Generalizability of harm and pain expectations after exposure in chronic low back pain patients

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Abstract
Background: Exposure treatments are shown to be effective in reducing pain-related fear and the perceived harmfulness of physical activities. However, due to the fragility of extinction its stability is questionable. We investigated the generalizability of exposure effects in chronic low back pain (CLBP) patients by integrating a behavioral test in the context of an intervention study.

Methods: The study is an additional analysis of a randomized controlled trial investigating the efficacy of exposure in vivo. A total of 67 CLBP patients were randomly assigned to one of the three groups: Exposure-short (EXP-S); exposure-long (EXP-L) and cognitive behavioral therapy (CBT). Participants rated the expected harmfulness of daily activities (Photograph Series of Daily Activities) before and after therapy. Post-treatment participants were confronted with an individually tailored, threatening movement in a new context. Harm and pain expectations before the exposure were compared to the actual experience after exposure.

Results: We found that EXP leads to more strongly reduced harm expectations ($F(2,50) = 11.37, p < .001, \eta^2 = 0.31$) compared to CBT, regardless of the duration of EXP. After therapy, patients expected less harm ($F(2,50) = 3.61, p = .034, \eta^2 = 0.13$) but not less pain ($F(2,50) = 3.61, p = .034, \eta^2 = 0.13$) when confronted with a novel movement.

Conclusions: Exposure successfully reduced harm but not pain expectations in patients with CLBP. Further, preliminary results showed that these specific exposure effects were generalized to a novel activity in a different context outside therapy.

Significance: This study investigates the generalizability and stability of exposure effects in patients with CLBP by combining a behavioral test with an intervention study. We found strong and stable effects on harm expectations but not on pain expectations. Results show promising preliminary evidence that reduced harm expectations can be generalized to a novel threatening activity in a new context. Clinical implications of our findings suggest that exposure treatment would benefit from a clear focus on harm expectations.

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1 | INTRODUCTION

Exposure is a promising tailored treatment approach developed for chronic low back pain (CLBP) sufferers with elevated levels of fear-avoidance (Vlaeyen, De Jong, Geilen, Heuts, & Van Breukelen, 2001). The idea behind this approach is that people with CLBP often avoid activities because they interpret their occasional pain as threatening (“perceived harmfulness”) and as evidence for a serious injury. Thus, the key element of exposure is the confrontation with feared movements combined with response prevention (omitting avoidance- and safety-seeking behaviors). Exposure treatments have been shown to be effective in reducing pain-related disability through group-based randomized controlled trials (RCT) (Bailey, Carleton, Vlaeyen, & Asmundson, 2010; Glombiewski et al., 2018; Leeuw et al., 2008; Linton et al., 2008; Woods & Asmundson, 2008) as well as single-case experimental designs (Boersma et al., 2004; Vlaeyen et al., 2001). However, the stability and generalizability of exposure effects are uncertain. During exposure treatments new inhibitory nonthreat associations are learned (Vlaeyen, Crombez, & Linton, 2016). Inhibitory learning as a model of extinction is highly context-dependent and therefore fragile (Bouton, 2002). Craske and colleagues recommend to maximally violate expectancies to reach greater inhibitory learning (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). Further, experimental results showed that focusing on expectation violations was more effective than a habituation-based approach in reducing pain tolerance (Schemer, Körfer, & Glombiewski, 2019). Fear-avoidant pain patients show a tendency to overpredict new pain events (Crombez, Vervaet, Baeyens, Lysens, & Eelen, 1996). Though there is strong evidence that these initial overestimations of both pain and harm are corrected after exposure, the generalization of corrective learning is ambiguous (Crombez et al., 2002; Goubert, Francken, Crombez, Vansteenkoven, & Lysens, 2002; Trost, France, & Thomas, 2008). Only one study showed that this correction was generalized from one movement to another (Trost et al., 2008). As findings mainly rely on lab-based results, a recent study combined a behavioural test with randomized replicated single case experimental designs and found support for successful generalization in patients with complex regional pain syndrome (CRPS) (Hollander, Jong, Onghena, & Vlaeyen, 2019).

The goal of the present study was to examine the generalization of exposure experiences in CLBP sufferers via a longitudinal design in a clear clinical setting. The study is an extension of a previously published RCT investigating the efficacy of exposure in vivo compared to a cognitive-behavioural treatment (Glombiewski et al., 2018). Post-treatment, we integrated a behavioral test where participants performed an individually chosen, novel harmful movement in a new context.

The first objective was to investigate the stability and generalizability of exposure experiences. Therefore, we hypothesized that exposure group participants would report weaker harm and pain expectations than the CBT control group when exposed to a novel movement in a different context. Following previous experimental evidence, we expected that participants without exposure experience (control group) would show an over-prediction of harm and pain (larger difference between expectations and experiences) compared to participants in the exposure groups. Second, we were interested in further treatment effects of exposure therapy on harm expectations. We hypothesized that participants of the exposure groups, relative to the control group, would yield lower ratings of expected harmfulness after therapy.

2 | METHOD

Our study was approved by the ethics committee of the German Psychological Society (DGPS, WR 052010_1). The data presented here include additional analysis of a RCT comparing exposure treatment and CBT for chronic low back pain (Clinical Trials NCT01484418). The main results of that trial are published elsewhere (Glombiewski et al., 2018). The analysis presented here includes an additional post-treatment behavioral test as well as the reports on outcomes that were not reported in our main publication.

2.1 | Participants

Study subjects were recruited from the RCT participants. At the end of treatment all participants were contacted and asked to participate in an additional investigation. Fifty-three of the 67 participants who had completed treatment were enrolled in this study (response rate of 79%). Two groups had undergone graded, in vivo exposure either in a short (“EXP-S,” n = 18 out of 20 completers) or a long version (“EXP-L,” n = 18 out of 20

| TABLE 1 Demographic characteristics |
|------------------------------------|-----------------|-----------------|-----------------|
| Variables a                         | CBT (n = 17)    | EXP-S (n = 18)  | EXP-L (n = 18)  |
| Age (y)                             | 52.12 ± 10.87   | 50.06 ± 9.37    | 54.5 ± 8.18     |
| Gender (% female)                   | 76.5            | 44.4            | 44.4            |
| Pain duration (years)               | 14.65 ± 14.88   | 13.78 ± 11.2    | 17.88 ± 12.63   |
| Pain intensity (0–10)               | 3.18 ± 1.98     | 4.11 ± 2.54     | 4.33 ± 2.47     |
| TSK                                 | 39.65 ± 5.54    | 41.22 ± 6.18    | 41.00 ± 6.27    |
| PDI                                 | 37.88 ± 8.4     | 41.33 ± 10.38   | 37.5 ± 9.88     |
| QBPDS                               | 60.94 ± 16.97   | 65.06 ± 15.92   | 64.33 ± 15.38   |

Abbreviations: CBT, cognitive behavioural therapy; EXP-S, exposure short; EXP-L, exposure long; TSK, Tampa Scale of Kinesiophobia; PDI, Pain Disability Index; QBPDS, Quebec Back Pain Disability Scale.

a Values are presented as means (± standard deviation) or percentages.
completers). The control group received cognitive-behavioral pain therapy lacking exposure elements (“CBT,” *n* = 17 out of 27 completers). Sample characteristics are shown in Table 1.

### 2.2 Treatment program

Participants received either exposure as a specific treatment approach developed for fear-avoidant back pain sufferers or CBT representing a broad-spectrum treatment for CLBP. Apart from comparing these two treatment approaches, the original study also analysed the dose effects of two different Exposure conditions (Exposure-long = 15 sessions, Exposure-short = 10 sessions) compared to CBT (15 sessions) to investigate the optimal setting and length of Exposure treatment.

Participants who had undergone a standardized version of CBT without exposure elements experienced these modules: goal development, graded activity, relaxation and cognitive interventions. Graded in vivo exposure included an individualized fear-avoidance model, development of a fear-hierarchy and exposure sessions where participants were confronted with feared back-stressing movements (Vlaeyen, Morley, Linton, Boersma, & Jong, 2012).

### 2.3 Measures

#### 2.3.1 Expected harmfulness (PHODA)

The short version of the Photograph Series of Daily Activities (PHODA-SeV; (Leeuw, Goossens, Van Breukelen, Boersma, & Vlaeyen, 2007b) was used to measure the expected harmfulness of 40 different daily activities. Movements are shown on photos and are divided into eight different categories (lifting, bending, turning, reaching, falling, intermittent load, unexpected movement and long-lasting load in stance or sit with limited dynamics) and represent four activity types (activities of daily living, housekeeping, work and sport and leisure time). The participant is asked to imagine him- or herself performing each movement and to rate the movement’s expected harmfulness on a scale ranging from 0 (“not harmful at all”) to 100 (“extremely harmful”). This version of the PHODA has strong psychometric properties, with high internal consistency, excellent test-retest reliability and established construct validity (Leeuw, Goossens, Van Breukelen, et al., 2007).

#### 2.4 PHODA equivalents

We created a set of 14 novel pictures (“PHODA Equivalents”) corresponding to 14 PHODA pictures to analyse generalisation effects with the first change of context. The new pictures were based on PHODA pictures, which were rated as “70” on the harmfulness scale at baseline. This procedure was possible as one inclusion criteria for the RCT was a specific PHODA profile including ratings above 50 and 80. These photographs displayed a similar movement compared to the corresponding original PHODA picture, but with someone else performing the movement and another background. Further, we used the same type of movement (e.g. carrying) with a different implementation of it (e.g. instead of carrying two shopping bags carrying two suitcases). To evaluate the quality of the new pictures, 33 experts rated the equivalence to the original PHODA pictures during an international invited pain research meeting. Experts rated strain, posture and comparability for each movement separately on a numerical rating scale (0 = not comparable at all; 100 = absolutely comparable). According to the experts’ ratings, we chose those pictures which were rated as comparable (mean comparability score was 70 or above).

### 2.5 Baseline measures

The German version of the Tampa Scale of Kinesiophobia (TSK) was used to measure the fear of movement/fear of (re) injury (Miller et al., 1990; Rusu, Kreddig, Hallner, Hülsbusch, & Hasenbring, 2014). The TSK has 17 items rated on a four-point scale from “strongly agree” to “strongly disagree.” The questionnaire has demonstrated good psychometric properties (French, France, French, & Evans, 2007; Swinkels et al., 2003; Wilgen, Stewart, Stegeman, Coppes, & Wijhe, 2010). Pain-related disability was measured using the Pain Disability Index (PDI) (Dillmann, Nilges, Saile, & Gerbershagen, 1994; Tait, Chibnall, & Krause, 1990). The PDI is a 7-item questionnaire measuring self-rated disability in various areas of daily living (e.g. leisure time, work) on an 11-point numeric rating scale (0 = no disability; 10 = maximum disability). The PDI has shown good internal consistency, test-retest reliability and construct validity (Grönbald et al., 1993; Soer et al., 2013; Tait et al., 1990). To provide a more behaviour-specific measure of disability, we also administered the Quebec Back Pain Disability Scale (QBPDs) (Kopec et al., 1995), which assesses functional disability related to basic daily activities. The QBPDs includes 20 items rated on a 6-point Likert scale indicating the level of difficulty of each activity (0 = “not difficult at all”; 5 = “unable to do”). The German version has strong psychometric properties (Riecke, Holzapfel, Lachnit, & Glombiewski, 2016). Pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS) (Sullivan, Bishop, & Pivik, 1995). The PCS is a five-point scale measuring three dimensions of catastrophizing (helplessness, magnification and rumination) on 13 items. The German version has demonstrated good psychometric properties (Meyer, Sprott, & Frances, 2008).
2.6 | Procedure

RCT participants were randomly assigned to one out of three treatment options (CBT; exposure long or short). Detailed descriptions of the randomisation procedure are available in our study protocol (Riecke, Holzapfel, Rief, & Glombiewski, 2013). Each participant was asked to rate the expected harmfulness of everyday life activities (PHODA) pre- and post-treatment. Post-treatment, we implemented a test of generalization including a behavioural test.

We manipulated different context conditions to test whether participants can transfer their treatment experiences to a different context outside the original treatment setting. The test was located in a different, unfamiliar building to alter environmental aspects. Furthermore, the experimenter was an unknown person, who had not been involved in the treatment, and whom participants had not met before. Participants were confronted with an unfamiliar, individually selected back-stressing movement. We chose those activities, which were rated as harmful (PHODA rating > 70) at baseline. At first, participants rated the expected harmfulness of that movement presented on an equivalent PHODA picture. Second, participants were asked to perform the movement which they have seen before (e.g. lifting a box, turning to fetch something from a shelf) during a behavioral test.

2.7 | Behavioral test

The behavioral test included the individually selected harmful movement, which was already rated on a picture (PHODA equivalent). Participants who had undergone exposure sessions performed a movement that was not addressed during treatment to further guarantee a change in context (dissimilar). The experimenter first modelled the movement. Participants rated expected pain and harm on an 11-point numeric rating scale before performing the movement. After doing so, participants were asked to rate the actual pain and harm they had experienced.

The procedure is illustrated in Figure 1.

2.8 | Statistical analyses

Several univariate ANOVAS were calculated to analyse group differences in demographic variables and in basic questionnaire scores.

Concerning hypothesis 1 (generalization) a 2 (time: expectations and experience) × 3 (group: CBT; EXP-S; EXP-L) repeated-measures ANOVA with harm ratings as the dependent variable examined whether reductions in expected harmfulness were transferred to a new context (represented by a novel picture set). Generalization in the behavioral test was tested with univariate ANOVAs for three groups (CBT;
EXP-S; EXP-L) with expected harm/pain as dependent variables. A 2 (expectation, experience) × 3 (groups) repeated-measures ANOVA was used to analyse the hypothesis of over-prediction. For hypothesis, a 2 (time: before and after therapy) × 3 (group: CBT; EXP-S; EXP-L) repeated measures ANOVA with PHODA ratings as the dependent variable was used to evaluate whether the treatment succeeded in reducing the expected harmfulness of activities (treatment effect).

3 | RESULTS

3.1 | Participant characteristics at baseline

Participants were fear-avoidant chronic back pain sufferers whose mean pain duration ranged from 1 to 50 years. Univariate ANOVAS revealed no group differences in any of the questionnaires at the baseline. Means and standard deviations for all baseline data are presented in Table 1. Further, groups showed no differences in demographic variables.

3.2 | Generalization part one (picture rating)

Do participants in the exposure treatments (EXP-S; EXP-L) rate the expected harmfulness of an individually selected movement, presented in a new context lower after therapy than those in the control group (CBT)?

A 2 (time: before and after therapy) x 3 (group: CBT; EXP-S; EXP-L) repeated-measures ANOVA compared an individually selected PHODA picture rated before therapy with an equivalent picture presented thereafter. This analysis revealed the main effect of time, $F(1,50) = 175.87, p < .001, \eta^2 = 0.78$, group $F(3,63) = 6, p = .001, \eta^2 = 0.22$ and the interaction effect also revealed significance $F(2,650) = 6.14, p = .004, \eta^2 = 0.19$ (see Figure 2). Post hoc tests showed that participants of the control group expected more harm than both EXP-groups ($p < .05$).

Besides the treatment effect, these results indicate that participants were possibly able to generalize the treatment effect (weaker harm expectations after exposure therapy) to a different context (represented by a novel, unfamiliar picture).

3.3 | Generalization part two (behavioral test)

The overall repeated-measures ANOVA with expected and experienced harm demonstrated a main effect of time $F(1,50) = 12.89, p = .001, \eta^2 = 0.218$. The group effect also revealed significance $F(2,50) = 3.28, p = .05, \eta^2 = 0.12$. No time x group interaction ($p = .483$) was detected.

The overall repeated measures ANOVA with expected and experienced pain revealed a significant effect of time $F(1,50) = 9.45, p = .003, \eta^2 = 0.16$, but the effect of group was not significant ($p = .76$).

Do participants in the exposure treatments (EXP-S; EXP-L) report weaker harm/pain expectations when confronted with a novel movement than participants of the CBT group?

A univariate ANOVA with expected harm before the behavioral test as the dependent variable exhibited significant differences amongst the three groups, $F(2,50) = 3.61, p = .034, \eta^2 = 0.13$. Post hoc tests indicated a significant difference between the CBT group and exposure short group ($p = .04$). Thus, participants who underwent exposure therapy in a short version exhibited weaker harm
expectations when confronted with an unknown move-
m\text{ment than participants who received CBT treatment (see F-i-g-
est 3). In contrast to our hypothesis, the difference be-
 tween exposure long and the CBT control group was not sig-
nificant.

A univariate ANOVA with expected pain before the first ex-
posure as the dependent variable showed no differences am-
ongst the three groups, $F(2,50) = 0.11, \ p = .9, \ \eta^2 = 0.004$
(see Figure 3).

Due to the difference between pain and harm data, we
additionally calculated separate correlation coefficients
to compare pain and harm expectations for the three
groups. Examination of Pearson correlations indicated
significant correlations between pain expectations and
harm expectations in the CBT group ($r = .56, \ p = .02$)
whereas the exposure groups’ harm-pain correlations
were lower and not significant (see Table 2). Fischers’ $z$
test was employed to test whether the correlation coeffi-
cients of the CBT group differed from those of the expo-
sure groups. The test revealed no significant differences
($p = .25, \ p = .13$).

Do participants of the control group, but not those in the
exposure groups, overpredict harm/pain?

A repeated-measures ANOVA with expected and ex-
perienced harm demonstrated a main effect of time
$F(1,50) = 12.89, \ p = .001, \ \eta^2 = 0.218$, with higher ratings
for expectations ($M = 1.76$) than for experiences ($M = 1.26$).
The group effect also revealed significance $F(2,50) = 3.28,$
$p = .05, \ \eta^2 = 0.12$. No time x group interaction ($p = .483$) was
detected. A one-tailed $t$-test and a univariate ANOVA were
performed to further corroborate these observations. These
tests revealed the following. Expected harm was signifi-
cantly higher than experienced harm $r(52) = 3.58, \ p = .001$.
Significant group differences only were found between CBT
and EXP-S for harm expectations, $F(2,50) = 3.61, \ p = .034,$
$\eta^2 = 0.13$.

These results demonstrate that participants irrespec-
tive of treatment condition overpredicted harm. For
pain ratings we also found a significant effect of time
$F(1,50) = 9.45, \ p = .003, \ \eta^2 = 0.16$, with higher ratings for
expectations ($M = 4.26$) than for experiences ($M = 3.94$).
A one-tailed $t$ test supported this finding, $t(52) = 3.00,$
$p = .004$. Results are in contrast to our hypothesis, as we
expected that only participants of the control group over-
predict harm/pain.

### 3.4 Treatment effect (PHODA)

Do participants in the exposure treatments (EXP-S; EXP-L)
rate the expected harmfulness of movements lower after ther-
apy than do participants of the control group (CBT)?

A 2 (time: before and after therapy) × 3 (group: CBT; EXP-S; EXP-L) repeated-measures ANOVA revealed a main effect of time, $F(1,50) = 205.19, \ p < .001, \ \eta^2 = 0.8$, for the PHODA ratings. Furthermore, the time x group interaction was significant, $F(2,50) = 11.37, \ p < .001, \ \eta^2 = 0.31$, with higher harm ratings after the treatment for the control group ($M_{\text{CBT}} = 35.04, \ SD_{\text{CBT}} = 15.50$) compared to the exposure groups ($M_{\text{EXP-S}} = 22.09, \ SD_{\text{EXP-S}} = 14.80; M_{\text{EXP-L}} = 23.93, \ SD_{\text{EXP-L}} = 15.29$). This suggests that the exposure treatment

![FIGURE 3](image-url)
was more successful at changing patients’ harm expectations than CBT.

4 | DISCUSSION

Though exposure is one of the key strategies in CBT and a promising approach for fear-avoidant back pain patients its long-term maintenance and generalization are questionable. Thus, the present study investigates this important and scarcely studied issue by combining an experimental paradigm with an intervention study. At first, we were interested if changes in expectations (harm and pain) due to treatment can be generalized to a new context. Second, we investigated the effect of exposure on harm expectations.

With regard to the generalizability of exposure effects, the results partially supported our hypotheses. First, participants of the CBT group rated the expected harmfulness of an individually selected movement (presented on a picture in a new context) higher than both exposure groups. Second, the results of the behavioral test showed group differences in harm but not in pain expectations. Participants of the exposure-short group expected less harm compared to those of the CBT group. In contrast to our hypothesis, the difference between exposure long and CBT was not significant. Third, irrespective of treatment condition all participants overestimated both harm and pain, as they expected more than they actually experienced. Fourth, we found that exposure treatment led to strong reductions in harm expectations associated with daily activities which are consistent with the results of previously published studies (Leeuw et al., 2008).

Based on the current findings we conclude that exposure in vivo treatment successfully reduces and thus corrects heightened harm but not pain expectations. Further, we found preliminary data that it seems possible to transfer this exposure effect to a different context outside therapy.

In contrast to our hypothesis for the behavioral test, we only found differences in harm expectations between exposure-short and CBT. Actually, it would be more logical that exposure in its long version creates stronger exposure effects as it includes more exposure sessions and therefore more context changes. Floor effects due to our intervention phase may have impacted our ability to detect effects. Our treatment seemed to be very strong and lead to relatively low levels of harm expectations. Otherwise, mean harm expectations were comparable with the data of previous experimental studies (Crombez et al., 2002).

We operationalized successful generalization with no or lower effects of over-estimation after exposure therapy compared to CBT. In contrast to our expectation, all participants overestimated harm and pain. There may be at least two explanations for this finding. First, in prior studies, the second exposure was shortly after the first one. Participants had just had the experience of over-estimation and afterwards quickly adapted their ratings. The current study had a longer time period between exposure sessions and the behavioral test, leading to weaker memories of the correcting experiences. The question as to whether exposure therapy results in a complete elimination of over-estimation or just a reduced difference between expectations and experiences warrants further investigation. Second, low statistical power due to our small sample size may account for the lack of group differences in this variable.

One interesting finding was a different pattern for harm as for pain ratings. Participants of both exposure groups expected less harm but not less pain after exposure therapy compared to the CBT group. Results are different to preceding experimental data which did not show any effect of exposure on harm but on pain (Crombez et al., 2002). These discrepancies might be explained by significant differences in study design. Experimental studies investigated a single exposure whereas the present study realized exposure as an individual intervention with several sessions. Our results suggest that repeated disconfirmatory experiences are required to correct harm-expectancies and a single experience might be insufficient. For pain overpredictions there might be no beneficial gain after a first correction. Our clinical impression also shows that during exposure people still experience intense pain but without the expected detrimental consequences.

With regard to the generalization of exposure effects, we found a positive trend that participants were able to transfer their exposure experience to a new context. Our results are comparable to a recent replicated single case study, that showed successful generalization in patients with CRPS (Hollander et al., 2019). In contrast, preceding experimental studies concluded that instead of generalizing their exposure experience back pain patients learned an exception of a rule (Crombez et al., 2002; Goubert et al., 2002). Notable differences in study designs between experimental studies and interventional approaches might explain the different findings. The most important difference is that the present study provided exposure as a treatment instead of a performance test including more disabled participants who were seeking treatment. Participants were confronted with functional, individualized activities. Further, we provided an extensive manipulation of context including a new not yet practised movement in a novel environment with an unknown investigator.

From a clinical perspective one of the most interesting findings was that exposure reduces harm but not pain expectations. These results can be interpreted in terms of the expectation violation approach. During exposure patients learn that their expected consequences of a feared movement are in fact a catastrophic overestimation. Leeuw and colleagues assumed that this corrective experience might diminish fear and further promote functional abilities.
Further, expectation violation is acknowledged as a central mechanism of inhibitory learning (Craske et al., 2014). In an experimental study Schemer and colleagues showed that an expectation violation approach was more successful in increasing pain tolerance compared to a habituation-based instruction (Schemer et al., 2019). Besides fear reduction and correction of overestimation exposure might result in a cognitive reappraisal of pain itself. After successful exposure, pain might be no longer interpreted as a threatening sign of a possible injury (“Lifting a box hurts but without injuring my back.”) and no longer represents a reason to avoid certain activities. Thus, it might be valuable for therapists to support patients to question their expected overestimated consequences of pain (disconnect pain from harm).

Besides underlying mechanisms of exposure treatment, also the theoretical conceptualization of fear-avoidance needs further discussion. Some researchers use the term fear of pain/fear of (re-)injury which has been primarily conceptualized as a phobia-based construct referred to as “kinesiophobia” (Miller et al., 1990). Recent articles have critiqued the original concept (Crombez, Eccleston, Damme, Vlaeyen, & Kröner-Herwig, 2016). This would certainly help to understand the generalization of fear extinction. Translated into therapeutic behavior, a distinct focus on negative expectations about pain and its consequences might further yield exposure effects. According the approach of expectation-focused psychological interventions also suggests that exposure treatments for pain patients might benefit from focusing on expectations associated with pain (Rief & Glombiewski, 2016). Future intervention studies should examine the underlying mechanisms of exposure to determine whether it is a fear reduction or the modification of cognitive processes that are most important during exposure therapy in CLBP.

The current report has several limitations. First, all findings were based on self-report measures. Future replications should also integrate behavioral data measured with a validated test such as the behavioral avoidance test for back pain “BAT back” (Holzapfel, Riecke, Rief, Schneider, & Glombiewski, 2016). This would certainly help to understand the behavioral aspects of generalization. The interpretation of successful generalization assessed with new pictorial material is limited because reduced harm expectations could also represent treatment effects, as perceived novelty was not rated separately. Nevertheless, the results of the behavioral test, which implied better manipulation of a new context, further support those of picture ratings. Another limitation is the small sample size of our study. The number of participants was restricted because of our mixed study design. While this study focused both on pain and harm expectations, future studies should also address fear expectations specifically to better understand the generalization of fear extinction.

Our study’s strengths include its longitudinal design, enabling us to examine the direct effects of treatment generalization within a clinical sample that received exposure as a treatment. Our seriously disabled cohort of chronic pain patients is also an advantage over prior human-conditioning studies, which have often examined undergraduate students. The extensive manipulation of context is further strength. According to Bouton’s definition of context as a variety of different background cues (Bouton, 2002), we considered both external aspects (an unfamiliar experimenter, an unfamiliar building and a not-yet-practiced movement) and internal aspects (passage of time). Finally, a major strength is our selection of fear-eliciting exposure stimuli. The stimuli reflect those common to everyday experience and were personally relevant to the participants, resulting in greater ecological validity than in prior studies.

To our knowledge, the current report represents the first study examining the generalizability and stability of exposure effects in severely disabled, fear-avoidant patients suffering from CLBP directly after therapy. Our findings showed that exposure treatment in CLBP leads to strong and stable changes of harm but not pain expectations, which suggests that exposure might benefit from a clear focus on harm belief disconfirmation. Further, results indicate that exposure effects particularly reductions in harm expectations are generalizable to new situations outside the treatment context.

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