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Common physical properties improve metaphor effect even in the context of multiple examples

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Abstract

A previous experimental analog study by Sierra, Ruiz, Flórez, Riaño-Hernández, and Luciano (2016) showed that including common physical properties to participants' pain in the metaphor content improved its effect in promoting pain tolerance. This study analyzed in a 2x2 factorial design the effect of common physical properties in the context of multiple examples of functionally equivalent metaphors. Eighty-four participants first responded to a measure of experiential avoidance. Subsequently, they were exposed to a cold-pressor task at pretest. Afterwards, participants were randomly assigned to four experimental protocols consisting of: (a) three functionally equivalent metaphors with common physical properties to participants' pain, (b) three functionally equivalent metaphors without common physical properties, (c) a metaphor with common physical properties that was repeated three times, and (d) a metaphor without common physical properties that was repeated three times. Then, participants were re-exposed to the cold-pressor task (posttest). Bayesian data analyses showed that the presence of common physical properties was the only variable associated with an increase of the metaphor effect, independently of the number of metaphors proposed. The update of evidence by means of a Bayes factor meta-analysis showed that data very strongly support the hypothesis of common physical properties being an effective component of metaphors. These results highlight the relevance of training therapists in designing metaphors with common physical properties to the clients' discomfort.

Key words: Metaphor; Acceptance and commitment therapy; Relational Frame Theory; Physical properties; Multiple examples.

Common physical properties improve metaphor effect even in the context of multiple examples

Multiple forms of psychological interventions use metaphors as a powerful tool to promote behavior change (e.g., Kopp, 1995; Tay, 2013; Törneke, 2017; Villatte, Villatte, & Hayes, 2016). Metaphors provide enriching verbal contexts that facilitate the individuals' experiential understanding of their problems and experiences by reference to another situation that is clearer and more illustrative. This way, metaphors create a context in which clients can explore with alternative behaviors and discover their associated contingencies, which avoid the potential traps (e.g., insensitivity to contingencies) of learning by rules directly provided by the therapist (Stewart & Barnes-Holmes, 2001; Törneke, 2017).

Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999, 2012) is one of the models of psychological intervention that makes more extensive use of metaphors. ACT is a contextual-behavioral model of psychological intervention that aims to promote psychological flexibility (Hayes, Luoma, Bond, Masuda, & Lillis, 2006) and is rooted in an approach to human language and cognition known as Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001). From an RFT perspective, psychological flexibility is conceptualized as the generalized repertoire of framing ongoing behavior in hierarchy with the deictic I (i.e., discriminating ongoing behavior and taking distance from it by framing oneself as I/Here/Now and behavior as There/Then, which facilitates framing behavior as a momentary part of the self). This typically reduces the discriminative functions of ongoing behavior and allows the derivation of rules that specify appetitive augmental functions (i.e., valued directions) and behavior that is in accordance with them (Luciano, Valdivia-Salas, Cabello, & Hernández, 2009; Luciano, Valdivia-Salas, & Ruiz, 2012; Ruiz & Perete, 2015; Törneke, Luciano, Barnes-Holmes, & Bond, 2016).

One of the topics with more fruitful research within RFT has been analogical reasoning (see reviews in Ruiz & Luciano, 2012; Stewart & Barnes-Holmes, 2004). Briefly, RFT suggests that the repertoire underlying analogy and metaphor is the establishment of a relation of coordination among common types of trained or derived relations (Lipkens, 1992; Stewart, Barnes-Holmes, Hayes, & Lipkens, 2001; note that other types of relating relations are also possible: McLoughlin & Stewart, 2017). In the clinical setting, metaphors usually consist of relating relations from separate relational networks or domains (Ruiz & Luciano, 2011). Additionally, clinical metaphors often incorporate physical or functional properties that are clearer and more representative than in the clients' problem (Foody et al., 2014; Törneke, 2010, 2017; Villatte et al., 2016). For instance, in the commonly used clinical "quicksand" metaphor, the relational network about quicksand is related to the one about anxiety: "struggling with anxiety is like struggling to escape quicksand; the more you struggle, the more you sink." The quicksand metaphor includes physical and functional properties that are clearer than in the client's behavior (e.g., struggling in the metaphor is a physical action, sinking in the quicksand provokes suffocation, etc.).

Following Törneke (2017), the empirical analysis of the components of metaphors that maximize their effect should be contextualized to specific therapeutic goals (see also McMullen, 2008). Therefore, with regard to ACT, research should be mainly focused on which components facilitate the promotion of psychological flexibility. Some suggestions have been made to improve the efficacy of metaphors in ACT from an RFT perspective (e.g., Foody et al., 2014; Törneke, 2017; Villatte et al., 2016). However, empirical evidence on the components of metaphors that enhance their effect is still scarce.

One component of metaphors and analogies that has been investigated within an RFT framework is the presence of common physical properties among the involved relational networks or domains (Ruiz & Luciano, 2015; Sierra, Ruiz, Flórez, Riaño-Hernández, & Luciano, 2016; Stewart & Barnes-Holmes, 2001; Stewart, Barnes-Holmes, Roche, & Smeets, 2001, 2002). The basic idea tested in these studies is that common physical properties among relational networks are additional contextual cues that facilitate analogy derivation. For example, Ruiz and Luciano (2015) found that participants judged experimental analogies as more apt when the relational networks contained common physical properties than when they did not share these properties.

In an experimental analogue study, Sierra et al. (2016) analyzed the effect of two variables in the metaphor effect on promoting psychological flexibility in a cold-pressor task: (a) the presence of common physical properties between the individual's experience and the metaphor, and (b) the specification of appetitive augmental functions (i.e., values). A 2x2 factorial design was implemented in which the presence/absence of the independent variables was manipulated. Eighty participants were first exposed to the cold-pressor task (i.e., introducing the right hand up to the wrist in a container with ice water). Subsequently, participants were randomly allocated to one of the four experimental conditions and listened to an audio that presented a metaphor. All protocols consisted of adapted versions of the swamp metaphor (Hayes et al., 1999). The independent variables were manipulated by stating that the water of the swamp was cold or dirty (presence or absence of common physical properties to the sensations induced by the cold-pressor task) and that, on the other side of the swamp, there was the most important thing for the participant or the same landscape (presence or absence of augmental functions to tolerate pain). The results showed that both common physical properties and augmental functions had a statistically significant effect, with medium effect sizes, on pain tolerance at posttest.

Manuals and ACT protocols usually present several functionally equivalent metaphors to introduce ACT concepts and for working on specific aspects of psychological flexibility (e.g., Eifert & Forsyth, 2005; Zettle, 2007). The implicit rationale behind this practice seems to be that introducing multiple examples of functionally equivalent metaphors would lead to a better abstraction of the relevant patterns of behavior presented in them. In other words, introducing different but functionally equivalent metaphors might lead to focusing mainly on the common central message of the metaphors (e.g., that human beings cannot voluntarily control private experiences) and not on specific but irrelevant details of them. Indeed, empirical evidence collected within cognitive psychology has shown that relational generalization takes place more easily when one analog is compared with multiple ones (Brown, Kane, & Echols, 1986; Catrambone & Holyoak, 1989; Chen & Daehler, 1989; Gick & Holyoak, 1983; Kotovsky & Gentner, 1996; Loewenstein, Thompson, & Gentner, 1999; Ross & Kennedy, 1990). However, there is no evidence of the effect of multiple examples in promoting psychological flexibility.

Following a similar procedure to the study by Sierra et al. (2016), the current study aims to analyze the effect of both common physical properties and multiple examples in the effect of metaphor on promoting psychological flexibility. Although common physical properties were shown to be an effective component in a previous study (Sierra et al., 2016), analyzing their effect in the current study seems relevant for two reasons. Firstly, the results found by Sierra et al. should be replicated in slightly modified conditions. Secondly, it could be argued that the presence of common physical properties might lose relevance when providing multiple metaphors to the client because these multiple examples would promote the abstraction of the relevant rule suggested by the metaphor. This way, the recommendation of designing metaphors with common physical properties to the client's problematic private events might be unnecessary when the therapist has the time to introduce several functionally equivalent metaphors.

Method

Participants

Eighty-four undergraduates (40 women; age range = 18 to 28; *M* = 20.50, *SD* = 2.45) attending different courses participated in the experiment. None of them had previous experience with the procedures or the theory (i.e., RFT and ACT) involved in this study. Exclusion criteria were suffering from cardiac and circulatory affections, hypertension, diabetes, epilepsy, chronic pain conditions, or recent wounds (only one participant was excluded because of suffering from arrhythmia) because the experimental task (i.e., cold-pressor) might have adverse effects on them.

Design and variables

This study follows a 2x2 factorial design. Independent variables were: (a) the presence or absence of common physical properties to the discomfort experienced in the cold-pressor task, and (b) the presence or absence of multiple examples of functionally equivalent metaphors. The combination of these two independent variables led to the four experimental conditions. The protocol of Condition A included three functionally equivalent metaphors with common physical properties to the participants' pain. The protocol of Condition B included three functionally equivalent metaphors without common physical properties. Condition C consisted of a protocol in which a metaphor with common physical properties was repeated three times. Lastly, the protocol of Condition D consisted of a metaphor without common physical properties that was also repeated three times. The dependent variables were pain tolerance and pain intensity as measured by the differential scores between pretest and posttest (differential score = posttest score – pretest score).

Participants were randomly allocated to the experimental conditions with the sole restriction of maintaining the same proportion of men and women because previous research has shown some gender differences in performance of the cold-pressor task (e.g., Keogh, Bond, Hanmer, & Tilston, 2005; Pokhrel et al., 2013).

Setting and Apparatus

All sessions were conducted individually in an experimental room equipped with a table, two chairs, an armchair, a tablet, headphones, a 30x20x20 cm glass container with two interconnected compartments: one for the ice and the other for the water. In the latter compartment, participants introduced their hands. A digital thermometer was adhered to the container to control the water temperature. Two water pumps (26 litres per hour) were also adhered to the glass container to maintain the water circulating. An ice maker machine was used to keep the temperature of the glass container constant.

Experimental Task

The cold-pressor task was the experimental task used in this study. It has been broadly used in medical and psychological studies because the sensation that it produces in participants is analog to particular conditions such as chronic pain and persistent psychological distress. During the task, participants introduced their right hand up to their wrist in a glass container with circulating ice water at 4.5 to 5.5 Celsius degrees. This temperature is higher than the usual (1 to 3 Celsius degrees) but was used because, according to Mitchell, MacDonald, and Brodie (2004), this higher temperature facilitates the use of the strategies trained by the experimenter. Participants were requested to leave their hand in the water for as long as possible, but they were also reminded that they were free to stop and remove their hand from the water at any time. Pain tolerance was measured by the total amount of time participants kept their hand in the water. Participants who kept the hand in the water for 300 seconds at pretest were excluded from further participation in the study for ethical reasons because they reached the maximum admissible pain tolerance.

Instruments

Acceptance and Action Questionnaire – II (AAQ-II; Bond et al., 2011; Spanish translation by Ruiz, Langer, Luciano, Cangas, & Beltrán, 2013). The AAQ-II is a 7-item, 7-point Likert-type scale (7 = *always true*; 1 = *never true*) that measures experiential avoidance. The items reflect unwillingness to experience unwanted emotions and thoughts and the inability to be in the present moment and behave according to value-directed actions when experiencing unwanted psychological events. The Spanish version by Ruiz et al. (2016) showed good psychometric properties and a one-factor structure in Colombian samples.

Self-reports of pain during the cold-pressor task. After each exposure to the cold-pressor task, participants were asked how intense was the induced pain on a 10 cm, visual analogue scale (VAS).

Protocols

The protocols were presented in audios of approximately 5 minutes through headphones connected to a tablet. They had common components at the beginning and the end of the recording. In the beginning, all participants listened to the following instructions: “Next, I am going to tell you something regarding the task you just finished. Your task during this time is listen to my voice and perform the simple imagination exercises that I will suggest. Firstly, let me to remind you that the aim of this experiment is to analyze which strategies people with chronic pain could use to obtain the things that are important for them even though they are experiencing pain. Your participation in this experiment is important because it could contribute to the quality of life of individuals living with chronic pain. We are not expecting any results in particular, anything you do is OK for us. We only ask you to do the task honestly and to try to follow the next exercise. Now, I'd like you to imagine this. You come from the cold-water task. Now, remember and feel the sensation you felt in your hand while you were doing the task (pause of 10 s)."

After the exposure to the metaphors of each condition (see below), the recording ended saying: "Now, you are going to do the task again. We suggest you to try to put into practice what the story told you and see if this could help you to bear the discomfort of the task better. Remember that anything you do is OK for us, and that we are not expecting anything special in any direction. We have finished, please call the experimenter."

All protocols consisted of adapted versions of the swamp metaphor (Gutiérrez, Luciano, Rodríguez, & Fink, 2004; Hayes et al., 1999; Sierra et al., 2016), where the independent variables were manipulated by stating that the water of the swamp is cold or dirty (presence or absence of common physical properties to the cold-pressor task: the differential sentences of the protocols are italicized) and by repeating the same metaphors or introducing two similar ones. In the conditions without multiple examples (i.e., Conditions C and D), the same metaphor was repeated with slight modifications in phraseology to make conditions equivalent in time.

Protocol A. This protocol presented three functionally equivalent metaphors that included common physical properties with the discomfort experienced during the cold-pressor task. After the introduction (see above), the recording went on to say: "Imagine you are at the edge of a big swamp. The other side of the swamp is very far away and it would take you several minutes to get there. On the other side of the swamp, there is the most important thing for you, this thing you dream about, the one that excites you the most and makes you vibrate. Please, let yourself think for a few seconds what would be on the other side of the swamp and the emotion that you would have when getting there (pause of 10 s).

The water of the swamp is *very cold* and when you look at the other side, you realize that the only way to get there is to cross the swamp by swimming. It would take you five minutes to get to the other side. The farther you swim in the swamp, the *colder* you would feel, but you would know that you would be much closer to this thing that is so important for you. What would you choose to do? Would you stand there watching how the most important thing for you fades away on the other side or would you jump into the water and swim despite the discomfort of the *cold*? (pause of 10 s)."

"Now, you are going to listen to a similar story. Please, continue to pay attention to my voice. Imagine you are in Russia and you want to cross a forest because the most important thing for you is on the other side. Please, allow yourself to think what would be on the other side of the forest and the emotion that you would feel when getting there (pause of 10 s). The forest is covered with a *huge layer of snow* and you realize that the only way to arrive at your destination is by crossing the *snow* although you only have sandals and you would need at least 5 minutes to arrive. The farther you advance in the forest, the *colder* you would feel, but you would know that you would be much closer to this thing that is so important for you. What would you choose to do? Would you stand there watching how the most important thing for you fades away on the other side or would you run through the forest despite the discomfort of the *cold*? (pause of 10 s)."

"Now, you are going to listen to a last similar story. Please, continue to pay attention to my voice. Imagine you are traveling on a ship through Alaska and you are very close to arriving at your destination where the most important thing for you would be waiting for you in just a few minutes. Please, allow yourself to think what would be on the dry land and the emotion that you would feel when getting there (pause of 10 s). However, the motor of your ship suddenly stops working and the only option to arrive on dry land is by swimming. The water of Alaska's sea is very cold and when you look at the dry land, you realize that you would need at least 5 minutes to arrive. The farther you advance in the sea water, the *colder* you would feel, but you would know that you would be much closer to this thing that is so important for you. What would you choose to do? Would you stand there watching how the most important thing for you fades away on the dry land or would you jump into the water and swim despite the discomfort of the *cold*? (pause of 10 s)."

Protocol B. This protocol presented three functionally equivalent metaphors without common physical properties to the participants' discomfort while performing the cold-pressor task. The recording proceeded in the same way as in Protocol A, but the water in the first metaphor was *thick, filthy, and smells like a water spout*. In the second metaphor, the Russian forest was substituted by a quagmire in Chocó (i.e., a Colombian region with jungle) that *smelt like a water spout and had bugs*. Lastly, in the third metaphor, Alaska's sea was substituted by the Black Sea and the water was *thick, full of dirt and smells like a water spout*.

Protocol C. This protocol presented the first metaphor of Protocol A three times with slight changes in phraseology.

Protocol D. This protocol presented the first metaphor of Protocol B three times with slight changes in phraseology.

Procedure

The procedure of the study was approved by the Center for Psychological Research of the institution. All participants signed an informed consent that made explicit the procedures and participation conditions. The experimental sessions were conducted individually and lasted approximately 30 minutes distributed in four phases (see Figure 1).

INSERT FIGURE 1 ABOUT HERE

Phase 1. Pre-experimental measures. During the first 10 minutes, the informed consent was presented to the participants, which excluded participants who reported some medical history incompatible with the cold-pressor task. In order to make the experimental task valuable to participants, they were told that the aim of the study was to analyze what kind of coping strategies might be helpful to people suffering from constant pain and/or who have to deal with situations that are accompanied by much discomfort. After signing the informed consent, participants responded to the AAQ-II.

Phase 2. Pretest cold-pressor task. Participants were first exposed to the cold-pressor task in company of the experimenter. Participants received the following instruction: "Insert your right hand up to the wrist and keep it in as long as possible. Remember that you can take it out at anytime." The experimenter measured the length of time participants' hand remained in the water using a chronometer. At the end of the exposure, participants responded to the VAS of the perceived pain during the task.

Phase 3. Protocols. Participants were then randomly assigned to one of the four experimental conditions. Participants seated and listened to the protocols through headphones. The experimenter did not know which protocol the participants were listening to avoid the potential influence of the experimenter's expectations in the results.

Phase 4. Posttest cold-pressor task. Participants performed the cold-pressor task again. Afterwards, they were debriefed about the aims of the experiment.

Data analysis

Bayesian analyses of variance were used to analyze the data of the current study with the free software JASP 0.8.5 (https://jasp-stats.org/). JASP provides a graphical interface of the R package BayesFactor, which permits the computation of Bayes factors in standard designs (e.g., *t*-tests, ANOVA, regression, etc.).

Bayes factor (*BF*) quantifies the relative evidence in the data, expressed as relative odds, for the hypothesis that a factor exerts an effect on the dependent variable. The *BF* can also be seen as the extent to which a rational person should adjust his or her beliefs in favor of the hypothesis of a factor having an effect on the dependent variable, where a $BF > 1$ means that data support that a factor exerts an effect and a $BF < 1$ that the factor does not exert an effect. Bayes factors can be interpreted according to the guidelines provided by Jeffreys (1961) and Wagenmakers, Wetzels, Borsboom, and van der Maas (2011): 1 = No evidence of treatment effect; 1-3 = Anecdotal evidence of treatment effect; 3-10 = Substantial evidence of treatment effect; 10-30 = Strong evidence of treatment effect; 30-100 = Very strong evidence of treatment effect; and >100 = Extreme evidence of treatment effect (note that BFs < 1 are interpreted in the same way, but favoring the hypothesis of no treatment effect).

According to Rouder, Morey, Verhagen, Swagman, and Wagenmakers (2017), there are at least two pragmatic advantages of Bayesian analyses: (a) Bayes factors can be used to state evidence for the absence of an effect, which contrasts favorably to significance testing where researchers state a lack of evidence for an effect; and (b) Bayes factors permit researchers to provide a graded measure of evidence for different models and not make dichotomous reject and fail-to-reject decisions. Additional advantages of Bayesian inference over classical inference can be observed in the review by Wagenmakers et al. (2017).

One of the distinctive features of Bayesian statistics is that they include prior expectations of the parameters. These prior expectations are expressed by prior distributions that receive high density at plausible parameter values and low density at implausible parameter values (Lee, 2004). Prior distributions can be determined based on previous research, expert knowledge, scale boundaries, and statistical considerations (Wagenmakers et al., 2017). The Bayesian ANOVA framework advocated by Rouder, Morey, Verhagen, Swagman, and Wagenmakers (2017) suggests Cauchy prior distributions in which the effect size of the factor, termed δ, is located at 0, and the researcher can modify the parameter *r* between the recommended values of 0.2 to 1.0 that represents the width of the distribution (higher values of *r* places more density at higher effect sizes).

Prior to data analysis, the presence of outliers in scores was first explored graphically. All outliers were replaced with the next higher value, following the Winsor method (Guttman, 1973). Bayesian one-way ANOVAs were conducted first to explore the equivalence of the experimental conditions on experiential avoidance (i.e., AAQ-II scores), and pretest tolerance and intensity of pain in the cold-pressor task (Phase 2). To conduct these analyses, we used the prior distribution with $r = 0.5$ because it is the suggested default distribution by Rouder et al. (2017).

Subsequently, Bayesian two-way ANOVAs were conducted to analyze the effect of common physical properties and multiple examples on pain tolerance and pain intensity. Differential scores on tolerance and pain intensity were used as dependent variables. Five models were compared in the Bayesian two-way ANOVAs: (a) the null model (factors do not affect the dependent variable), (b) the model with only multiple examples affecting the dependent variable, (c) the model with only common physical properties affecting the dependent variable, (d) the model with both factors affecting the dependent variable (multiple examples + commnon physical properties), and (e) the model with both factors and their interaction affecting the dependent variable (multiple examples + common physical properties + the intercation between both factors). All factors were given the same prior probability (i.e., 0.200).

According to the previous evidence (Sierra et al., 2016), we selected *r* = 0.35 as the width for the prior distributions. However, we also conducted a Bayesian sensitivity analysis that investigated the robustness of the results with *r* values of 0.2 and 0.5, which posit higher density in the Cauchy distribution at, respectively, lower and higher effect sizes. Conducting sensitivity analyses is frequently suggested by Bayesian statisticians to investigate whether the results obtained are excessively dependent on the selected prior distribution (Gelman et al., 2014).

One further advantage of Bayesian statistics is that they permit updating evidence for hypotheses (Wagenmakers et al., 2017). To update the evidence of including common physical properties in the metaphor content, we conducted a Bayes factor meta-analysis (Rouder & Morey, 2011) for *t*-tests with the BayesFactor package. As both studies that explored this hypothesis (Sierra et al., 2016, and the current study) used 2x2 factorial designs, we computed two independent samples *t*-tests for each study. For the study by Sierra et al., we computed a *t*-test for the comparison between the experimental conditions that included augmental functions (i.e., Conditions A and C) and another *t*-test for the comparison between the conditions that did not include augmental functions (i.e., Conditions B and D). For this study, we computed a *t*-test for the conditions with multiple metaphors (i.e., Conditions A and B) and another *t*-test for the conditions with the same metaphor repeated three times (i.e., Conditions C and D). As suggested by Rouder and Morey, we used a Cauchy prior distribution with the effect size located at 0 and a value of 0.707 for the parameter *r*.

Results

Initial equivalence between groups

The Bayesian one-way ANOVAs revealed that data supported the hypothesis that random allocation of participants produced equivalent groups with regard to AAQ-II scores, pain tolerance, and pain intensity because *BF* for the factor condition was lower than 1 in all cases (see Table 1).

INSERT TABLE 1 ABOUT HERE

Effect of the experimental protocols

Table 2 shows the descriptive data in differential pain tolerance from pretest to posttest for each experimental condition, whereas Figure 2 shows the data for each participant. Participants in Conditions A and C (i.e., the conditions with common physical properties) showed the highest increase of pain tolerance. The protocols of both conditions included common physical properties to participants' discomfort. Participants in Conditions B and D (i.e., conditions without common physical properties) showed similar increases in pain tolerance.

INSERT TABLE 2 ABOUT HERE

INSERT FIGURE 2 ABOUT HERE

Table 2 also shows the results of the Bayesian two-way ANOVA conducted on pain tolerance. As previously stated, all models were given the same prior probability (i.e., 0.200). The column "P(M)" shows the updated probabilities after having observed the data, the column "BF_M" shows the degree to which the data have changed the prior model odds, and the column "BF" shows the Bayes factors associated with each model. The model with common physical properties being the only factor exerting effect on pain tolerance was clearly superior to the remaining models, with a *BF* of 7.105. The results did not change significantly with alternative prior distributions, which indicates that the results obtained are robust under the different reasonable prior distributions.

The model with only multiple examples obtained a *BF* lower than 1 under all tested prior distributions. This indicates that the observed data support the hypothesis that proposing multiple metaphors do not increase pain tolerance over repeating the same metaphor three times.

Table 3 shows the descriptive data with regard to differential pain perception for each condition. The Bayesian two-way ANOVA showed that the independent variables did not seem to affect pain intensity because, in all cases, the *BF* associated with the null model (by default *BF* = 1) was superior to the *BFs* associated with the remaining four models.

INSERT TABLE 3 ABOUT HERE

Updating empirical evidence for common physical properties

The Bayesian meta-analysis through the independent *t*-tests of the current study and of Sierra et al. (2016) lead to a Bayes factor of 104.54. This value indicates that the accumulated evidence for the effect of common physical properties is extremely supportive according to the guidelines by Jeffreys (1961) and Wagenmakers et al. (2011).

Discussion

The current study aimed to analyze the effect of common physical properties and multiple examples in the metaphor effect on promoting psychological flexibility with pain tolerance. A 2x2 factorial design was implemented in which the presence/absence of common physical properties and multiple examples was manipulated. The main dependent variable was pain tolerance as measured in the cold-pressor task. After conducting the pretest in the task, 80 participants were randomly allocated to one of the four experimental conditions with the only restriction of maintaining the same ratio of men and women. Then, participants were re-exposed to the experimental task.

According to the Bayesian one-way ANOVAs, there were no differences among conditions at pretest in experiential avoidance (i.e., AAQ-II scores), pain tolerance, and pain intensity. A Bayesian two-way ANOVA showed that the model with common physical properties being the only factor exerting effect on pain tolerance was clearly superior to the remaining models. This indicates that common physical properties to the participants' discomfort was the only independent variable that significantly increased pain tolerance. With regard to pain intensity, the Bayesian two-way ANOVA showed that neither of the two independent variables exerted a significant effect on pain intensity. The sensitivity analyses indicated that the results of both Bayesian two-way ANOVA were robust under the different reasonable prior distributions.

The results of this study replicate the finding of Sierra et al. (2016) regarding the beneficial effect of incorporating common physical properties to participants' pain in the metaphor content. Moreover, the update of the evidence of the effect of common physical properties led to a Bayes factor of 104.54, which indicates extreme evidence favoring the hypothesis that common physical properties enhance the metaphor effect. These results are also in line with the more basic study presented by Ruiz and Luciano (2015) in which the authors found that common physical properties among relational networks increased the aptness judgments of analogies. Additionally, as in Sierra et al. (2016), the inclusion of common physical properties did not show an effect on pain intensity. This suggests that the process of change of the metaphors was the alteration of the discriminative functions for avoiding pain rather than the decrease of pain intensity (i.e., it promoted a more flexible reaction to the experience of pain). These results are also consistent with similar studies by Gil-Luciano, Ruiz, Valdivia-Salas, and Suárez-Falcón (2016), and Gutiérrez et al. (2004).

The inclusion of multiple examples of functionally equivalent metaphors did not promote higher pain tolerance or lower pain intensity than repeating the same metaphor three times. This finding may be surprising, given the frequency with which multiple similar metaphors are presented in ACT books and protocols (e.g., Stoddard & Afari, 2014). Also, following RFT principles and findings from the cognitive approach to analogical reasoning, multiple examples of similar metaphors could help participants to abstract the most important aspect of the metaphor (i.e., the rule indicating that to advance in the most valued direction, you may need to be willing to experience pain). One possible explanation for this lack of effect of multiple examples is that the metaphors in this study were very similar to each other so that they do not promote greater abstraction of the rule than repeating the first metaphor three times. Accordingly, further studies might compare the effect of multiple more diverse metaphors versus one metaphor directed at the same goal.

One interesting finding of the current study is that common physical properties to the participants' pain were a powerful component even in the context of multiple examples. In this sense, a criticism of the findings by Sierra et al. (2016) could be that common physical properties might lose relevance when presenting multiple metaphors because they would promote the abstraction of the relevant rule suggested by the metaphor. The results of this study, however, do not support that hypothesis and highlight the importance of identifying the core physical properties of the clients' suffering and designing metaphors that contain them. Further studies might analyze the effect of common physical properties in the clinical context (e.g., do clients find metaphors with common physical properties more apt and powerful than metaphors without them?).

Some limitations of the current study are worth mentioning. Firstly, the effect of the protocols was tested only in an experimental task. Further research might analyze the effect of common physical properties and multiple examples in alternative experimental tasks. Secondly, only undergraduate students participated in this study, which reduces the generalizability of the results. Thirdly, the experimental analog conducted in this study is not perfect. For instance, in the clinical context clients usually connect the actions and values involved in the metaphor with specific actions and values in their lives. It might be argued that the latter functional properties were not entirely present in this experimental analog. Specifically, introducing the hand in cold water and tolerating more pain did not lead to valued actions in the participants' lives; however, it seemed to be an action that was symbolically equivalent to advancing towards a value in their lives. Future studies might explore alternative ways in which specific valued actions can be present in the experimental task. Fourthly, it might be argued that participants in Conditions B and D showed less improvement in pain tolerance because the dirty water had more aversive functions than cold water (i.e., the dirty water has a more deterrent effect than cold water). Further studies might improve the experimental control by assessing previously the aversive functions and willingness to be in contact with cold and dirty water. Lastly, the study did not explore whether the abilities in analogical reasoning might moderate the effect of the protocols. Future research could explore whether the inclusion of common physical properties and multiple examples might show a higher effect in participants with low and medium levels of analogical reasoning abilities because they facilitate the comparison of the two parts of the metaphor (i.e., relational networks). However, participants with a high level of analogical reasoning might not benefit from the inclusion of both components because these participants derive metaphors very fluently so that they do not need aids to compare the two parts of the metaphor.

In conclusion, the results of the current study strengthen the evidence that including common physical properties to clients' problematic private events might be a way to improve the metaphor effect in promoting psychological flexibility. This accumulated evidence suggests that training ACT therapists in identifying the core physical properties of the clients' suffering and designing metaphors that contain them might be a way to improve the effect of the therapy.

Compliance with Ethical Standards:

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval: All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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Table 1

Descriptive Data for Each Condition at Pretest and Results of the Bayesian One-Way ANOVAs

	Condition A *M* (*SD*)	Condition B *M* (*SD*)	Condition C *M* (*SD*)	Condition D *M* (*SD*)	BF condition	Error %
AAQ-II	16.45 (5.10)	17.65 (6.47)	21.30 (7.04)	18.15 (6.58)	0.633	8.345e-6
Pretest Time	37.00 (23.40)	32.55 (18.92)	30.40 (17.14)	25.95 (13.10)	0.247	3.022e-4
Pretest Pain	6.08 (1.93)	6.22 (1.92)	7.12 (1.73)	6.48 (2.42)	0.201	4.716e-4

Note. BF = Bayes factor

Table 2

Descriptive Data for each Condition in Differential Pain Tolerance and Results of the Bayesian Two-Way ANOVA

	Condition A (ME + CPP)	Condition B (ME)	Condition C (CPP)	Condition D (none)
M	30.25	15.95	39.50	14.80
(*SD*)	(31.30)	(11.13)	(51.00)	(12.50)
		Bayesian two-way ANOVA with *r* = 0.35		
	P(M|data)	BF_M	BF	error %
Null model	0.082	0.358	1.000	
ME	0.029	0.119	0.352	0.008
CPP	0.584	5.615	**7.105**	1.588e -4
ME + CPP	0.207	1.045	2.520	0.776
ME + CPP + ME * CPP	0.098	0.434	1.190	2.196
		Bayesian two-way ANOVA with *r* = 0.2		
	P(M|data)	BF_M	BF	error %
Null model	0.075	0.326	1.000	
ME	0.038	0.158	0.505	0.002
CPP	0.484	3.754	**6.421**	0.001
ME + CPP	0.247	1.314	3.280	1.986
ME + CPP + ME * CPP	0.155	0.734	2.057	0.906
		Bayesian two-way ANOVA with *r* = 0.5		
	P(M|data)	BF_M	BF	error %
Null model	0.094	0.417	1.000	
ME	0.025	0.103	0.266	0.022
CPP	0.643	7.213	**6.815**	8.820e -4
ME + CPP	0.174	0.845	1.847	0.861
ME + CPP + ME * CPP	0.063	0.268	0.666	2.208

Note. BF = Bayes factor; BF_M = Degree to which the data have changed the prior model odds; CPP = Common Physical Properties; ME = Multiple Examples; P(M|data) = Updated probabilities after having observed the data.

Table 3

Descriptive Data for each Condition in Differential Pain Intensity and Results of the Bayesian Two-Way ANOVA

	Condition A (ME + CPP)	Condition B (ME)	Condition C (CPP)	Condition D (none)
M	-0.23	-0.25	-0.82	0.06
(*SD*)	(1.95)	(1.80)	(2.23)	(1.55)
		Bayesian two-way ANOVA with *r* = 0.35		
	P(M|data)	BF_M	BF	error %
Null model	0.496	3.929	**1.000**	
ME	0.161	0.766	0.324	0.005
CPP	0.230	1.198	0.465	4.346e -4
ME + CPP	0.073	0.315	0.148	2.230
ME + CPP + ME * CPP	0.040	0.168	0.081	1.694
		Bayesian two-way ANOVA with *r* = 0.2		
	P(M|data)	BF_M	BF	error %
Null model	0.373	2.376	**1.000**	
ME	0.176	0.856	0.473	0.021
CPP	0.234	1.224	0.629	1.731e -4
ME + CPP	0.136	0.629	0.365	19.323
ME + CPP + ME * CPP	0.081	0.352	0.217	0.909
		Bayesian two-way ANOVA with *r* = 0.5		
	P(M|data)	BF_M	BF	error %
Null model	0.576	5.437	**1.000**	
ME	0.140	0.652	0.243	0.022
CPP	0.209	1.055	0.362	0.020
ME + CPP	0.050	0.212	0.087	1.015
ME + CPP + ME * CPP	0.025	0.101	0.043	1.335

Note. BF = Bayes factor; BF_M = Degree to which the data have changed the prior model odds; CPP = Common Physical Properties; ME = Multiple Examples; P(M|data) = Updated probabilities after having observed the data.

Figure 1. Overview of the experimental procedure.

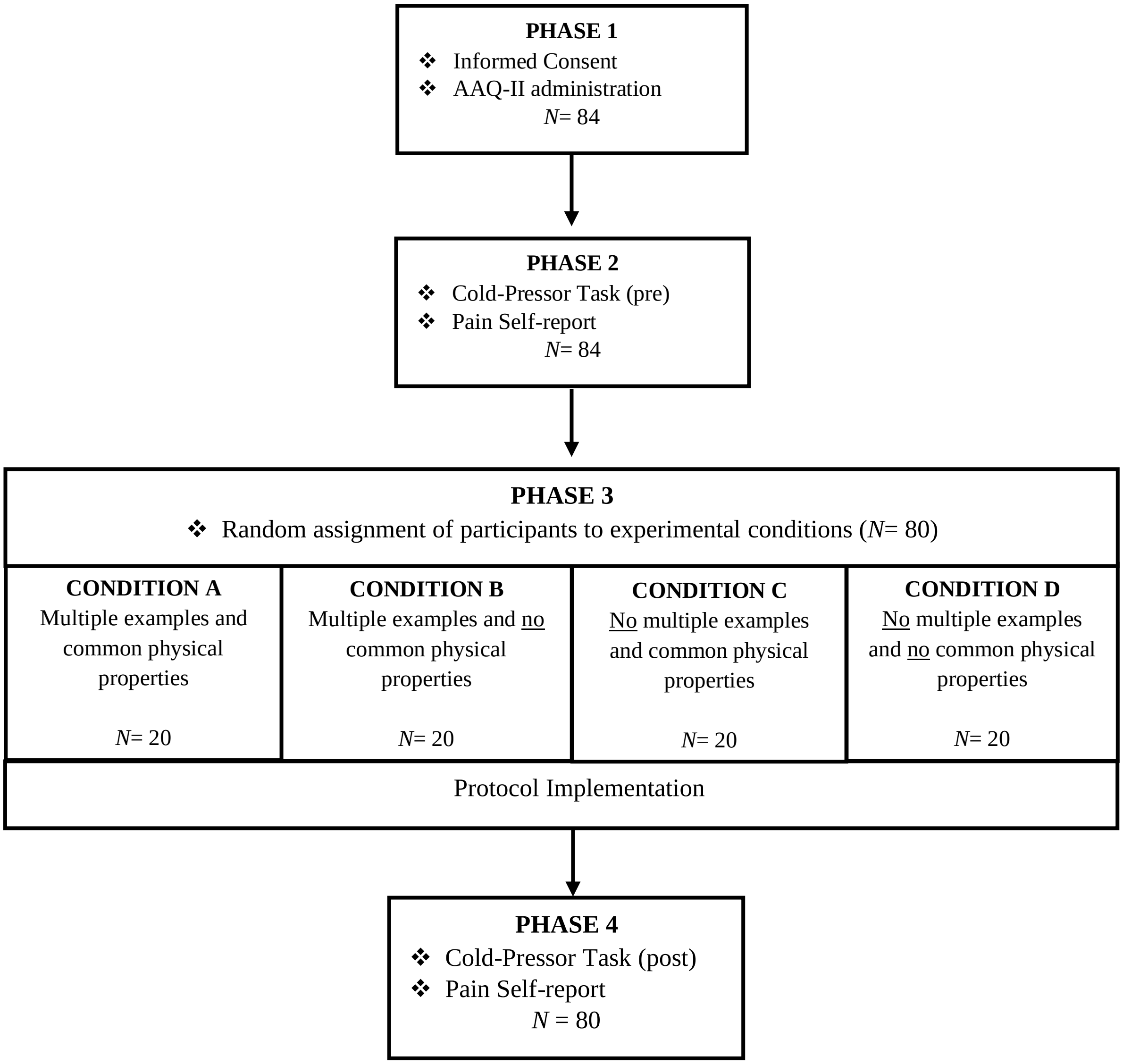
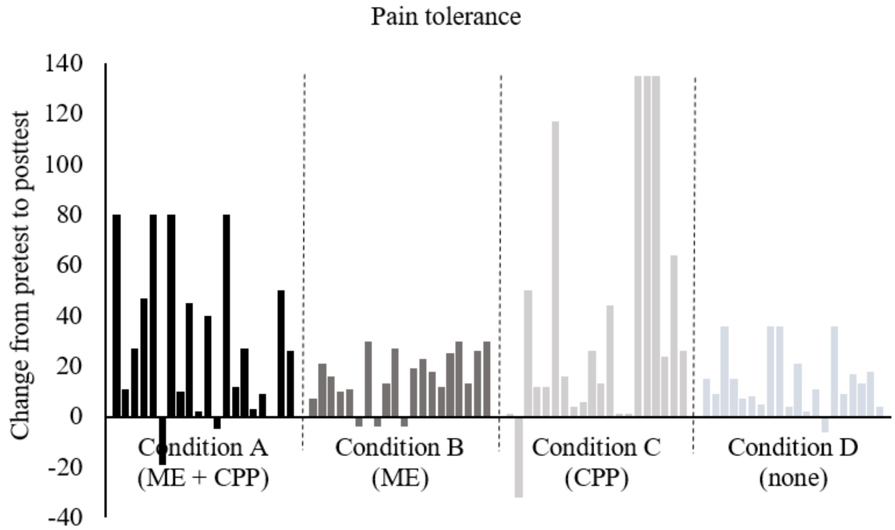


Figure 2. Differential pain tolerance for each experimental condition. Each bar represents the score of one participant.



Note. CPP = Common physical properties; ME = multiple examples.