden, Dale, & DeGood, 2001; Ahles, Blanchard, & Leventhal, 1983; Finlay & Anil, 2016; Geisser, Robinson, Pickren, 1992; Mitchell, MacDonald, & Knussen, 2008; Petter, McGrath, Chambers, & Dick, 2014; Pollatos, Herber, Füstös, Weimer, Enck, & Zipfel, 2012; Prescott & Wilkie, 2007). The CPT induces an aching or crushing pain sensation by submerging the typically non-dominant hand in water maintained at a temperature around 0 to 7 degrees Celsius (Mitchell, MacDonald, Brodie, 2004; Walsh, Schoenfeld, Ramamurthy, & Hoffman, 1989).

Certain individuals differ in their response to the CPT. Males tend to tolerate the CPT longer than females (Geisser et. al., 1992; Mitchell et al., 2004; Westcott, Huesz, Boswell, & Herold, 1977). It has also been shown that one's ability to tolerate CPT ischemic pain deteriorates with age (Walsh et al., 1989). Other evidence also suggests that individuals fall into "pain-tolerant" (longer average tolerance times) or "pain-sensitive" (shorter average tolerance times) groups during a CPT (Chen, Dworkin, Haug, & Gehrig, 1989a, 1989b). This finding has been replicated and it has also been shown that pain tolerant individuals report less pain catastrophizing compared to pain sensitive individuals (Geisser et al., 1992).

Generally, previous research with the CPT has approached the study of pain in three ways: manipulation of environment, manipulation of how one expresses pain, and manipulation of cognitive coping strategies. Concerning environmental manipulations, music, sweet smelling odors, food deprivation, and carbon dioxide concentrations have been shown to significantly influence pain perception (Mitchell et al., 2008; Pollatos et al., 2012; Prescott & Wilkie, 2007; Vowles et al., 2006). Studies related to the expression of pain have found tolerance times to increase when swearing in response to the CPT-induced pain and decrease when expressing pain

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in emotionally negative ways (moans, sighs, yelling, etc.; e.g., see Stephens, Atkins, & Kingston, 2009; Ahles et al., 1983).

The current investigation will focus on the third approach: cognitive coping strategies. A review of pain research categorized cognitive coping strategies into six major types: external focus of attention, neutral imaginings, pleasant imaginings, dramatized coping, rhythmic cognitive activity, and pain acknowledging (Wack & Turk, 1984). In a later review, the utility of the six cognitive coping strategies was assessed in past research and it was found that each strategy significantly reduced pain relative to control conditions – the best and least effective strategies being imagery and pain acknowledgement respectively (Fernandez &Turk, 1989). Imagery was argued as the most effective cognitive coping strategy because it demands the highest amount of attentional resources from the perceiver. This demand reduces the amount of attention devoted to the incoming pain information, thus resulting in a less intense perceived intensity of the pain sensation (Fernandez & Turk, 1989).

Several characteristics of an imagined object or scene mediate the type of effect it produces in the perceiver. Affect quality and directional focus are two such characteristics and were found to affect pain perception during a CPT experiment (Alden et al., 2001). In their study, affect quality was split into positive and negative conditions. The same image was paired with either positive or negative feelings using emotionally charged language such as "you feel good" or "you feel uncomfortable and disturbed". Directional focus was split into internal and external conditions. Internal imagery was specific to the internal painful body part and external imagery was completely unrelated to the pain and outside of the body. Participants were separated into one of five groups: control, positive internal, positive external, negative internal, and negative external. Both positive affect conditions yielded significantly lower reported pain

ratings. However, significantly lower mean pain ratings were found in the positive external group compared to the positive internal group, suggesting an external direction of focus enhances the pain reducing effects of positive imagery.

Cognitive coping strategies that fall under the category of pain acknowledgement use less distractive methods (relative to imagery) and tend to focus the perceiver's attention towards painful sensations. It has been found that pain acknowledgment significantly reduces pain (Fernandez & Turk, 1989), yet confusion regarding the efficacy of pain acknowledgement exists. One study found that divided attention reduces pain whereas attending to pain increases its perceived intensity (Quevedo & Coghill, 2007). However, the painful experience in this study lasted only five seconds. Five seconds is not enough time to meaningfully process a painful sensation which is specifically what other studies have found pivotal for the success of pain acknowledging strategies (Ahles et al., 1983; Leventhal, Brown, Shacham, Engquist, 1979).

Research supporting pain acknowledging strategies have focused on objectively processing the sensory qualities of a painful experience (Ahles et al., 1983; Leventhal et al., 1979). Significantly lower distress ratings were reported in both studies when objectively attending to the sensations in their hands compared to those in a control condition who were not given any instruction prior to the CPT. It was also found that objectively attending to pain produced greater pain reduction than attending to the emotive qualities of pain and a distraction task (Ahles et al., 1983). Participants were told to talk about the sensations during a CPT in either an objective fashion (attending only to sensory qualities), emotive fashion (i.e. moan and groan), or to name their high school courses, teachers, and activities (distractive condition). Those who processed the pain sensation objectively experienced less distress compared to those who processed the pain emotively or who were distracted. The results from the two studies

described above suggest that the relative success of attending to pain as a cognitive coping strategy is dependent on the ability to meaningfully process the painful sensation, and on the processing style used.

In imagery, an external direction of focus significantly enhanced the effects of a positive image (Alden et al., 2001) whereas in pain acknowledgement, an objective processing style produced pain-reducing effects (Ahles et al., 1983; Leventhal et al., 1979). The current study aims to find a way to integrate these two crucial components. Combining components within individual cognitive coping strategies has received little attention and so the potential effects remain to be determined. However, if these two components (external focus and objective processing) were successfully combined, the positive (i.e., pain-reducing) effects of a single integrated strategy could show an additive or even multiplicative result relative to the individual strategies that encompass it.

The current investigation seeks to address whether there could be any additional pain-reducing benefits of combining cognitive strategies relative to either attention or imagery-based approaches alone. Specifically, a novel integrative strategy is introduced in which perceivers explicitly focus on (i.e., attend to) the sensory qualities of the pain (objective processing) and then to imagine those sensory qualities filling up an object external to their body (external direction of focus). This strategy combines an objective processing style (Ahles et al., 1983; Leventhal et al., 1979) with an external focus of imagery (Alden et al., 2001). An approach like this differs from more traditional imagery-based approaches (such as imagining a pleasant distracting environment) in that it potentially affords a heightened sense of perceived control over the pain sensation. If this new approach demonstrates additional pain-reducing effects

relative to the individual strategies during a CPT, then it could act as a foundation for further

research on integrative cognitive coping strategies.

Methods

Participants

Participants were recruited through the James Madison University participant pool. A total of 28 students participated in the experiment. Four participants were excluded for reasons described below. As a result, 24 students ranging in age from 18 to 24 ($M = 19.46$, $SD = 1.47$) were included in the data analysis. Most of the participants were in their first year of college (n = 13) while 6 were in their second year, 3 in their third year, and 2 in their fourth year. Participants were compensated in the form of course credit. Exclusion criteria included feelings of pain prior to the experiment and self-reported chronic pain, stimulant use other than caffeine (e.g. marijuana, alcohol, etc.) within the last 24 hours, use of analgesic or antidepressant medication within the last 12 hours, lymphoma, vascular disorders, cancers which alter the lymphatic system, hypothyroidism, diabetes, high blood pressure, history of rheumatic fever, or heart disease.

Data from four participants were excluded from the study for various reasons. Two participants were excluded because they did not follow instruction (i.e., admitted to not following the strategies on the prompts) and were disengaged (e.g., reading lab material on walls, talking to the experimenter) during the CPT trials. One participant was excluded because they did not understand the instructions and had difficulty comprehending the meaning of the word sphere as English was not their primary language. The fourth excluded participant was submitted to an incorrect order of trials and was therefore omitted from data analysis. Therefore, data from 24 participants (18 female, 6 male) were used to conduct analyses.

Apparatus

A refrigerated circulating water bath, Polyscience Model 9105, was used to conduct the CPT. This model water bath has a six liter liquid capacity with sufficient space in the inner tank to accommodate the size of a hand if making a fist. Temperatures within the bath remain stable with a variation of 0.1 °C, and temperature readout accuracy is within 1 °C. Distilled water was used to fill the inner tank. For this water bath, distilled water has a normal range of 10 °C to 90 °C and an extreme range of 2 °C to 100 °C. Based on two related studies (Ahles et al., 1983 & Leventhal et al., 1979), a temperature of 7 °C was to be used for the CPT. However, the water bath was unable to maintain a stable 7 °C resulting in a mean temperature of 7.50 °C (*Min =* 7.1, *Max =* 7.8, *SD =* 0.14 °C) across all experiment trials.

Room temperature water was filled in a small rectangular bucket. Temperatures for the room temperature water were recorded using a glass thermometer. On average, the temperature of the water prior to the first hand normalization (before the first CPT trial) was 20.93 °C (*SD =* 1.13). Temperatures ranged from 18.89 °C to 22.22 °C.

Time Recording

Tolerance time measures were recorded using an online stopwatch (http://stopwatch.online-timers.com/) that measures time to the millisecond. Participants used a computer keyboard in order to begin and end time recording. Times were recorded from the beginning of each trial (initial submersion of the hand) and after removal.

Procedure

Upon entering the lab, participants received a general explanation of procedure from the experimenter, and were asked to read over the consent form. Prior to obtaining signed consent,

the experimenter ensured the participant met all health requirements. Participants were tasked with completing the CPT four times, which involved forming a loosely closed fist shape with their non-dominant hand and submerging it into the water bath for as long as they could tolerate the pain. If participants reached 5 min (300s) of submersion, they were instructed to remove their hand from the water bath.

The overall experiment included a 20 s familiarization procedure followed by four CPT trials consisting of an initial baseline measure followed by three complete counterbalanced strategy trials. During the familiarization procedure, participants submerged their non-dominant hand in the water bath for 20 s so that they could learn the task and become familiar with the coldness of the water. Prior to each CPT the participant submerged their non-dominant hand into a container filled with room temperature water (21 °C) for 4 minutes. This was done to ensure hand temperatures were normalized before each trial. During the CPT, participants reported their perceived pain intensity verbally after being signaled by the experimenter on a scale from 0 (no pain) to 100 (worst pain ever experienced) every 20 s post submersion. After removal, the participant reported their perceived level of control over the pain on a scale from 0 (no control) to 100 (maximum control). Perceived control was explained to the participants as "how well you felt you were mentally able to reduce the pain".

During the baseline measure, participants were told to submerge their non-dominant hand into the refrigerated water bath and to keep their hand submerged for as long as they could without any coping strategy given. After the baseline measure, participants continued into three strategy trials (imagery, attention, and integrated), normalizing hand temperature prior to each subsequent trial. The order in which strategy trials occurred was completely counterbalanced resulting in six orders. During the strategy trials, participants were presented with a prompt prior

to the submersion of their non-dominant hand detailing the specific coping strategy to be used. For the imagery condition, the prompt used was an adaptation of the instructions used in Alden et al.'s (2001) research on imagery use during a CPT:

> "In this trial we would like you to imagine you are in a meadow. You feel comfortable and content. The sun is shining and you are away from the pain. Continue to hold this image in your mind for as long as your hand is submerged in the water."

For the attention condition, the prompt presented was similar to the instructions used in Leventhal et al.'s (1979) study on attentional focus during a CPT:

> "During the time your hand will be in the water bath, you will feel many sensations in your hand. The sensation will change over time. We would like you to ignore everything else and focus your attention to the sensations or feelings in your hand only. Continue to focus your attention on the sensations you are experiencing in your submerged hand for as long as you can."

The third, integrated strategy condition, and the current study's exploratory coping strategy was described and presented to the participant in the following prompt:

> "During this trial we would like you to imagine a sphere located at a comfortable distance away from you. Focus on the sensations in your submerged hand and fill the imaginary sphere with these sensations. Continue thinking of filling up this sphere with the sensations you are experiencing for as long as you are able to."

Time was recorded using an online stopwatch displayed on a monitor visible to the experimenter only. Participants pressed the spacebar as soon as they felt their wrist breach the surface of the water in order to begin time recording. The spacebar was pressed again when the participant removed their hand from the water bath. After the completion of all four trials, participants were debriefed.

It was expected to find a main effect of strategy on each of the three dependent measures. Specifically, it was hypothesized that this study's exploratory integrated strategy will have higher tolerance times, higher perceived control ratings, and lower average pain intensity ratings compared to the baseline and other two strategies (imagery & attention), indicating the effects of a single integrated strategy produced additional pain reducing effects relative to the individual strategies that encompass it.

Results

Data Analysis

Due to the nature of the CPT, pain inducement is typically gradual and also decreases after the hand is numbed. Therefore, outliers within continuous pain may exist towards the beginning and end of the test. Median pain ratings were chosen instead of mean pain ratings because of these factors. Median pain ratings for each participant in each condition were found. These were then averaged together to give an overall pain rating for each condition. Tolerance times and perceived control ratings also were averaged for each condition.

Data for each dependent variable were first submitted to separate 6 (order) x 3 (strategy: imagery, attention, integrated) mixed ANOVAs with order as the between subjects factor and strategy as the within subjects factor. No significant interaction between order and strategy was found for average median pain ratings, $F (10, 36) = 0.657$, $p = 0.755$, $\eta^2 = 0.154$, average perceived control ratings, $F (10, 36) = 0.621$, $p = 0.786$, $\eta^2 = 0.147$, or tolerance times, $F (7.654, 27.553) = 0.693$, $p = 0.689$, $\eta^2 = 0.161$.

These analyses reveal that any potential impact of order did not differentially impact the strategy conditions, and thus should not explain any observed differences across those conditions. Therefore, data was simplified by collapsing across order and each dependent measure was separately analyzed using one-way repeated measures ANOVAs with strategy (baseline, imagery, attention, integrated) as the within subjects factor. Post-hoc Bonferroni corrected pairwise comparisons were used to asses differences between strategy conditions. LSD comparisons were relied upon as an alternative if Bonferroni comparisons were too

stringent to reveal the sources for obtained effects. In any cases where assumptions of

sphericity were violated, Greenhouse-Geisser corrections to degrees of freedom were used.

Median pain ratings and corresponding standard errors for each condition are displayed in

Figure 1. As can be seen in Figure 1, the integrated and imagery strategy showed a pattern of

greater pain reduction relative to the baseline and attention strategy. This pattern contributed to a

significant effect of strategy on median pain ratings, $F(3, 69) = 9.023$, $p < 0.001$, $\eta^2 = 0.282$.

Subsequent pairwise comparisons revealed that this effect was due to the fact that the imagery

led to significantly lower median pain ratings than the baseline ($p = 0.01$), and attention

condition ($p = 0.002$). Furthermore, the integrated strategy likewise led to significantly lower

median pain ratings than the attention strategy, $p = 0.031$. Mean pain ratings also were analyzed

and showed no overall differences from the median pain ratings[1].
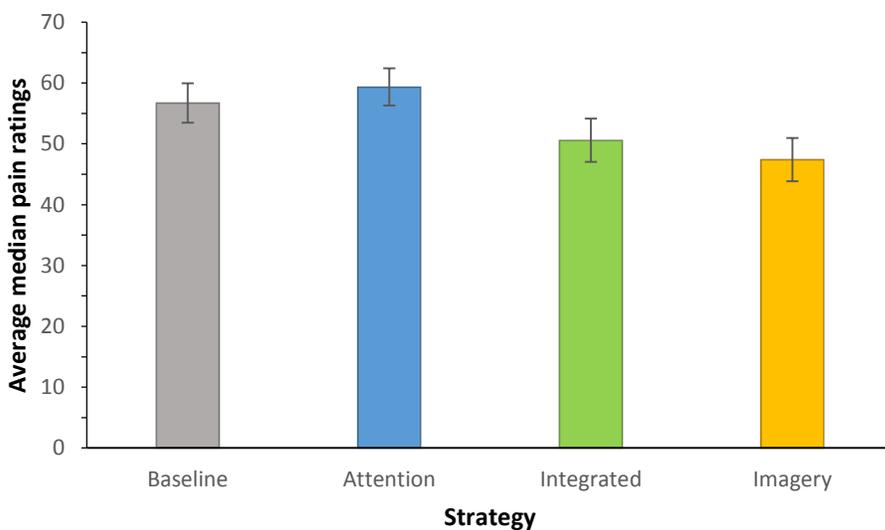
Figure 1. Average median pain ratings for the baseline measure and the three experimental cognitive coping strategies along with corresponding error bars.

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[1] Strategy significantly impacted mean pain ratings, $F(3, 69) = 10.383$, $p < 0.001$, $\eta^2 = 0.311$. The imagery condition had higher mean pain ratings than the baseline ($p = 0.005$) and attention condition ($p < 0.001$). The integrated strategy had higher mean pain ratings than the attention condition, $p = 0.02$.

A consistent inverse relationship between the median pain ratings and mean tolerance times was found, such that lower median pain ratings were associated with higher mean tolerance times. Figure 2 displays mean tolerance times for each condition and shows a trend for higher response times in each of the three experimental strategies relative to the baseline measure. A significant effect of strategy was found, $F (1.85, 42.58) = 3.545$, $p = 0.041$, $\eta^2 = 0.134$. Results of the LSD post-hoc pairwise comparisons showed that tolerance times were higher in the imagery condition compared to the baseline condition, $p = 0.013$. No other significant differences between strategies were found.
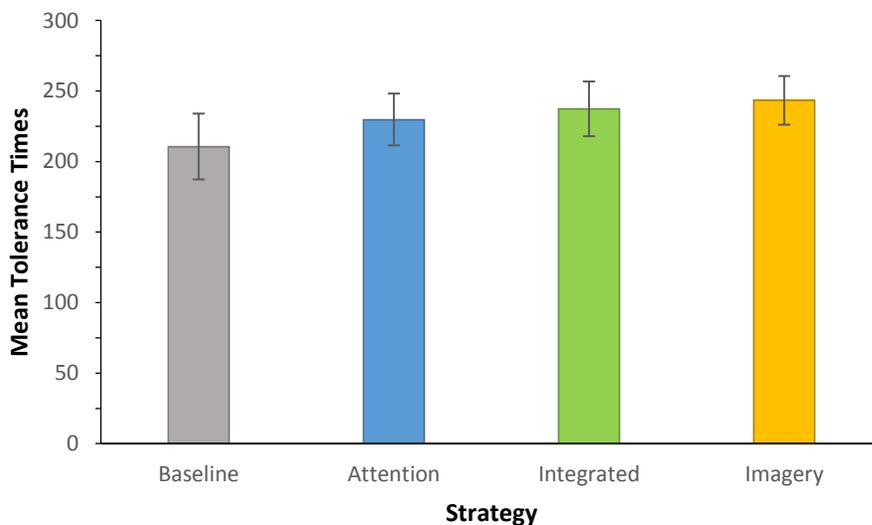
Figure 2. Mean Tolerance times for the baseline measure and the three experimental cognitive coping strategies along with corresponding standard error bars.

As with tolerance times, pain ratings and perceived control ratings showed the same inverse relationship. Figure 3 displays the mean perceived control ratings and standard errors for each condition. As shown in Figure 3, there was a tendency for participants to report higher

perceived control ratings in the integrated and imagery condition. Perceived control ratings in the integrated strategy were in between those of the imagery strategy and the other conditions. This pattern contributed to a significant main effect of strategy on perceived control ratings, F (3, 69) = 6.150, p = 0.001, η^2 = 0.211. Specifically, the imagery strategy had higher perceived control ratings than both the baseline and attention conditions, as revealed by pairwise comparisons of means (p = 0.003 and 0.01, respectively). Though there was a trend for the integrated strategy to differentiate from the baseline and attention conditions, the stringent Bonferroni tests didn't reveal a significant difference.
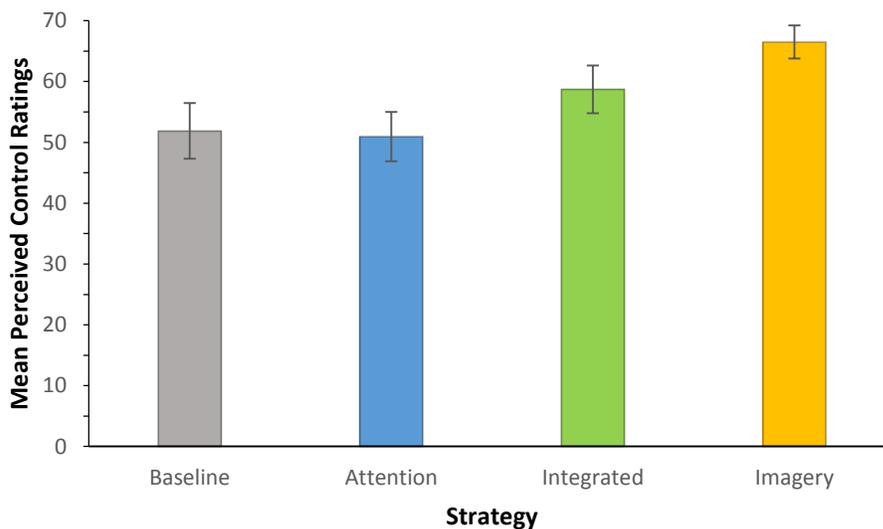
Figure 3. Mean perceived control ratings for the baseline measure and the three experimental cognitive coping strategies along with standard error bars.

General Discussion

Across all dependent measures, the imagery strategy showed the best performance. The integrated strategy, which is also an image-based coping strategy showed a consistent pattern of being just below the pain reducing effects of the imagery strategy and above the pain reducing effects of the baseline and attention condition. Thus, the results indicated a trend for larger pain reduction in the image-based coping strategies relative to the baseline and attention conditions. This trend supports the notion that image-based cognitive coping strategies are most effective for pain reduction (Fernandez & Turk, 1989).

Regarding the imagery condition, the results further the work done by Alden et al. (2001) by showing a comparison of their positive external imagery strategy to other strategies not previously compared with before. In particular, the imagery strategy showed markedly better pain reduction measures relative to the objective attention strategy. The imagery strategy also had the highest perceived control ratings. Participants tended to report that the imagery strategy was easy to perform which might explain why perceived control ratings were higher than any other strategy.

Statistically, the integrated strategy was no different than the imagery strategy but showed a consistent trend of being in between the performance of the imagery strategy and both baseline and attention strategies. This result disagrees with the current study's hypothesis and poses several interpretations. One could argue that the integrated strategy was simply not as effective at reducing pain as the imagery strategy. In this single experiment, this interpretation may be true, but as complete reflection of the integrated strategy's potential, may be false. Counter to the imagery condition, many participants during the debriefing process expressed that the integrated strategy was more difficult than the other conditions. Thus, participants had a

harder time with the integrated strategy compared to the imagery strategy and also felt less in control of the pain relative to the imagery strategy as can be seen in Figure 3. This suggests that the integrated strategy suffered from being an unfamiliar concept for participants. As a result, participants may have benefitted from prior training or practice with the strategy.

The relationship between training on image-based cognitive coping strategies and their effectiveness as a pain reducer has not directly been studied. Most likely, this relationship has not received attention because previous research has used familiar types of images such as a meadow or desert (Alden et al., 2001; Spanos, Horton, Chaves, 1975). However, research on another less familiar approach has shown benefits from experience and training. Specifically, experience and training have been shown to moderate the effectiveness of bodily awareness based attention strategies and meditation based strategies (Petter et al., 2014; Zeidan, Gordon, Merchant, & Goolkasian, 2010). It is hypothesized then that practice or training with each strategy used in the current study would increase their effectiveness, but that the integrated strategy would show the greatest improvement.

Another interpretation of the integrated strategy results is that it only alleviated pain because it involved an image. This interpretation assumes imagining an image is all that matters in order to produce pain reducing benefits. However, research suggests this assumption is incorrect as it has been shown that affect quality and direction of focus alter the effectiveness of image-based cognitive coping strategies (Aldent et al., 2001). With this in mind, it is important to consider that the integrated strategy performed statistically no different than the imagery condition even though it did not have positive affect. This brings to question what the role of the imagined pain was in the integrated strategy. One possibility is that the imagined pain in the integrated strategy served as an additional distraction. This could be assessed by attaching an

additional rating of distraction from one's own sensations to the procedure used in the current study. If imaging pain was indeed a distractor, similar levels of distraction would be reported for the integrated and imagery strategy.

It would also be important to investigate if imaging pain sensations is any different than imaging pain related imagery (e.g., stepping on a nail barefoot). It would be expected that pain related imagery would not produce pain reducing benefits because it is tightly linked with negative affect – a quality shown to negate the pain reducing effects of imagery (Alden et al., 2001). Unlike pain related imagery, imagining pain sensations has no inherent affect quality and has shown a trend to produce pain reduction in the current study. Therefore, if imagining pain sensations produced greater levels of pain reduction relative to pain related imagery, this would give further evidence that the imagined pain in the integrated strategy served as a distractor.

The attention condition resulted in higher pain ratings and lower perceived control ratings relative to the baseline condition, as can be seen in Figure 1 and Figure 3 respectively. This is an important difference because it suggests the attention strategy used in the current study might be a more valid baseline measure. Traditionally, participants are given no instructions for baseline measures in a CPT design but this does not mean they are unable to use coping strategies. The attention strategy may be a more reliable baseline condition because it ensures to some degree that the participant cannot use any other coping strategies. However, the results of the attention strategy would need replication before it could be treated as a baseline condition.

Previous research has shown that attending to pain in an objective manner reduces perceived levels of distress (Ahles et al., 1983; Leventhal et al., 1979), however the current study showed opposing results. The attention strategy was nearly identical to that of Leventhal et al. (1979) and similar to that of Ahles et al. (1983) so the results were unexpected. Describing the

attention strategy in the same manner was thought to be enough to produce effects showing a similar pattern of pain reduction found in these two studies.

A possible explanation for this discrepancy across findings may lie within methodological differences between the current study and previous literature (Ahles et al., 1983; Leventhal et al., 1979). Both of these studies used a temperature of 7 °C for the CPT whereas the current study used a temperature of 7.5 °C. Mitchell et al. (2004) studied the effect that different temperatures had on pain ratings during CPTs and found that a temperature change of 2 °C and 4 °C was needed in order to significantly alter pain ratings and tolerance times, respectively. This suggests the temperature used in the present study was not a significant cause for the discrepancy across findings.

However, a majority (n = 14) of the participants in the current study tolerated the pain for the full 5 min limit regardless of condition. Combined with pain reports, this suggests that pain inducement was successful but not severe enough to cause most participants to withdraw from the water bath. If the higher temperature used in the present study did in fact reduce pain intensity, all of the conditions would have been impacted in a way that increased performance closer to ceiling levels. Even so, the attention strategy showed a trend to have the worst performance on pain and perceived control ratings. Therefore, the temperature difference cannot represent a valid explanation for the discrepancy across findings.

The current study also omitted additional instructions that both Leventhal et al. (1979) and Ahles et al. (1983) gave to their participants. The additional instructions may have introduced an unwanted element of distraction in their experiments. Distraction is considered to reduce the perceived intensity of pain (Wiech, Ploner, & Tracey, 2008), making it especially important to eliminate when determining the effects of a coping strategy based on attending to

painful sensations. In Leventhal et al. (1979) participants were told to focus on the sensations in their hand "so that [they] will be able to describe each of the specific feelings and sensations that [they] experienced" and that the experimenter would "ask many questions about the different sensations in [their] hand afterwards, and this is the most important part of the study". Everything else in the current study's instructions were nearly identical to that of Leventhal et al. (1979). Though it can be seen that these instructions were meant to keep participants focused on the sensations in their submerged hand, the participants may have been distracted by the thought of being questioned about their sensations.

In Ahles et al. (1983), participants were instructed to focus on the pain sensations in an objective fashion and to verbalize the sensations they were attending to. A similar study that did not explicitly focus the participant's attention towards the objective sensations found that verbalizing present sensations and thoughts reduced pain reports (Kanfer & Goldfoot, 1966). This brings to question whether or not the pain reduction reported in Ahles et al. (1983) was due to the objective attention based coping strategy or from a distractive effect caused by verbalizing sensations. Unfortunately, both studies did not include any measure of task involvement or distraction experienced by the participants so this question remains difficult to answer and deserves further investigation.

Limitations and future directions

There are certain limitations to the results of the current study. Since there were no instructional tasks measuring involvement during the attention condition, it cannot be said for certain if the participants were engaged in the correct manner. One way to measure involvement would be to have participants verbalize their sensations but we did not do this because the task may have introduced an unwanted element of distraction (Ahles et al., 1983). It was thought that these additional tasks would detract from the goal of the strategy which is to focus all attention towards the painful sensations.

Care should also be taken not to generalize the results of the current study without further testing. The current study used a college age population ranging in age from 18 to 24. One's ability to cope with CPT induced pain has been shown to decrease with age (Walsh, et al., 1989) and there has been little research on the effectiveness of different types of cognitive coping strategies in different age groups. There was also an underrepresentation of males (n = 6) in the current study. Potential gender differences were therefore unable to be analyzed. Males have shown to have on average higher pain tolerances in response to the CPT (Geisser et. al., 1992; Mitchell et al., 2004; Westcott et al., 1977), but differences in the effectiveness of cognitive coping strategies based on sex has not been investigated directly.

More investigation is needed on the effect of training and abstract image-based cognitive coping strategies such as the integrated strategy used in the current study. If participants were to have been familiar with the strategy, perhaps they would experience more pain reduction than even the imagery strategy condition. Investigating how pain related imagery affects pain ratings would allude in more detail as to the role that imagery content plays on pain perception. Studying the effect of verbalizing moment to moment sensations and the expectation of being

questioned during a CPT also needs further investigation to completely solve potential

methodological concerns.

For now, what we know is that the current study supports literature on the positive, pain

reducing effects of image-based cognitive coping strategies. This study also introduced a novel

cognitive coping strategy that was found difficult for participants, yet still yielded relatively high

pain reducing benefits. The efficacy of objectively attending to pain was also put to question by

the current study's contrary findings. In sum, this study found evidence suggesting an integrated

cognitive coping strategy alleviated pain and serves as a lead into further research.

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