**BRIEF REPORT**

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# Long-Term Improvements in Probability and Cost Biases Following Brief Cognitive Behavioral Therapy for Social Anxiety Disorder

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## Abstract

This study examines whether improvements in probability and cost biases following cognitive behavioral therapy for social anxiety disorder endure over the long-term. Participants (N = 65) diagnosed with social anxiety disorder were randomly assigned and completed eight sessions of either exposure group therapy or virtual reality exposure therapy delivered according to a treatment manual. 24 participants completed standardized self-report measures of probability and cost biases at pre-treatment, post-treatment, and 5½ years, on average, after completing active treatment (range 2.5–6.5 years). Analyses of variance show that, relative to wait list, participants who completed an active treatment reported greater decline in probability and cost biases at post-treatment. Further, relative to pre-treatment, all treated participants reported significant improvements in probability and cost biases at post-treatment and at long-term follow-up. Cognitive-behavioral therapy may lead to long-lasting reductions in cognitive biases.

**Keywords** Social anxiety disorder · Cognitive behavioral therapy · Threat reappraisal · Cognitive · Biases · Long-term follow-up · Virtual reality

## Introduction

Cognitive biases are at the heart of cognitive behavioral theory and therapy for anxiety disorders (Clark and Beck 2010). In their seminal work, Butler and Matthews (1983) argued that anxiety disorders are characterized by two primary cognitive biases: overestimating the likelihood of a feared event (i.e. probability bias) and overestimating the costs of feared outcomes (i.e. cost bias). Cognitive behavioral therapy is thought to improve anxiety by reducing these exaggerated appraisals of the likelihood and cost of feared outcomes, also referred to as threat reappraisal.

Exaggerated appraisals of the probability and cost of negative outcomes following *social* events is key for people with social anxiety disorder. Clark and Wells (1995) theorize that individuals with social anxiety disorder believe that "(1) they are in danger of behaving in an inept and unacceptable fashion, and (2) that such behavior will have disastrous consequences in terms of loss of status, loss of worth, and rejection" (p. 69–70). According to this model, a variety of dysfunctional beliefs (e.g., the belief that other people are holding them to a high standard of performance) and assumptions (e.g., if I make a mistake, then I will fail) lead people with social anxiety disorder to develop inflated estimates about the probability and cost of negative outcomes. Heimberg's cognitive-behavioral model of social phobia (Heimberg et al. 2010; Rapee and Heimberg 1997) also emphasizes the importance of cognitive biases in the maintenance of the disorder; persons with social anxiety disorder assume that others are critical and thus overestimate the likelihood of being negatively evaluated.

Empirical research shows that compared to non-anxious controls, people with social anxiety disorder report that negative outcomes following social events are more likely and more costly (Foa et al. 1996; McManus et al. 2000; Uren et al. 2004). Several studies show that cognitive-behavioral therapy (CBT) for social anxiety disorder is associated with significant reductions in probability and/or cost biases immediately following treatment (Boden et al. 2012; Lucock and Salkovskis 1988; Poulton and Andrews 1996). A number of randomized clinical trials have tested whether CBT for social anxiety disorder causes improvements in probability and/or cost biases immediately following treatment.

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Studies using wait-list control groups found that various forms of CBT lead to significantly greater reductions in probability and/or cost biases, including cognitive behavioral group therapy (Hofmann 2004; Taylor and Alden 2008), exposure group therapy (Calamaras et al. 2015; Hofmann 2004), and virtual reality exposure therapy (Calamaras et al. 2015). McManus et al. (2000) used an active control (placebo medication) and found that cognitive therapy and fluoxetine produced significant reductions in probability and cost biases. Finally, two studies compared active treatments to each other. Hoffart et al. (2009) found that cognitive therapy and interpersonal therapy were associated with reductions in probability and cost biases, and Rapee et al. (2009) found that relative to stress management and standard CBT, CBT that was intentionally modified to target cognitive processes (enhanced CBT) produced greater changes in cost biases, but not probability biases. In summary, the small body of research designed to test whether standard CBT causes changes in cognitive biases tends to suggest this is the case, as all studies show that CBT produces reductions in probability and/or cost biases (Calamaras et al. 2015; Hoffart et al. 2009; Hofmann 2004; McManus et al. 2000; Taylor and Alden 2008), with one exception (Rapee et al. 2009).

No study to date has examined the extent to which improvements in probability and cost biases endure. Heimberg et al. (1993) come the closest, as this team evaluated the extent to which cognitive behavioral group therapy was associated with changes in the negativity of thoughts following a speech task. Their results showed that, relative to a credible placebo, participants receiving cognitive behavioral group therapy for social phobia listed more positive and fewer negative thoughts immediately following treatment; there were, however, no differences between the two treatment groups on number of positive and negative thoughts following the speech task at 5-year follow-up. Simply put, we do not know if CBT treatment for social anxiety disorder produces long-lasting changes in the cognitive biases that are theorized to be at the heart of anxiety disorder psychopathology and its treatment.

This is the first study to evaluate the extent to which improvements in probability and cost biases are detectable over the long-term (5½ years, on average, after treatment) following a brief course of CBT for social anxiety disorder. Data from the present study are drawn from a parent study (Anderson et al. 2013) which compared Exposure Group Therapy (EGT; Hofmann 2007) and virtual reality exposure therapy for social anxiety disorder (VRE; Anderson et al. 2005) to a wait list control using a randomized controlled trial, in which participants in the wait list control group were subsequently randomly assigned to EGT or VRE. All participants had a clinical diagnosis of social anxiety disorder with a predominant fear of public speaking and received 8 weekly sessions of VRE or EGT delivered according to a treatment

manual. Results from the parent study demonstrated similar improvement across both treatments on most outcome measures, including self-report measures, behavioral measures, and diagnostic status. For the present study, we hypothesized that cognitive biases as measured by standardized self-report questionnaires would be lower immediately following treatment than at pre-treatment and lower at long-term follow-up than at pre-treatment.

## Method

### Participants

Everyone who completed the parent study and received either virtual reality exposure therapy or exposure group therapy was eligible for the current study (see Anderson et al. 2013 for details). Of the 65 eligible participants, 20 could not be contacted, five declined participation, and 16 agreed to take part in the study but never did so, yielding a sample of participants ($N = 24$) who completed virtual reality exposure therapy ($n = 12$) or exposure group therapy ($n = 12$) 5½ years earlier, on average (range 2.5–6.5 years). See Fig. 1 for participant flow.

Participants were predominately female (71%), middle-aged ($X = 43$ years, range = 22–69 years; SD = 13.6), and well-educated, with 69% attaining an undergraduate degree or higher. Participants reported having an average income of 50,000 or more (38%), being married (38%) and self-identified as "Caucasian" ($n = 14$; 58%), "African-American" ($n = 6$; 25%), "Latino" ($n = 2$; 8%), "Asian American" ($n = 1$; 4%), or "Other" ($n = 1$; 4%).

### Measures

*Outcome Probability and Cost Questionnaires* (OPQ; OCQ; Uren et al. 2004). The OPQ and OCQ are 12-item self-report questionnaires that assess an individual's estimate of the likelihood that negative social events will occur and how distressing it would be if the event did occur. The negative events are the same for the OPQ and the OCQ (e.g., "You will feel embarrassed by something you did"). The OPQ asks participants to rate how "likely it is that the following outcome will happen to you" using a 9-point Likert-type scale ranging from 0 ("not at all likely") to 8 ("extremely likely"). The OCQ asks participants to rate "how bad or distressing the following outcomes would be for you if they were to occur" on a scale of 0 ("not at all distressing") to 8 ("extremely distressing"). As recommended by the original scale development paper, the 10-item versions were used in the present study.

The scale's developers report that internal consistency for the OPQ subscale ranges from good to excellent (Cronbach's
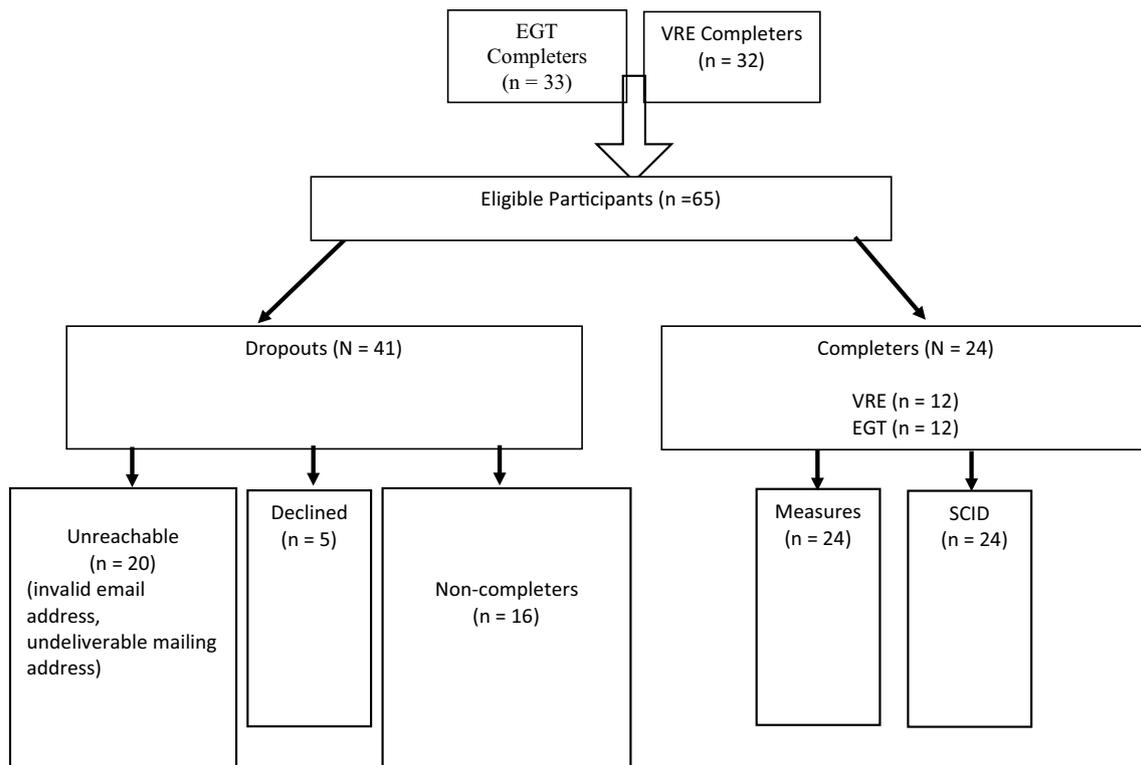
**Fig. 1** Participant flow chart

α = 0.89–0.90) and that the internal consistency for the OCQ is excellent (Cronbach's α = 0.92–0.94; Uren et al. 2004). The internal consistencies for the OPQ and OCQ in the current study were good at pretreatment (α = 0.85, α = 0.83), excellent at posttreatment (α = 0.89, α = 0.88), and excellent at long term follow-up (α = 0.87, α = 0.93), respectively.

*Structured Clinical Interview for the DSM-IV* (SCID; First et al. 1994). The anxiety, mood, and substance disorder modules were administered to assess inclusion and exclusion criteria and diagnose social anxiety disorder.

## Treatments

Five study therapists administered both treatments—therapists were not nested within treatment type. Two therapists were licensed psychologists and three therapists were doctoral students in clinical psychology. All therapists attended 2-day intensive training workshops conducted by the developers of the treatments prior to administering the study protocol. All treatment sessions were video recorded, and a randomly selected subset of treatment sessions (14%) were reviewed by the developers of the respective treatments and rated for compliance. Compliance ratings were 92% for VRE and 93% for EGT. The developers reported one infraction for each treatment arm across all sessions reviewed.

The VRE and EGT treatment groups were designed to be as similar as possible and addressed specific aspects of social anxiety disorder identified in psychopathology literature, including self-focused attention, perceptions of self and others, perceptions of emotional control, rumination, and realistic goal setting for social situations. Both treatments specifically targeted probability and cost biases with psychoeducation, cognitive restructuring, cognitive preparation, exposure and/or social mishaps.

Treatment adherence was measured by therapists' ratings of participants' completion of handouts and preparation for in-session activities. Adherence ratings were completed at the beginning of treatment sessions 2–8. Therapists used the following ratings: "did not understand"; "did not attempt"; "completed, but didn't bring in"; "completed a small part of homework"; "completed at least half of homework"; or "completed homework." Among those who completed the long-term follow-up study, homework compliance was comparable across treatment groups for all sessions (all $p$'s > .05) except for session 3, which consisted of completing a daily mirror task ($\chi^2(2) = 11.49$, $p < .01$, $\varphi = 0.04$). For this session, 81.8% of participants in the VRE and 54.5% of participants in the EGT condition completed half or more of homework.

## Procedure

A brochure was sent to participants' last known address, and participants were later contacted by phone and/or email to schedule an in-person assessment. Participants completed standardized self-report measures, a behavioral avoidance task, and a structured clinical diagnostic interview at Georgia State University. Self-report measures included questionnaires assessing symptoms of social anxiety and global ratings of improvement in addition to the OCQ and the OPQ. Clinical interviews were conducted by advanced doctoral students in clinical psychology who were trained in the interview to establish the diagnosis of social anxiety disorder. All interviews were videotaped, and a randomly selected subset ($n = 5$) were reviewed by a licensed psychologist to calculate the inter-rater reliability (100% agreement for primary diagnosis, with one disagreement on severity).

All dependent variables were screened for errors, outliers (defined as scores greater than three standard deviations from the mean), and missing values. One outlier was identified for the pre-treatment OCQ, but this score was kept because the OCQ scores for this participant were relatively stable over time. Comparisons between those who did and did not complete the follow-up assessment were made using a series of t-tests, which revealed no significant differences on any demographic factors, pre-treatment scores on probability and cost biases, and post-treatment scores on probability and cost biases (all $p$'s > .05).

Long-term improvements in the symptoms of social anxiety are reported elsewhere (Anderson et al. 2017). Briefly, participants showed statistically significant improvement on all self-report measures from pre-treatment to long-term follow-up, most participants no longer met diagnostic criteria for social anxiety disorder, and the majority of participants were willing to engage in the behavioral avoidance task. Improvements did not differ by treatment group. One participant reported receiving additional treatment for social anxiety disorder between the end of treatment and the long-term follow-up assessment.

## Results

Using data from the parent study, we initially tested the assumption that cognitive biases decreased significantly from pre-treatment to post-treatment among those in an active treatment condition ($n = 63$) compared to those in the waitlist control condition ($n = 23$; see Anderson et al. 2013 for participant flow). Results from an independent t-test revealed no significant differences in cognitive biases (OCQ, OPQ) when measured at pre-treatment between the active treatment and waitlist control conditions (OCQ: $p = .84$; OPQ: $p = .66$).

Two separate $2 \times 2$ time (pre-treatment, post-treatment) × condition (active treatment, wait-list control) repeated measures ANOVAs were used to test this assumption. A Bonferroni correction was applied to the alpha value to control for bias resulting from multiple testing. As such, the critical $p$ value was adjusted to .025 for both analyses. There was a significant main effect of time for each measure: OCQ, $F(1, 84) = 32.50$, $p < .001$, partial $\eta^2 = 0.28$; OPQ, $F(1, 84) = 66.87$, $p < .001$, partial $\eta^2 = 0.44$. There was not a main effect of Condition for either measure: OCQ, $F(1, 84) = 1.56$, $p > .025$, *partial $\eta^2 = 0.02$*; OPQ, $F(1, 84) = 1.78$, $p > .025$, *partial $\eta^2 = 0.02$*. However, a significant interaction was detected: OCQ, $F(1, 84) = 9.28$, $p = .003$, partial $\eta^2 = 0.01$; OPQ, $F(1, 87) = 7.95$, $p = .006$, partial $\eta^2 = 0.01$. Bias scores decreased more among participants who received active treatment compared to those who did not. Means and standard deviations for OCQ and OPQ scores among those in an active treatment condition and those in the waitlist control condition are reported in Table 1.

To test the main hypothesis that self-reported outcome cost and probability biases would be lower immediately following treatment than at pre-treatment and lower at long-term follow-up than at pre-treatment, two separate $3 \times 2$ time (pre-treatment, post-treatment, follow-up) × treatment type (virtual reality exposure therapy, exposure group therapy) repeated measures ANOVAs were conducted. For these analyses, only data from participants who completed the long-term follow-up were included ($n = 24$). A Bonferroni correction was applied to the alpha value in order to control for bias resulting from multiple testing. As such, the critical $p$ values were adjusted to .025.

As shown in Table 2, there was a significant main effect of Time for each measure. Contrasts showed that, compared to pre-treatment, judgmental biases were significantly lower at post-treatment: OCQ (*M* difference = − 19.38, $p < .001$) and OPQ (*M* difference = − 18.86, $p < .001$) and at long-term follow-up: OCQ (*M* difference = − 19.59, $p < .001$), OPQ (*M* difference = − 18.58, $p < .001$). There was not a main effect of treatment type nor time × treatment type interaction for the OCQ or for the OPQ.

**Table 1** Means and standard deviations for self-report ratings of cognitive biases for active treatment and wait-list controls at pretreatment and posttreatment

|  | Active treatment | | WL control | |
|  | Pre | Post | Pre | Post |
|---|---|---|---|---|
| OCQ | 65.05 (15.95) | 42.84 (22.71) | 62.26 (17.49) | 55.52 (18.07) |
| OPQ | 52.48 (18.91) | 29.39 (18.54) | 52.42 (18.62) | 41.86 (20.07) |

**Table 2** Means, standard deviations, and 3 × 2 (time × treatment type) ANOVA comparing Self-report ratings of cognitive biases at pretreatment, posttreatment, and long-term follow-up

| | VRE | | | EGT | | | Main effect of time | | Main effect of treatment | | Interaction | | Partial eta² | | | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | LTF | Pre | Post | LTF | F | p | F | p | F | p | Pre/post | Pre/LTF | | |
| OCQ | 57.81 (19.38) | 40.92 (15.40) | 43.33 (17.95) | 62.94 (12.03) | 41.08 (19.68) | 38.25 (16.66) | 16.68 | <.001 | 0.00 | .99 | 0.86 | .43 | 0.46 | 0.55 | | 24 |
| OPQ | 47.83 (19.04) | 30.94 (16.91) | 33.25 (15.27) | 49.67 (16.18) | 28.83 (17.02) | 27.08 (16.87) | 20.75 | <.001 | 0.14 | .711 | 0.71 | .50 | 0.58 | 0.56 | | 24 |

*OCQ* Outcome Cost Questionnaire, *OPQ* Outcome Probability Questionnaire, *VRE* virtual reality exposure, *EGT* exposure group treatment, *LTF* long-term follow-up

## Discussion

This is the first study to show that there are measurable improvements in cognitive biases 5½ years, on average, after completing a brief course of cognitive behavioral therapy for social anxiety disorder. Participants' self-report of both probability and cost biases were significantly lower at post-treatment and long-term follow-up compared to pre-treatment, with no differences between virtual reality and exposure group therapy. These results should be considered highly preliminary, given the high level of attrition between the post-treatment and long-term follow-up assessments. It is not possible to determine whether participants who did not complete the long-term follow-up assessment experienced relapse, increased symptoms, and/ or increased probability and cost biases compared to those who did. Comparisons between those who did and did not complete the follow-up assessment, however, showed no differences in demographic characteristics, symptom severity, or cognitive biases at pre-treatment or post-treatment. In addition, the limited sample size prevented utilization of more sophisticated analytical techniques, such as multi-level modeling, which could have allowed for a more nuanced understanding of change in probability and cost biases over time, and how these variables may have related to changes in symptoms of social anxiety.

Limited as they may be, these results are encouraging— short term CBT may indeed lead to durable improvement in probability and cost biases. It adds to the small body of research which consistently shows that standard CBT produces changes in probability and/or cost biases immediately following treatment (Calamaras et al. 2015; Hoffart et al. 2009; Hofmann 2004; McManus et al. 2000; Taylor and Alden 2008) and probability biases (Calamaras et al. 2015; Hoffart et al. 2009; McManus et al. 2000; Taylor and Alden 2008), but see Rapee et al., (2009) for an exception. Our results extend this work by showing that improvements in probability and cost biases endure for up to 6 years after treatment has concluded.

Future research on long-term changes in cognitive biases is needed to test the mechanistic role of threat reappraisal in the treatment of social (and other) anxiety disorders. If threat reappraisal is indeed a mechanism through which treatment leads to improved symptoms of anxiety, we would expect that long-lasting symptom improvement would be associated with long-lasting reductions in cognitive biases—although such cross-sectional associations would not be sufficient to establishing threat reappraisal as a mechanism of action for CBT (see Smits et al. 2012 for an excellent review).

Notably, future research will need to consider the use of multi-modal assessment of probability and cost biases. To

date, these variables have been operationalized exclusively by various self-report measures [e.g., Social Probability and Cost Questionnaire (McManus et al. 2000); Probability/Cost Questionnaire (Foa et al. 1996)]. Researchers have frequently modified these measures to suit their purposes or to address limitations (e.g., Rapee et al. 2009), which could lead to inconsistent results across studies. In the present study we used unmodified and standardized measures of probability and cost bias with known psychometric properties. Exclusive use of self-report from a single source is an important limitation to consider. Critically, researchers have found that pre- to post-treatment change in self-report measures do not strongly correlate with behavioral change (Cohen 1977). Behavioral measures are more reliable and valid indicators of therapeutic change following cognitive-behavioral treatment for anxiety disorders (Craske et al. 2008). Many computer tasks designed to assess cognitive bias have been used extensively in the interpretation bias literature (e.g., Mathews and Mackintosh 2000). These paradigms may potentially be modified to operationalize, and even experimentally manipulate, probability and cost biases. This would be important for enhancing the credibility of empirical investigations of these variables as a potential mechanism of change in cognitive-behavioral treatments for social anxiety disorder.

An interesting question is the extent to which threat-reappraisal is unique to CBT, as research shows that other treatments that are presumed to operate via different mechanisms also produce changes in cognitive biases. Recall that McManus et al. (2000) found that relative to a placebo medication control, both cognitive therapy and fluoxetine produced significant reductions in probability and cost biases at post-treatment. Goldin et al. (2016) compared cognitive behavioral group therapy and mindfulness-based stress reduction and found that threat reappraisal self-efficacy mediated symptom improvement for cognitive behavioral group therapy only, but that threat reappraisal frequency mediated symptom improvement for both treatments. These findings are limited because they demonstrated statistical mediation at one point in time. Hoffart et al. (2009), however, compared CBT and interpersonal therapy delivered in a residential format and measured change processes and symptom change at multiple time points. Results showed that improvements in probability and cost biases predicted subsequent symptom improvement (and vice versa) for both treatments.

Another area of active inquiry is the extent to which probability bias versus cost bias mediate symptom improvement. Originally, cost biases were proposed to be more important than probability biases for social anxiety psychopathology and treatment because negative outcomes following social events are common, but the cost of such outcomes is relatively low as compared to other anxiety disorders (e.g., panic

disorder, in which the probability of having a heart attack is low, but the cost is high; Foa and Kozak 1986). Two studies using rigorous methods for evaluating threat reappraisal as a causal mechanism of CBT, however, showed that probability, but not cost, bias, mediate symptom improvement following CBT for social anxiety disorder (Calamaras et al. 2015; Smits et al. 2006). Future research on the extent to which CBT and other treatments lead to long-term changes in probability and/or cost biases is needed for a rigorous examination of the threat-reappraisal hypothesis.

The importance of assessing the impact of treatment over the long term is widely acknowledged (Heimberg 1989; Seivewright et al. 1998). This research, however, is difficult and time-consuming. Nevertheless, randomized clinical trials show that cognitive-behavioral therapy produces long-lasting (5+ years) improvement in the symptoms of social anxiety disorder (Anderson et al. 2017; Hedman et al. 2011; Heimberg et al. 1993; Mörtberg et al. 2011; Willutzki et al. 2012). The present findings suggest that CBT can also lead to durable improvements in the cognitive biases that are theorized to be at the heart of anxiety disorders and its treatment.

## Compliance with Ethical Standards

**Conflict of Interest** Amanda A Benbow and Page L Anderson declare that they have no conflict of interest.

**Ethical Approval** All procedures performed in studies involving human participants 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.

**Animal Rights** No animal studies were carried out by the authors for this article.

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