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Social and monetary incentives counteract fear-driven avoidance: Evidence from approach-avoidance decisions

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ABSTRACT

Background and Objectives: The reduction of avoidance behavior is a central target in the treatment of anxiety disorders, but it has rarely been studied how approach of fear-relevant stimuli may be initiated. In two studies, the impact of hypothetical monetary and symbolic social incentives on approach-avoidance behavior was examined.

Methods: In Study 1, individuals high or low on fear of spiders (N = 84) could choose to approach a fear-relevant versus a neutral stimulus, which were equally rewarded. In a subsequent micro-intervention, approaching the fear-relevant stimulus was differentially rewarded either by monetary or social incentives. In Study 2 (N = 76), initial incentives for approach were discontinued to investigate the stability of approach.

Results: Hypothetical monetary and symbolic social incentives reduced or eliminated initial avoidance, even in highly fearful individuals. Approach resulted in a decrease of self-reported aversiveness towards the fear-relevant stimulus. However, even after successful approach, fearful individuals showed significant avoidance behavior when incentives for approach were discontinued.

Limitations: Future research should investigate the long-term effects of prolonged approach incentives on multiple levels of fear (e.g., self-report, behavioral, physiological). It should also be tested if such an intervention actually improves compliance with exposure based interventions.

Conclusions: The present findings highlight that incentives are useful to initiate initial approach towards a feared stimulus. Although incentive-based approach may neither fully eliminate avoidance nor negative feelings towards the feared stimulus, such operant interventions may set the stage for more extensive extinction training.

1. Introduction

Avoidance is the most prominent behavioral symptom across all anxiety disorders and its reduction is a central target of behavioral treatments (Alpers, 2010; Craske et al., 2009; Dymond & Roche, 2009). To this end, exposure therapy requires the individual to approach a fear-relevant stimulus or situation. Subsequently, approach sets the stage for extinction learning and fear reduction (Foa & Kozak, 1986; Vervliet, Craske, & Hermans, 2013). The effectiveness of such exposure-based interventions has been well documented (e.g., Bakker, van Balkom, Spinhoven, & Blaauw, 1998; Hofmann & Smits, 2008; Tolin, 2010). However, not all patients benefit equally. Sustained avoidance or a lack of willingness to initiate exposure exercises is indicated by substantial rates of refusal and drop-outs before exposure (Arch & Craske, 2009; Gloster et al., 2014). Diminished compliance with exposure is related to poor outcome (see Cammin-Nowak et al., 2013). Hence, strategies that may increase the individual willingness to engage in exposure may help to further optimize exposure-based interventions.

Exposure exercises crucially depend on an individual's decision to initiate appropriate actions to change pathological behaviors. In prominent models, highlighting benefits and incentives for behavior change have been proposed as an effective strategy to initiate such actions (Prochaska, DiClemente, & Norcross, 1992). Importantly, clear incentives have been well documented to alter behavior in the realm of operant treatment protocols for diverse conditions (Dutra et al., 2008; Ellgring & Alpers, 2009). Moreover, research on instrumental conditioning clearly indicates that incentives are essential to translate learning into behavioral performance (Bouton, 2007; Tolman & Honzik, 1930). In the case of anxiety disorders, the decision to approach a fear-relevant stimulus commands all of the individual's courage, as goal-directed approach is in direct opposition with avoidance tendencies. Incentives for approach may thus help to facilitate initial approach during exposure. Despite their relevance, incentives for approach and the actual decision conflict between approach and avoidance have

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rarely received attention in experimental psychopathology research.

Behavioral avoidance of single fear-relevant stimuli has been well-documented in instrumental learning tasks. For example, individuals quickly learn to perform avoidance responses to prevent the re-occurrence of aversive stimuli (e.g., by pressing a button; Cameron, Roche, Schlund, & Dymond, 2016; Dymond, Schlund, Roche, & Whelan, 2014; Lovibond, Mitchell, Minard, Brady, & Menzies, 2009; Lovibond, Saunders, Weidemann, & Mitchell, 2008; Ly & Roelofs, 2009). Such avoidance represents an adaptive response to naturally threatening stimuli. Moreover, fearful individuals also show similar avoidance responses towards fear-relevant stimuli in laboratory tasks (e.g., Lau & Viding, 2007; Tolin, Lohr, Lee, & Sawchuk, 1999; Wieser, Pauli, Weyers, Alpers, & Mühlberger, 2009), virtual reality (e.g., Rinck et al., 2010, 2016), or behavioral approach tests (e.g., Richter et al., 2012; Rinck & Becker, 2007; Zoellner, Echiverri, & Craske, 2000). Whereas these findings highlight the intensity and persistence of avoidance in fearful individuals, they do not account for the costs or impairments caused by pathological avoidance.

Recent studies thus focused on avoidance measures in which avoidance responses inflict costs. For example, spider-fearful individuals had to maximize monetary gains in a gambling task, in which high-reward options were paired with presentations of spider pictures and low-reward options with neutral stimuli. Despite missing higher monetary rewards, fearful individuals continuously chose to avoid (Pittig, Brand, Pawlikowski, & Alpers, 2014). Similar findings have been documented in both socially anxious individuals and patients with social anxiety disorder (Pittig, Alpers, Niles, & Craske, 2015; Pittig, Pawlikowski, Craske, & Alpers, 2014) as well as healthy individuals in response to newly acquired fear stimuli (Bublatzky, Alpers, & Pittig, 2017; Pittig, Schulz, Craske, & Alpers, 2014; van Meurs, Wiggert, Wicker, & Lissek, 2014). Such costly avoidance was not only found when avoidance is in conflict with hypothetical monetary rewards, but also when in conflict with shorter waiting periods within the experimental task (Rattel, Miedl, Blechert, & Wilhelm, 2016).

Most importantly, some of these studies provide preliminary support that competing incentives may counteract avoidance in non-fearful individuals. For example, healthy individuals avoided aversive stimuli when competing rewards were too small, but approached the very same stimuli for higher rewards (Aupperle, Sullivan, Melrose, Paulus, & Stein, 2011; Sierra-Mercado et al., 2015). In addition, short-term avoidance of a newly introduced threat stimulus was quickly overcome in favor of maximizing rewards (Bublatzky et al., 2017). These findings indicate that incentives can counteract avoidance in non-fearful individuals, but corresponding effects were rarely tested in fearful individuals. In addition, most studies used (hypothetical) monetary rewards as incentives.

Beyond monetary incentives, the role of social incentives and reinforcement has long been highlighted as an important factor for successful treatment (e.g., Krasner, 1962), and it has been formally integrated in treatment protocols for children with anxiety disorders (e.g., Beidas, Benjamin, Puleo, Edmunds, & Kendall, 2010). In basic research, happy faces have been found to guide decision making in ambiguous situations (Averbeck & Duchaine, 2009; Pittig et al., 2015; Pittig, Pawlikowski, et al., 2014). However, experimental investigation rarely tested whether symbolic social incentives suffice to counteract avoidance of fear-relevant stimuli in fearful individuals.

2. Study 1 – reduction of initial avoidance

The first study investigated whether hypothetical monetary and symbolic social incentives initiate self-chosen approach to fear-relevant stimuli in fearful individuals. Participants completed an approach-avoidance task, in which choosing one option was followed by a fear-relevant stimulus (picture of a spider) and another option was followed by a neutral stimulus (picture of a butterfly). In two different versions of the task, either hypothetical monetary (monetary incentives version) or symbolic social outcomes (social incentives version) were contingent with these options. Both versions of the task included two different contingency phases. During *Equal Contingency*, both options were followed by the same monetary or social reward stimulus to probe baseline differences in approach-avoidance. Here, fear-driven avoidance is indicated by less frequent choices of the fear-relevant option. To verify avoidance behavior during equal contingencies, approach-avoidance decisions of fearful participants was compared to non-fearful control participants. During *Approach Contingency*, choosing the fear-relevant option was linked to high monetary or social reward stimuli. For both types of rewards, Study 1 thus investigated whether initial avoidance behavior under equal contingencies is reduced by incentives for approach. In addition to behavioral approach-avoidance decisions, we expected a decrease in self-reported aversiveness following task completion. Before and after completion of the task, all participants therefore rated their levels of unpleasantness, fearfulness, and arousal when presented with the spider picture used in the task (i.e., the task-spider) as well as additional pictures, which were only presented during ratings (to control for repeated measures effect).

2.1. Materials and methods

2.1.1. Participants

In total, 84 participants were recruited from the community and from students enrolled at the University of Mannheim.[1] Participants were pre-selected as either high or low spider fearful using the Spider Fear Screening (Rinck et al., 2002). This screening questionnaire uses four items to assess the four diagnostic criteria for spider phobia: fear of spiders, physiological arousal, avoidance, and self-reported impairment (0 = *not at all* to 6 = *absolutely*). Following Rinck et al. (2002), participants with scores between 0 and 3 were recruited as non-fearful and participants with a score of 18 or higher as spider fearful. Exclusion criteria included any neurological or other severe medical condition, traumatic brain damage, current or history of psychiatric hospitalization, and current use of psychoactive medication. 20 fearful and 20 non-fearful participants completed the monetary incentives version (N = 40) and 22 fearful and 22 non-fearful participants completed the social incentives version (N = 44). Groups were pseudo-randomized with regard to balanced group sizes between fearful and non-fearful participants and sex ratio.

Questionnaire and demographic data are shown in Table 1. Fearful participants had significantly higher scores on the Fear of Spiders Questionnaire (FSQ; German version: Rinck et al., 2002). The average fear in the present sample was comparable to the level of FSQ scores of clinically diagnosed individuals with spider phobia (e.g., Gerdes & Alpers, 2014; Rinck & Becker, 2006). Fearful participants in the social incentives compared to money incentives version were significantly more fearful of spiders.

2.1.2. Questionnaires and procedure

Participants provided written informed consent to procedures approved by the institutional ethics committee before completing a questionnaire battery. Fear of spiders was assessed with the FSQ (Rinck et al., 2002), a widely used self-report questionnaire with 18 items (0 = *not at all* to 6 = *absolutely*). Previous studies provided clear evidence for significant differences in FSQ scores in spider fearful compared to non-fearful individuals (e.g., Alpers et al., 2009; Gerdes, Alpers, & Pauli, 2008; Pittig, Brand, et al., 2014), with non-overlapping

[1] Effect size was estimated based on two recent studies pitting reward stimuli against unpleasant stimuli (Aupperle et al., 2011; Talmi, Dayan, Kiebel, Frith, & Dolan, 2009). Relevant effect sizes for the impact on rewards on approach-avoidance were transformed into Cohen's *f* and ranged from *f* = 0.34 to 0.62. For Cohen's f = 0.34, power analyses conducted with GPower (Faul, Erdfelder, Lang, & Buchner, 2007) yielded an overall sample size of 68 participants (for between, within and interaction effects of the critical repeated measures ANOVA with power = .80, α error = 0.05).

Table 1
Demographic and questionnaire data.

	Spider fearful				Non-fearful				F/χ^2	p	
Study 1: Reduction of avoidance											
	Monetary Incentive (A)		Social Incentive (B)		Monetary Incentive (C)		Social Incentive (D)				
n	20		22		20		22				
Age	24.35	(9.01)	21.55	(3.00)	21.40	(3.58)	22.41	(1.76)	1.46[a]	.231	
Sex = Female	17	(85.0%)	19	(86.4%)	14	(70.0%)	13	(59.1%)	5.82[b]	.121	
Fear of spiders (FSQ)	44.75	(19.81)	58.82	(19.91)	1.85	(1.90)	2.00	(1.85)	94.87[a]	< .001	B > A > C = D
State anxiety (STAI-S)	44.65	(8.76)	39.45	(8.80)	39.35	(5.61)	31.45	(3.67)	12.66[a]	< .001	A = B = C > D
Trait anxiety (STAI-T)	40.20	(7.19)	43.23	(9.83)	40.70	(9.27)	33.86	(6.79)	4.96[a]	.003	B > D
Depression (BDI)	7.58	(5.45)	9.77	(6.44)	5.40	(4.08)	5.05	(4.68)	3.75[a]	.014	B > D
Study 2: Stability of reduced avoidance											
	Monetary Incentive (E)		Social Incentive (F)		Monetary Incentive (G)		Social Incentive (H)				
n	20		18		20		18				
Age	25.79	(7.27)	21.71	(4.33)	22.10	(2.20)	22.83	(6.32)	2.21[a]	.094	
Sex = Female	16	(80.0%)	15	(88.2%)	13	(65.0%)	13	(72.2%)	3.04[b]	.386	
Fear of spiders (FSQ)	50.70	(21.85)	55.35	(22.90)	4.85	(4.61)	2.44	(1.77)	60.11[a]	< .001	E = F > G = H
State anxiety (STAI-S)	40.07	(13.67)	41.00	(10.90)	33.52	(7.80)	31.39	(4.64)	4.56[a]	.006	E > H, F > H
Trait anxiety (STAI-T)	41.95	(14.23)	43.76	(10.80)	34.95	(8.63)	33.17	(8.60)	4.16[a]	.009	F > H
Depression (BDI)	9.01	(6.53)	7.35	(4.43)	4.25	(5.22)	5.28	(4.44)	2.95[a]	.039	E = F = G = H

Note. Means (and standard deviations) separately for spider fearful and non-fearful participants in the monetary and social incentives version for Study 1 and 2. n = Number of participants; FSQ = Fear of Spiders Questionnaire (Rinck et al., 2002; Szymanski & O'Donohue, 1995); STAI-S and -T = State and trait version of the State-Trait Anxiety Inventory (Laux et al., 1981; Spielberger, Gorsuch, Lushene, & Vagg, 1983); BDI = Beck Depression Inventory (Beck, Steer, Ball, & Ranieri, 1996).
[a] F score for group comparison.
[b] χ^2 score for gender ratio comparison.

distributions between spider fearful participants and non-fearful controls (Rinck et al., 2002). Unspecific state and trait anxiety were assessed with the State-Trait Anxiety Inventory (STAI; German version: Laux, Glanzmann, Schaffner, & Spielberger, 1981). Because depression can bias the processing of rewards and social stimuli (Eshel & Roiser, 2010; Mineka, Watson, & Clark, 1998), symptoms of depression were assessed with the Beck Depression Inventory (BDI-II; German version: Hautzinger, Keller, & Kühner, 2006).

2.1.3. Stimuli

For both versions of the decision task, one colored picture of a spider and one picture of a butterfly were used as fear-relevant and neutral stimuli (task-spider and -butterfly). Only one spider picture was used to test whether repeated approach reduces self-reported aversiveness of the picture within the limited number of trials of the task. Before and after completing the task, participants rated these pictures on unpleasantness, arousal, and fearfulness, each on an 11-point scale (0 = *not at all* to 10 = *extremely*). In addition, ratings also included two additional spider pictures to measure a generalization of fear reduction to novel fear-relevant stimuli (i.e., these pictures were not presented during the task). Furthermore, ratings included three pictures of snakes as unspecific aversive stimuli to account for the retest design of the ratings.

For the monetary version, incentive stimuli included a written feedback stating the magnitude of a hypothetical reward gained. Hypothetical monetary feedback comprised either no reward (*0.00€*), a small reward (*0.50€*), or a high reward (*2.00€*). For the social version, social incentive stimuli comprised pictures of facial expressions (selected from the NimStim; Tottenham et al., 2009) with a more or a less affirmative comment beneath (for an example see Fig. 1). To manipulate the intensity of the social incentives similar to the monetary incentives, faces displayed neutral, mildly happy, or strongly happy expressions. Furthermore, corresponding comments matched the facial expressions: neutral face with neutral comment (e.g., "You chose the left deck"), mildly happy face with mildly positive comment (e.g., "That was okay"), and strongly happy face with strongly positive comment (e.g., "That was great"). As a manipulation check, the social incentive stimuli were rated on valence and arousal using the 9-point self-assessment manikins (Bradley & Lang, 1994). Valence ratings confirmed that social stimuli were judged as neutral, mildly positive, and strongly positive by both fearful and non-fearful participants (see Supplemental material S1).

2.1.4. Behavioral approach incentive task (BAIT)

The goal of the monetary version was to win as much hypothetical money as possible in 40 trials. At the beginning, participants were not aware of the different contingencies or the duration of the task. Each trial followed the same sequence (see Fig. 1). Participants freely chose between two decks displayed as the neutral back of a card. After each selection, a spider (i.e., the task-spider) or a butterfly was presented. Contingencies for the spider and butterfly picture were fixed across the entire task. Specifically, selecting one deck (left or right) was always followed by the spider and selecting the other deck followed by the butterfly (left-right location counterbalanced between participants). After the spider or butterfly picture was presented for 5s, participants had to perform a mouse-click within a small square in the middle of the picture (approximately 0.57° visual angle) to continue. This ensured that participants fixated on the picture (instead of visually avoiding the presentation after a selection). After participants clicked into the small square, an incentive feedback was presented.

For the monetary version, reward contingencies changed after half of the trials from a non-differential, equal payoff to a differential payoff for the spider option. Specifically, reward contingencies were identical for both options with a small reward after each selection during *Equal Contingency* (Trials 1–20: 100% probability of winning 0.50 €). This phase served as a baseline assessment of avoidance. During *Approach Contingency* (Trials 21–40), only choosing the spider option was associated with a high reward (100% probability of winning 2.00 €), but choosing the butterfly option was never rewarded (0% probability of winning). Thus, the second half of the task tested whether participants would overcome avoidance for the goal of maximizing gains. Reward contingencies were maximally clear (100% vs. 0% probability) to

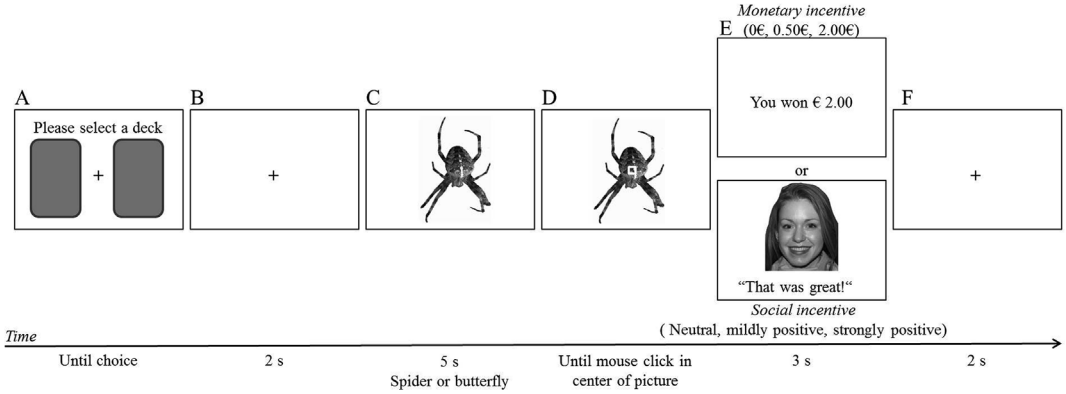

Fig. 1. Example of a trial sequence of the behavioral approach incentive task (BAIT). A selection screen (A) was presented until the participant chose one of the two decks. After a short break (B), a picture of a spider or a butterfly was shown depending on which deck was selected (C). To proceed with the task, participants had to click in the middle of the corresponding picture (indicated by a little square;D). Monetary or social reward feedback presentation followed (E) and the next trial began after another short break (F).

ensure explicit understanding that the spider was the advantageous choice during *Approach Contingency*. This was done to rule out delayed learning in some participants, which would have been difficult to differentiate from sustained avoidance.

The social incentives version incorporated the same contingencies; however, with social instead of monetary incentives. During *Equal Contingency* (Trial 1 to 20), incentives were identical for both decks with a presentation of a mildly positive social stimulus after each selection (100% probability). During subsequent *Approach Contingency* (Trial 21 to 40), only choosing the spider option was always associated with a presentation of a strongly positive social stimulus. Choosing the butterfly deck was always followed by a neutral social stimulus.

2.1.5. Statistical analysis

The 40 trials of each version were averaged in blocks of ten trials. As contingencies changed after 20 trials, each version thus consisted of two *Equal Contingency* and two *Approach Contingency* blocks (see Fig. 2). Per block, the number of trials the spider option was chosen served as main outcome and was entered into a 2 × 2 × 2 × 2 repeated measures ANOVA. Between subject factors were Fear (fearful vs. non-fearful participants) and Incentive (monetary vs. social incentives), whereas Contingency (equal vs. approach contingency) and Block (first vs. second block of each contingency phase) were tested as within subject factors. Greenhouse-Geisser corrected degrees of freedom were used whenever necessary. In addition, the critical change from *Equal* to *Approach Contingency* was analyzed using a 2 × 2 × 2 ANOVA with Fear and Incentive as between subject's factors and Block as within subject's factor (second block of *Equal Contingency* vs. first block of *Approach Contingency*). This planned analysis was conducted because this change represents the modification of approach-avoidance behavior by change in contingencies. In all the above analyses, the group factor Fear analyzed relative avoidance between fearful and non-fearful individuals. In addition, absolute avoidance in each block was analyzed within each group using one-sample *t*-tests against 5 (as 5 would indicate that spider and butterfly decks were chosen equally often). Given the number of *t*-tests, α error levels were Bonferroni-Holm adjusted.

For the picture ratings, main analyses aimed to test whether self-reported aversiveness of the task-spider decreased after the task. For each rating dimension, a repeated 2 × 2 × 2 ANOVAs with Time (pre vs. post), Fear (fearful vs. non-fearful participants), and Incentive (monetary vs. social incentives) was conducted. Further analyses were conducted to test whether aversiveness of the additional spiders also decreased (as an index of generalization) and whether a decrease in aversiveness of the spider picture used in the task was stronger compared to the other pictures. For brevity, these results are reported in the supplementary (see Supplemental materials S2).

2.2. Results

2.2.1. Approach-avoidance behavior

Fearful participants clearly avoided the spider option during initial *Equal Contingency* (see Fig. 2A), but as soon as approach of spiders was reinforced, all participants increasingly chose the spider option.

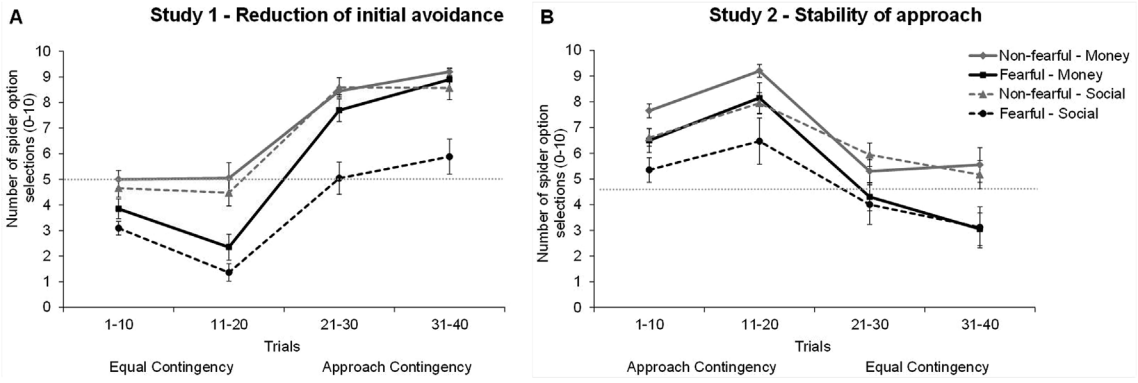

Fig. 2. Mean number (with SEM) of choosing the spider option for fearful and non-fearful individuals in the version with hypothetical monetary (Money) and symbolic social incentives (Social). A: Study 1 tested the reduction of initial avoidance; B: Study 2 tested the stability of incentive-based approach. Values above five indicate that participants more frequently chose the spider option compared the butterfly option. *Equal Contingency* = selections from both decks were equally rewarded, *Approach Contingency* = only selections from the spider deck were rewarded.

2.2.1.1. Between fearful vs. non-fearful participants. The overall 2 × 2 × 2 × 2 ANOVA was conducted with the between subject's factors Fear (fearful vs. non-fearful participants) and Incentive (monetary vs. social incentives) and the with subject's factors Contingency (equal vs. approach contingency) and Block (first vs. second block of each contingency phase). Results yielded no significant four-way interaction, $F(1, 80) = 0.17$, $p = .680$, $\eta_p^2 = 0.002$, but a significant three-way interaction of Contingency × Block × Fear, $F(1, 80) = 19.96$, $p < .001$, $\eta_p^2 = 0.200$. Follow-up analyses on this three-way interaction were separately conducted for fearful and non-fearful participants. Non-fearful participants chose the spider option significantly more often during *Approach Contingency* compared to *Equal Contingency*, main effect Contingency: $F(1, 41) = 134.73$, $p < .001$, $\eta_p^2 = 0.767$. No other main effect or interaction was significant, $Fs(1, 41) < 1.77$, $ps > .190$, $\eta_p^2 < 0.041$. Fearful participants similarly chose more spiders when reinforced, main effect Contingency: $F(1, 41) = 108.41$, $p < .001$, $\eta_p^2 = 0.726$. Moreover, a significant interaction between Contingency × Block was observed, $F(1, 41) = 49.15$, $p < .001$, $\eta_p^2 = 0.545$. This interaction indicated increasing avoidance of the spider option during *Equal Contingency*, $t(42) = 6.30$, $p < .001$, $d = 1.94$, but an increase of approach during *Approach Contingency*, $t(42) = 4.28$, $p < .001$, $d = 1.32$. In sum, fearful and non-fearful participants showed significantly more spider selections during *Approach Contingency* compared to *Equal Contingency* in the monetary as well as the social incentive version. In fearful but not in non-fearful participants, avoidance increased during *Equal Contingency*, whereas approach increased during *Approach Contingency*.

Moreover, a significant interaction of Incentive × Contingency × Fear, $F(1, 80) = 4.59$, $p = .035$, $\eta_p^2 = 0.054$, was followed up separately for fearful and non-fearful participants. For non-fearful-participants, no significant main effect of Incentive, $F(1, 40) = 0.82$, $p = .371$, $\eta_p^2 = 0.020$, or interaction Incentive × Contingency was found, $F(1, 40) = 0.10$, $p = .758$, $\eta_p^2 = 0.002$. A significant main effect of Contingency indicated more frequent spider option selections during *Approach* compared to *Equal Contingency* across both versions, $F(1, 40) = 131.12$, $p < .001$, $\eta_p^2 = 0.766$. For fearful participants, an interaction between Incentive × Contingency emerged, $F(1, 40) = 6.82$, $p = .013$, $\eta_p^2 = 0.146$. Follow-up *t*-tests indicated that avoidance of the spider option in fearful individuals during *Equal Contingency* did not differ between the monetary and social version, $t(40) = 1.87$, $p = .076$, $d = 0.59$. However, approach in fearful individuals during *Approach Contingency* was more pronounced in the money compared to social version, $t(40) = 3.68$, $p = .001$, $d = 1.16$. This difference was also evident when the three-way interaction was followed-up separately for both versions. In the money version, a significant interaction of Fear × Contingency was found, $F(1, 38) = 5.02$, $p = .031$, $\eta_p^2 = 0.117$. Follow-up *t*-tests indicated that fearful compared to non-fearful participants chose fewer spiders during *Equal Contingency*, $t(38) = 3.20$, $p = 003$, $d = 1.01$, but there was no difference during *Approach Contingency*, $t(38) = 1.19$, $p = .241$, $d = 0.38$. In the social version, no significant interaction of Fear × Contingency was found, $F(1, 42) = 0.98$, $p = .329$, $\eta_p^2 = 0.023$. A significant main effect of Contingency indicated that all participants chose the spider option more frequently during *Approach* compared to *Equal Contingency across participants*, $F(1, 42) = 85.85$, $p < .001$, $\eta_p^2 = 0.671$. Across both contingencies, fearful participants chose fewer spiders, main effect Fear: $F(1, 42) = 32.51$, $p < .001$, $\eta_p^2 = 0.436$. Summarized, these findings indicate that all participants approached the spider option during *Approach Contingency*. In fearful participants in the money version, approach was more pronounced resulting in no differences compared to non-fearful participants. In the social version, approach of fearful participants was less pronounced so that differences compared to non-fearful participants remained.

These behavioral results indicate that both hypothetical monetary incentives as well as social incentives counteracted avoidance behavior, however, with a weaker impact of social incentives. As fearful participants in the social version reported significantly higher fear of spiders (see Table 1), FSQ scores were entered as a covariate into the ANOVA probing the Incentive × Contingency interaction in fearful participants. Effects remained in the same direction, but the interaction was not significant anymore, $F(1, 39) = 4.01$, $p = .052$, $\eta_p^2 = 0.093$. Significant main effects indicated that all fearful participants more frequently chose the spider option during *Approach* compared to *Equal Contingency*, $F(1, 39) = 29.33$, $p < .001$, $\eta_p^2 = 0.429$, and in the monetary compared to social incentives version, $F(1, 39) = 9.04$, $p = .005$, $\eta_p^2 = 0.188$.[2]

Regarding the critical change from *Equal* to *Approach Contingency*, the planned 2 × 2 × 2 ANOVA yielded a significant three-way interaction, $F(1, 80) = 4.11$, $p = .046$, $\eta_p^2 = 0.049$. Follow-up analyses were separately conducted for the monetary and social incentives version. For the monetary version, a significant interaction of Block × Fear was found, $F(1, 38) = 5.29$, $p = .027$, $\eta_p^2 = 0.122$. Follow-up dependent *t*-tests indicated a significant increase in choices of the spider option in non-fearful participants, $t(19) = 5.43$, $p < .001$, $d = 1.73$, which was even more pronounced in fearful participants, $t(20) = 9.35$, $p < .001$, $d = 2.52$. Furthermore, fearful compared to non-fearful participants chose the spider option significantly less frequent in the second block of *Equal Contingency*, $t(38) = 3.43$, $p = .001$, $d = 1.09$, but no differences were found between groups in the first block of *Approach Contingency*, $t(38) = 1.60$, $p = .117$, $d = 0.51$. For the social version, no interaction of Block × Fear was found, $F(1, 42) = 1.03$, $p = .598$, $\eta_p^2 = 0.007$. Both fearful and non-fearful participants showed more frequent spider option selections across blocks, main effect Block: $F(1, 42) = 92.13$, $p < .001$, $\eta_p^2 = 0.687$. In addition, fearful compared to non-fearful participants chose the spider option less frequently, main effect Fear: $F(1, 42) = 37.77$, $p < .001$, $\eta_p^2 = 0.473$.

Taken together, spider fearful compared to non-fearful participants showed increasing avoidance during *Equal Contingency*. However, avoidance decreased when the spider option was differentially rewarded. Whereas avoidance in fearful compared to non-fearful participants vanished in the monetary incentives version, relative avoidance persisted in the social incentives version.

2.2.1.2. Within non-fearful and fearful participants. The one-sample *t*-test against 5 indicated that non-fearful participants had no significant preference for a particular deck during both blocks of *Equal Contingency* in both versions, $ts < 1.02$, $ps > .32$, $ds < 0.47$. However, they chose the spider option significantly more often during both blocks of *Approach Contingency*, $ts > 7.78$, $ps < .001$, $ds > 3.57$. Fearful participants less frequently chose the spider option during both blocks of *Equal Contingency* in both versions, $ts > 2.98$, $ps < .009$, $ds > 1.37$. During *Approach Contingency*, fearful participants in the money version showed a preference for the spider option, Block 1: $t(19) = 6.11$, $p < .001$, $d = 1.36$; Block 2: $t(19) = 8.97$, $p < .001$, $d = 2.01$, whereas fearful participants in the social version showed no preference for a particular option, Block 1: $t(21) = 0.07$, $p = .943$, $d = 0.02$; Block 2: $t(21) = 1.30$, $p = .209$, $d = 0.28$. Summarized, non-fearful participants changed their decision behavior from a non-preferential strategy to a significant preference of the spider option. All fearful participants initially showed behavioral avoidance, which changed to a preference of the spider deck in the money version and a non-preferential selection in the social version.

2.2.2. Stimulus ratings

Ratings of unpleasantness, fearfulness, and arousal before and after the task are shown for the task-spider picture in Fig. 3. Unpleasantness

[2] Effects involving FSQ scores did not reach significance, main effect: $F(1, 39) = 1.69$, $p = .202$, $\eta_p^2 = 0.041$; Interaction FSQ x Contingency: $F(1, 39) = 2.44$, $p = .126$, $\eta_p^2 = 0.059$.

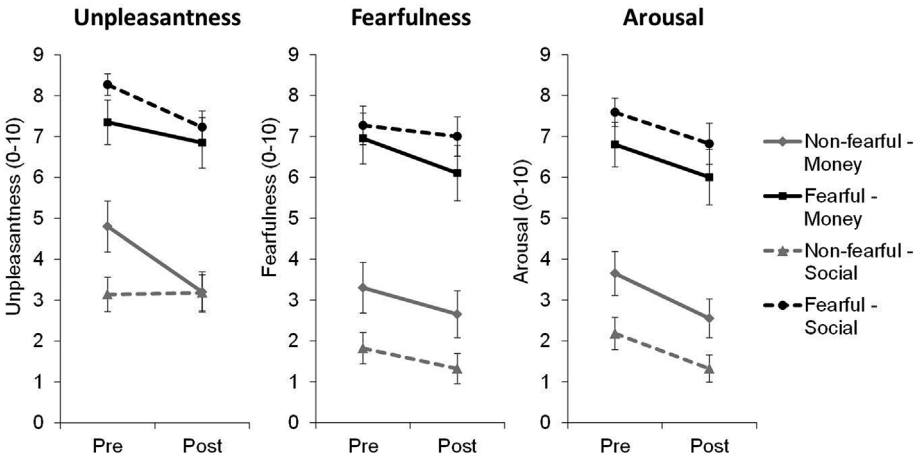

Fig. 3. Self-reported ratings (with SEM) on unpleasantness, fearfulness, and arousal for Study 1 before and after completing the Behavioral Approach Incentive Task (pre rating – post rating) for fearful and non-fearful participants.

significantly decreased after the task, main effect of Time: $F(1, 80) = 20.37$, $p < .001$, $\eta_p^2 = 0.203$, which varied as a joint function of Incentive × Fear, three-way interaction: $F(1, 80) = 10.17$, $p = .002$, $\eta_p^2 = 0.113$. Separate ANOVAs for the monetary and social incentives version yielded significant Time × Fear interactions, $Fs > 4.26$, $p < .047$, $\eta_p^2 > 0.101$. Follow-up *t*-tests indicated a significant reduction of unpleasantness for non-fearful participants in the money version and fearful participants in the social version, $ts > 3.69$, $ps < .002$, $ds > 1.20$, but not for fearful participants in the money version and non-fearful participants in the social version, $ts < 1.46$, $ps > .163$, $ds < 0.47$. Fearfulness and arousal ratings significantly decreased after the task, main effect of Time: $Fs > 11.70$, $p < .002$, $\eta_p^2 > 0.128$, which did not differ as a function of Fear, Incentive, or Incentive × Fear; $Fs < 1.20$, $ps > .227$, $\eta_p^2 < 0.015$. Additional findings can be found in the supplemental material (see Supplemental materials S2).

2.3. Interim discussion: Reduction of initial avoidance (Study 1)

Study 1 investigated whether hypothetical monetary and symbolic social incentives initiate self-selected approach to previously avoided fear-relevant stimuli. Results indicated initial avoidance in fearful individuals when approach and avoidance of the fear-relevant stimulus were equally rewarded. Indeed, fearful participants already avoided the spider option during the first block of the task. This initial avoidance likely resulted from fast learning of the unambiguous contingencies in the paradigm (100% reinforcement rate). However, all participants showed a significant increase in choosing the spider when only these decisions were associated with hypothetical monetary or symbolic social incentives. This approach behavior was associated with the repeated exposure to the fear-relevant stimulus and may thus be seen as a necessary precursor for fear extinction learning. Indeed, results provided preliminary evidence that the self-selected approach was accompanied by a reduction in self-reported unpleasantness, fearfulness, and arousal towards the fear-relevant stimulus. Given the small number of trials, reduction of aversiveness was, however, limited. In sum, behavioral avoidance can be counteracted by monetary and social incentives for approach, which may help to initiate fear extinction learning. However, it is unclear whether the increase in approach and the accompanying decrease in aversiveness ratings may endure after differential incentives for approach are discontinued. This was tested in a second study in which initial decisions were to be made under *Approach Contingency*, which was followed by *Equal Contingency* (i.e., the order of contingencies was reversed).

3. Study 2 – stability of reduced avoidance

Study 2 tested whether incentive-based approach of a fear-relevant stimulus persists after differential incentives for approach are discontinued. Spider fearful and non-fearful participants completed identical procedures as in Study 1, with one difference: *Equal Contingency* and *Approach Contingency* phases were reversed. Thus, only choosing the spider option was rewarded within the first 20 trials, but both decks were rewarded equally during the last 20 trials.

3.1. Materials and methods

All procedures, materials, and statistical analyses were identical to Study 1 with the exception of a reversed order of incentive contingencies. A new sample was recruited, with 20 fearful and 20 non-fearful participants completing the monetary incentives version and 18 fearful and 18 non-fearful participants completing the social incentives version (see Table 1).

3.2. Results

3.2.1. Approach-avoidance behavior

Fig. 2B shows that both groups chose the spider option more frequently during initial *Approach Contingency*; however, this was followed by a decrease in all groups during *Equal Contingency*.

3.2.1.1. Between fearful vs. non-fearful participants. The overall 2 × 2 × 2 × 2 ANOVA was again conducted with the between subject's factors Fear (fearful vs. non-fearful participants) and Incentive (monetary vs. social incentives) and the within subject's factors Contingency (equal vs. approach contingency) and Block (first vs. second block of each contingency phase). Results did not yield any significant four- or three-way interaction, $Fs < 1.52$, $ps > .222$, $\eta_p^2 < 0.022$. However, there was a significant interaction of Contingency × Block, $F(1, 71) = 35.76$, $p < .001$, $\eta_p^2 = 0.335$. Follow-up *t*-tests yielded a significant increase in choices of the spider option during *Approach Contingency*, $t(74) = 6.77$, $p < .001$, $d = 1.57$, and a significant decrease during subsequent *Equal Contingency*, $t(74) = 2.89$, $p = .005$, $d = 0.67$.

Furthermore, there was a significant interaction of Contingency × Incentive, $F(1, 71) = 3.97$, $p = .050$, $\eta_p^2 = 0.053$. Follow-up tests revealed that participants more often chose the spider option in the monetary compared to social incentives version during *Approach Contingency*, $t(74) = 2.70$, $p = .009$, $d = 0.63$, but there was no difference between versions during *Equal Contingency*, $t(74) = 0.06$, $p = .953$, $d = 0.01$. Finally, fearful compared to non-fearful participants chose the spider option less frequently, main effect Fear: $F(1,$

71) = 15.20, $p < .001$, $\eta_p^2 = 0.176$, but no significant interaction effect including Fear was observed, $Fs < 2.70$, $ps > .105$, $\eta_p^2 < 0.037$.

Regarding the critical change from *Approach* to *Equal Contingency* (i.e., from Block 2 of *Approach Contingency* to Block 1 of *Equal Contingency*), the planned 2 × 2 × 2 ANOVA indicated that fearful compared to non-fearful participants less frequently chose the spider option, main effect Fear: $F(1, 71) = 8.70$, $p = .004$, $\eta_p^2 = 0.109$. No two- or three-way interaction effects involving Fear were significant, $Fs < 0.55$, $ps > .463$, $\eta_p^2 < 0.009$. However, analyses yielded a significant interaction of Block × Incentive, $F(1, 71) = 6.47$, $p = .013$, $\eta_p^2 = 0.084$. Follow up *t*-tests indicated a significant reduction of choices of the spider option in the social version, $t(35) = 5.18$, $p < .001$, $d = 0.79$, which was even more pronounced in the money version, $t(39) = 8.40$, $p < .001$, $d = 1.79$. Furthermore, all participants more frequently chose the spider option during the second block of *Approach Contingency* in the money compared to social version, $t(74) = 2.44$, $p = .018$, $d = 0.57$, but there were no differences in the first block of *Equal Contingency*, $t(74) = 0.34$, $p = .731$, $d = 0.08$.

In sum, all participants more frequently chose the spider option during initial *Approach Contingency*. This approach behavior was elevated in the money version. When incentives were discontinued during *Equal Contingency*, selection of the spider option decreased, which was again elevated in the money version.

3.2.1.2. Within non-fearful and fearful participants. As in Study 1, one-sample *t*-tests against 5 yielded a significant preference for the spider for non-fearful participants during both blocks of *Approach Contingency* in both versions, $ts > 4.81$, $ps < .001$, $ds > 2.21$. However, they showed no preference for a particular deck during both blocks of subsequent *Equal Contingency*, $ts < 2.09$, $ps > .053$, $ds < 0.96$. Spider fearful participants also showed a significant preference for the spider during initial *Approach Contingency* in the money version, Block 1: $t(19) = 3.21$, $p = .005$, $d = 0.72$; Block 2: $t(19) = 5.33$, $p < .001$, $d = 1.19$, but no preference in the social version, Block 1: $t(17) = 0.74$, $p = .470$, $d = 0.18$; Block 2: $t(17) = 1.63$, $p = .122$, $d = 0.40$. Similar to non-fearful participants, they showed no preference for a specific option during the first block of *Equal Contingency* in both versions, Money version: $t(19) = 1.28$, $p = .217$, $d = 0.29$; Social version: $t(17) = 1.30$, $p = .213$, $d = 0.31$. However, avoidance of the spider option was evident during the last block in both versions, Money version: $t(19) = 3.07$, $p = .006$, $d = 0.69$; Social version: $t(17) = 2.36$, $p = .032$, $d = 0.57$. In sum, monetary and social incentives motivated approach in fearful participants at the beginning. However, this effect was not stable. Even after successful approach, fearful individuals showed significant avoidance behavior when incentives for approach were discontinued.

3.2.2. Stimulus ratings

Rating data and statistical results were similar to Study 1. For brevity, they can be found in the supplementary material (see Supplemental material S2). Ratings of the task-spider on all three dimensions significantly decreased after the task, main effect of Time: $Fs > 22.22$, $p < .001$, $\eta_p^2 > 0.222$, which did not differ as a function of Fear, Incentive, or Incentive × Fear; $Fs < 2.46$, $ps > .122$, $\eta_p^2 < 0.034$.

4. General discussion

The present studies investigated approach-avoidance behavior to fear-relevant stimuli with and without incentives for approach. Main results indicated 1) initial behavioral avoidance in fearful individuals in the absence of incentives for approach, 2) significant approach even in fearful individuals when the fear-relevant stimulus was associated with monetary or social incentives, and 3) significant avoidance behavior in fearful individuals, even after a phase of successful approach, when incentives were discontinued. Furthermore, self-reported aversiveness of the fear-relevant stimulus decreased following completion of behavioral approach incentive task. The overall pattern of results was highly replicable in independent samples completing a version of the task with hypothetical monetary and symbolic social incentives.

Having the choice between approaching or avoiding a fear-relevant stimulus, fearful individuals showed pronounced avoidance when no incentives were provided to motivate approach. This finding supports previous studies showing absent approach or elevated avoidance behavior when sufficient incentives are lacking or uncertain (Aupperle et al., 2011; Pittig, Brand, et al., 2014; Pittig, Schulz, et al., 2014; Sierra-Mercado et al., 2015). Importantly, avoidance was attenuated or even eliminated by monetary and social incentives. Even fearful individuals significantly approached the fear-relevant stimulus when rewarded (with large effect sizes). For both types of incentives, this behavioral modification is noteworthy as incentives were hypothetical or symbolic in nature. For symbolic social incentives, pictures of facial expressions are clearly more abstract than the friendly face of a therapist sitting next to a patient. Similarly, monetary incentives were only hypothetical. The effect of hypothetical monetary incentives may indicate that approach motivation was not based on external payoffs, but rather on an internal motivation to perform well in the task.

These results expand recent findings on approach of aversive stimuli for high incentives in healthy individuals (Aupperle et al., 2011; Sierra-Mercado et al., 2015) to highly fearful individuals. They are also in line with other studies showing elevated avoidance in fearful individuals under uncertainty about rewards, but diminished avoidance with more experience with reward contingencies (Pittig, Pawlikowski, et al., 2014; Pittig, Schulz, et al., 2014). Whereas these studies incorporated monetary rewards, the present results expand these findings by demonstrating a comparable effect of positive social stimuli. Whereas positive social stimuli have already been shown to facilitate automatic approach tendencies (Seidel, Habel, Kirschner, Gur, & Derntl, 2010; Stins et al., 2011), the present results expand this effect to more reflective and elaborate decision making behavior (see Strack & Deutsch, 2014). Approach of the feared stimulus was less pronounced for social compared to monetary incentives. However, differences were (at least partially) accounted for by higher fear of spiders in participants completing the social incentives version in Study 1. In addition, participants in the monetary incentives version were instructed to maximize their gains, whereas participants in the social incentive version received no such instruction. The differences in approach behavior between the different forms of incentives may thus be explained by methodological factors, rather than the nature of the incentive per se. Moreover, social incentives still initiated significant approach compared to equal contingencies. Thus, in addition to monetary incentives, a smile and social reinforcement may initiate approach towards a fear-relevant stimulus.

However, approach behavior only occurred during differential contingencies for approach. Results from Study 2 indicated significant avoidance behavior after successful approach in fearful individuals when incentives were discontinued. These results are in line with a recent study using an instrumental avoidance paradigm showing that low-cost avoidance behavior persists even despite successful fear reduction (Vervliet & Indekeu, 2015). However, results need to be interpreted cautiously. The present design is analogous to a micro-intervention with limited approach trials (maximum of 20 trials), which certainly limits longer lasting beneficial effects on avoidance behavior. Apparently, comprehensive fear reduction to highly feared stimuli typically takes much more time to develop (e.g., Alpers & Sell, 2008; Alpers, Wilhelm, & Roth, 2005). In addition, the present task was designed to test highly predictable contingencies (100% vs. 0%). Such continuous reinforcement protocols are typically associated with fast acquisition of instrumental behavior, but they often do not result in stable behavior when reinforcement is discontinued (Bouton, 2007). Indeed, fast acquisition in the present paradigm is seen by fearful participants in Study 1 already showing avoidance in the first block, whereas participants in Study 2 already showed approach. Instrumental

protocols for long-term stability thus typically use partial reinforcement schedules (Bouton, 2007). Future research may therefore investigate if prolonged training phases or a transition from continuous to partial reinforcement protocols may result in more stable approach.

Nevertheless, evidence from self-reported ratings suggests that self-chosen approach partially reduced unpleasantness, fearfulness, and arousal of the targeted fear-relevant stimulus. This reduction was larger compared to additional stimuli, which were not used in the task (see supplemental material). Operant incentive-based initiation of approach may thus set the stage for fear extinction and evaluative learning to take place. Interestingly, self-reported aversiveness similarly decreased in both studies despite the significant avoidance at the end of the task in Study 2. This finding may indicate some beneficial evaluative effects in the absence of a longer lasting behavioral change. As fearful individuals still indicated relative high levels of aversiveness after the task, there may have been little motivation to further approach an albeit less, but still aversive stimulus. This could be seen in the light of a distinction between learning and behavioral performance, which suggests that incentives may be necessary to translate learning into a stable behavior change (see Bouton, 2007; Tolman & Honzik, 1930). Thus, incentive-based interventions may facilitate initial approach and fear reduction, but apparently more refined learning seems necessary to prompt sustained fear reduction.

In terms of clinical implications, it needs to be noted that we did not examine a patient sample and that the present paradigm represents an experimental approximation of a micro-intervention. In patient samples, it is likely that avoidance behavior and aversiveness of the feared stimulus are more pronounced compared to subclinical fearful individuals. It may thus need more potent positive incentives than hypothetical monetary or symbolic social incentives to initiate approach behavior. Real payoffs and actual social feedback are likely to possess a more positive or reinforcing quality than hypothetical rewards or symbolic feedback. In this regard, pitting feared stimuli against hypothetical and symbolical incentives in subclinical individuals may serve as laboratory model to pitting phobic stimuli against real payoffs and actual verbal or mimic reinforcement in clinical samples. Such laboratory models may provide insights into the mechanisms and individual differences of motivated approach in exposure-based interventions (see Pittig, van den Berg, & Vervliet, 2016). For example, a training of approach-directed decisions may be useful to foster motivation to initiate exposure exercises (Prochaska et al., 1992) as recent evidence has linked deficits in goal-directed decision making to poorer responses to treatment (Alvares, Balleine, & Guastella, 2014; Pittig et al., 2015). However, future research needs to examine the validity of these models for clinical samples and their link to performance in exposure exercises. As another limitation, the present results are restricted to behavioral and self-reported data. Future research needs to expand effects on different levels of fear and avoidance (e.g., physiological responses, fear questionnaires, or real-life approach tasks).

4.1. Conclusion

Although approaching a fear-relevant stimulus is essential for effective exposure therapy, only few studies have targeted the underlying mechanisms of how such approach may be initiated. To this end, the present studies showed that hypothetical monetary as well as symbolic social incentives facilitated such self-chosen approach (with large effect sizes in fearful participants). When incentives were discontinued, fearful individuals showed significant avoidance behavior even after successful approach. Self-chosen approach was associated with a decrease of self-reported unpleasantness, fear, and arousal towards the fear-relevant stimulus. Thus, incentives are useful to initiate approach. Although incentive-based approach may not fully eliminate avoidance and negative valence of the feared stimulus in the long-run, such operant interventions may set the stage for more extinction training.

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Appendix A. Supplementary data

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