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You never get a chance to undo a negative first impression: Social anxiety is associated with impaired positive updating of social information

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ABSTRACT

In an ever-changing social world, learning and updating beliefs about others are essential for smooth interpersonal functioning. Social anxiety is a common and burdensome condition involving difficulties in interpersonal functioning. However, the processes governing the learning and updating of beliefs regarding others, processes crucial for these interactions, are poorly understood. In order to address this gap, we used a novel modification of a reversal-learning task. The task consisted of two phases. In the first (learning) phase, participants learned that interactions with certain individuals were associated with negative outcomes and other individuals with positive outcomes. In the second (updating) phase, these associations were reversed. Hence, negative individuals became positive and vice-versa, and participants had to update their initial beliefs. Study 1 (n = 87; undergraduate students) revealed that social anxiety was not associated with biases in learning positive or negative information about others. However, social anxiety was associated with a deficit in positively updating existing negative beliefs. Study 2 (n = 248; Mturk workers) replicated these findings in a representative and demographically diverse sample, controlling for depression severity and age. The current research suggests that social anxiety-related difficulty in the positive updating of negative social information may contribute to the impairment in interpersonal functioning.

1. Introduction

Imagine yourself starting a new job. One of your new colleagues is initially welcoming but unexpectedly turns a cold shoulder. Another colleague may, at first, appear rather hostile and is becoming progressively friendlier as time goes by. To take advantage of social opportunities and protect ourselves when social fortune changes, we need to be responsive to the behavior of people around us. First, we need to learn whether an interaction with a particular person will result in a positive or negative outcome. Later, if their behavior changes, we need to flexibly reevaluate our beliefs and update them accordingly. In the social realm, learning new information and flexibly updating existing beliefs about others is crucial for smooth interpersonal functioning (Ciairano et al., 2006; Frey et al., 2021; Stevens, 2009). Deficits in learning and updating are associated with a wide range of interpersonal difficulties (Kashdan & Rottenberg, 2010; Maia & Frank, 2011).

Maintaining smooth interpersonal functioning is important for mental health (Abbas et al., 2019; Wang et al., 2018) and is one of the core difficulties in social anxiety (SA) (Asher et al., 2020; Heerey & Kring, 2007). SA disorder is defined by a marked and persistent fear of social situations in which there is a potential for negative evaluation from others (American Psychiatric Association, 2013). SA disorder is the fourth most common psychiatric disorder, with a lifetime prevalence rate of 12 % (Kessler et al., 2005; Ruscio et al., 2008). Even in its subclinical manifestations, SA is associated with significant impairments in intrapersonal and interpersonal functioning (Fehm et al., 2007; Zabag et al., 2018). Cognitive theories suggest that biases in attention, interpretation, and learning are at the core of SA (Clark & Wells, 1995; Rapee & Heimberg, 1997). Yet, the links between these cognitive processes and the ability to learn new information and update existing beliefs about

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others – are only partially understood.

Several studies have examined the relationship between SA and the ability to learn new information with positive and negative outcomes (Abraham & Hermann, 2015; Becker et al., 2019; Peterburs et al., 2021). In these studies, SA has been consistently associated with enhanced learning of information that results in negative outcomes (Abraham & Hermann, 2015; social stimuli; Becker et al., 2019; Peterburs et al., 2021; non-social stimuli), whereas positive outcomes yielded mixed results (Khdour et al., 2016; Koban et al., 2017; Reilly et al., 2020). Importantly, these studies have used probabilistic tasks that imitate volatile and uncertain environments (Becker et al., 2019; Voegler et al., 2019), which require tolerance of uncertainty, a major difficulty for individuals with anxiety (Flores et al., 2018; Lamba et al., 2020). Therefore, it is difficult to disentangle the ramifications of the uncertain learning environments from the effects of learning negative and positive information in SA. Hence, the first aim of the current research is to examine the learning of new negative and positive information about others in an unambiguous and non-probabilistic (stable) environment.

Recent theories propose that SA is associated not only with biased learning but also with an inflexible updating of existing beliefs and cognitions (Kashdan & Rottenberg, 2010). Importantly, research on belief updating in SA has been conducted mostly in the context of self-referential tasks. Indeed, when compared to low-SA individuals, high-SA individuals were found to be rigid in their self-referential interpretations (Everaert et al., 2018), self-evaluations (Koban et al., 2017), and emotion regulation (O'Toole et al., 2017). The direction of updating - whether the information changes from negative to positive (positive updating) or from positive to negative (negative updating) may play a role in determining the nature and degree of these (in)flexibilities (Levens & Gotlib, 2010; Stange et al., 2017; Zabag et al., 2022). While SA was found to be associated with a deficit in using novel positive information to update initial negative interpretations about events occurring to the self, the such deficit was not found in negative updating of initial positive interpretations (Everaert et al., 2018). In addition, in a computerized ball-catching game, SA was associated with fewer throws to a previously punishing avatar; However, no such discrepancy was found in throws to a previously rewarding avatar (Beltzer et al., 2019). Therefore, the second aim of the present studies is to examine whether SA is selectively associated with inflexible updating of existing negative information about others.

Emotional facial expressions are a common and acceptable operationalization for examining the process of navigating the social world (Azoulay et al., 2020). SA was found to be associated with detecting angry expressions faster than happy ones (Gilboa-Schechtman et al., 1999; Moriya & Tanno, 2011) and subsequently with greater avoidance of angry faces (Heuer et al., 2007). Moreover, compared to low-SA individuals, high-SA individuals were less able to flexibly update their beliefs when the stimuli involved angry rather than neutral faces (Mohlman & DeVito, 2017). Thus, the third aim of the current study was to test whether SA is associated with enhanced learning and reduced updating of angry facial expressions compared to happy and neutral facial expressions.

2. The present research

We examined learning and updating information about others in a non-probabilistic dynamic environment. To this end, we adapted a classic reversal-learning paradigm. In this task, an initial learning phase was followed by an updating (reversal) phase. During the learning phase, participants learned that certain stimuli (i.e., persons with happy, angry, or neutral facial expressions) are associated with positive outcomes (rewarding) and some with negative outcomes (punishing). Later, without warning, these stimulus-outcome associations are reversed. Hence, persons that were associated with a negative outcome are now associated with a positive outcome and vice versa. The participants are expected to update their initial beliefs regarding the outcome of their previous interactions.

Three hypotheses were examined. First, based on previous research indicating enhanced learning from negative feedback in SA (Abraham & Hermann, 2015), we predicted that SA-severity is associated with better learning of negative, as compared to positive, person-outcome associations (i.e., *biased negative learning hypothesis*). Second, based on previous research about impaired updating in SA (Beltzer et al., 2019; Everaert et al., 2018; Zabag et al., 2022), we hypothesized that SA-severity is associated with difficulty in positive updating (learning that a person who was previously associated with a negative outcome is now associated with a positive outcome) (i.e., *inflexible positive updating in SA hypothesis*). Third, based on enhanced reactivity to and reduced flexibility in the processing of angry expressions in SA (Mohlman & DeVito, 2017), we hypothesized that SA-severity is correlated with enhanced learning of and reduced updating of information associated with angry facial expressions, as compared to neutral or happy, facial expressions (*impaired anger processing in SA hypothesis*).

3. Study 1

3.1. Power analysis

Sample sizes were calculated using the G*Power software (Faul et al., 2007). Based on effect sizes found in previous studies (Abraham & Hermann, 2015; Mohlman & DeVito, 2017), we expected to observe a medium-sized effect (Cohen's $f = 0.28$). A-priori power analysis for repeated measures GLM was conducted to detect this effect size with a significance (α) of 5 % and power ($1-\beta$) of 80 %. This analysis suggested the need to recruit at least 78 participants.

3.2. Material and methods

3.2.1. Participants

We recruited 88 undergraduate students who participated in the study in exchange for course credit. One participant did not follow the task instructions, and therefore 87 participants were included in the study (for demographic characteristics, see Table 1).

3.2.2. Measures

Liebowitz Social Anxiety Scale - Self-Report version (*LSAS-SR*; Liebowitz, 1987) Consists of 24 items that assess levels of anxiety and avoidance in social or performance situations using a 0–3 Likert-type scale.

Social Phobia Inventory (Connor et al., 2000) is a 17-item self-report scale designed to assess fear, avoidance, and physiological discomfort in social situations. Each item is rated on a 0–4 Likert-type scale.

3.2.3. The learning and updating of person-related information

This modification of the classic reversal-learning task consists of two phases: learning and updating (Fig. 1). In each trial, a face of a male person was presented on the screen, and the participants had to decide whether to approach or avoid him. Approaching a person associated with a positive outcome led to points gained and approaching a person associated with a negative outcome led to point loss. Avoiding or approaching a neutral person scored no points. The task included only male stimuli because those were found to exert stronger effects on both women and men compared to female stimuli (Kret & de Gelder, 2012; Seidel et al., 2010). The stimuli were selected from the well-validated Radboud Faces Database (RaFD; Langner et al., 2010).

During the learning (acquisition) phase, three people (happy, angry, and neutral) were associated with a positive outcome ("rewarding" persons, points gained), three with a negative outcome ("punishing" persons, points loss), and three with a neutral outcome ("neutral" persons, no change in points). Participants learned the positive and negative person-outcome associations by trial and error. The learning phase consisted of 14 blocks of 9 stimuli each, resulting in 126 trials. A

Table 1
Frequencies or means and standard deviations (in parentheses of demographic characteristics, psychopathology severity, and performance parameters by study).

Variable	Cronbach's alpha	Mean/ frequencies	SD
Study 1:			
Demographic characteristics			
Gender (% females)		86.2	
Age		22.10	2.40
Education		12.48	0.87
Psychopathology severity			
LSAS	0.952	38.34	17.80
SPIN	0.926	13.90	10.11
% Individuals with SA scores above clinical cutoff (LSAS>50; SPIN>20)		14.9	
Performance parameters (%)			
Total engagement (approach) decisions		48.67	10.34
Overall accuracy in negative-outcome associations learning	0.748	79.65	11.76
Overall accuracy in positive-outcome associations learning	0.887	70.22	20.48
Overall accuracy in positive-to-negative updating	0.842	80.72	17.46
Overall accuracy in negative-to-positive updating	0.914	82.38	21.77
Study 2:			
Demographic characteristics			
Gender (% females)		51.6	
Age		37.74	10.66
Education		15.43	2.20
Ethnicity (%)			
Caucasians		77.8	
African Americans		7.3	
Hispanics		6.5	
Asians		6.5	
Native Americans		1.2	
Other		0.8	
Psychopathology severity			
LSAS	0.974	48.76	30.30
SPIN	0.956	20.88	15.95
BDI	0.959	10.97	11.72
% Individuals with SA scores above clinical cutoff (LSAS>50; SPIN>20)		40.3	
Performance parameters (%)			
Total engagement (approach) decisions		49.87	12.33
Overall accuracy in negative-outcome associations learning	0.764	73.16	16.41
Overall accuracy in positive-outcome associations learning	0.875	71.40	21.38
Overall accuracy in positive-to-negative updating	0.85	85.23	17.31
Overall accuracy in negative-to-positive updating	0.955	77.91	29.08

subsequent updating-phase followed the learning phase without any signaled cue or delay. In this phase, the stimulus-outcome associations were reversed. Specifically, persons that were associated with a positive outcome in the learning phase became associated with a negative outcome in the updating phase, and vice versa. Neutral associations remained unchanged. The updating phase consisted of 10 blocks of 9 stimuli each, resulting in 90 trials. Participants were instructed to gain as many points as possible (for full instructions, see the link to the task below). Correct responses refer to decisions increasing the total gain in the task (engagement with a person associated with a positive outcome) and decisions avoiding losses (disengagement from a person associated with a negative outcome). Incorrect responses refer to decisions increasing loss (engagement with a person associated with a negative outcome) and decisions disregarding possible gain (disengagement from a person associated with a positive outcome). Decisions concerning neutral outcomes did not affect accuracy.

At the end of the task, participants were paid proportionally for their performance (up to $2). Performance and reliability measures are presented in Table 1. The task, conducted originally in Eprime, can be found here: https://barilanpsychology.qualtrics.com/jfe/form/SV_dnDoZwLzOBgevYi

3.2.4. Procedure

All participants provided informed consent before taking part in the study. Participants first completed the aforementioned Learning and Updating of person-related Information Task and afterward filled out self-report questionnaires through a secured research software service (Qualtrics). At the end of the study, participants were debriefed and compensated. The research was approved by Bar-Ilan University Ethics Committee.

3.3. Results

First, we conducted zero-order correlations on the associations between SA and accuracies during the learning and updating phases. Accuracy levels were calculated as the percentage of correct responses (i.e., decisions increasing the total gain in the task): engagement with positive-outcome stimuli and disengagement from negative-outcome stimuli. As can be seen from Table 2, negative and positive stimulus-outcome learning accuracies are essentially uncorrelated. Yet, negative stimulus-outcome learning accuracy was moderately correlated with negative updating accuracies, and vice-versa – positive stimulus-outcome learning accuracy was moderately correlated with positive updating accuracies. SA was negatively associated with decision accuracy of positive updating.

To further examine whether SA is associated with a distinct learning pattern during the learning phase of stimulus-outcome associations, we conducted a repeated-measures general linear model (GLM) analysis on decision accuracy during the learning phase. SA was computed as the mean standardized scores of the LSAS and SPIN questionnaires (for a similar approach, see Azoulay et al., 2020). Outcome-valence (positive, negative), Expression (angry, happy, neutral), and Block (1–14) were within-subjects variables, and SA (continuous) was a between-subjects variable.

The full description of the findings is presented in the supplementary materials (Table S1). In the following, we review only the findings of our *specific* hypotheses. Contrary to our biased negative learning hypothesis, no effect of SA on initial learning was identified ($p > 0.2$, Table S1) (See Fig. 2a). In contrast to our impaired anger processing in SA hypothesis, no SA*Expression interaction was found, suggesting that SA was not associated with facial expression-specific learning patterns ($p > 0.3$).

An identical analysis was conducted on decision accuracy during the updating phase to examine our inflexible positive updating in SA hypothesis. Updating-Direction (positive, negative), Expression (angry, happy, neutral), and Block (1−10) were again within-subjects variables, and SA (continuous) was a between-subjects variable. In line with our inflexible positive updating in SA hypothesis, we found a significant SA*Direction interaction ($F\ (1, 85) = 4.43, p = .038, \eta 2 = .050$), indicating that SA was associated with impaired positive updating of negative stimuli-outcome associations ($F\ (1, 85) = 6.83, p = .011, \eta 2 = .074$); no such differences were observed in the negative updating condition ($p > 0.3$) (See Fig. 2b). In contrast to our impaired anger processing in SA hypothesis, no effect of SA*Expression or SA*Expression*Direction was found, suggesting that updating patterns in SA were not moderated by facial expression. The full analysis is presented in the supplementary materials (Table S2).

In sum, we found that participants were able to learn both positive and negative stimulus-outcome associations independent of their SA-severity. SA-severity was related to difficulty in positive (but not negative) updating of stimulus-outcome associations. Emotional facial expressions were not found to moderate any of these effects.

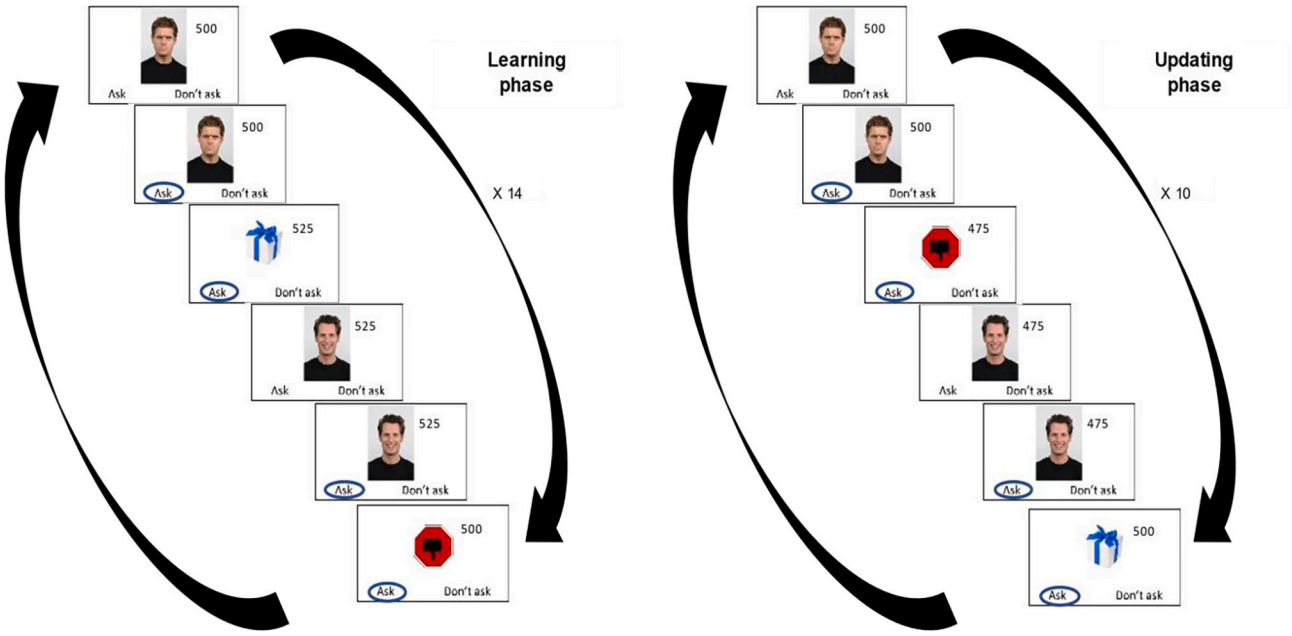

Fig. 1. The Learning and Updating of Person-related Information Task.

Table 2
Pearson correlations of SA and accuracies during learning and updating phases.

Variable	1	2	3	4	5
1. SA	–	0.010	−0.081	0.120	−0.212*
2. Negative stimulus-outcome learning	0.000	–	−0.052	0.346**	0.128
3. Positive stimulus-outcome learning	−0.073	0.031	–	0.127	0.442***
4. Positive-to-negative updating	−0.014	0.490***	0.214**	–	−0.007
5. Negative-to-positive updating	−0.156*	0.065	0.613***	0.123	–

Note. The results from study 1 are presented above the diagonal. The results from study 2 are presented below the diagonal. SA = mean of standardized scores of the LSAS and SPIN.
* $p < .05$.
** $p < 0.01$.
*** $p < 0.001$.

4. Study 2

The first aim of Study 2 was to replicate the findings of Study 1, which included mostly undergraduate women, in a representative and demographically diverse online sample. In addition, given the high co-morbidity between SA and depression on the one hand (Ohayon & Schatzberg, 2010; Adams et al., 2016) and the association between depression severity and updating difficulties on the other hand (Stange et al., 2017), the second aim of Study 2 was to understand whether SA is related to difficulty in positive updating beyond depression-severity. We also controlled for the effect of age, which is associated with learning and updating accuracy (Head et al., 2009).

4.1. Power analysis

We calculated the sample size based on the small-to-medium effect found in Study 1 and a previous online study (Beltzer et al., 2019). A-priori power analysis for repeated measures GLM, based on the ability to detect this effect size with a significance level (α) of 5 % and power level (1-β) of 80 %, indicated the need to recruit at least 232 participants.

4.2. Methods

4.2.1. Participants

We recruited 336 participants through Amazon's Mechanical Turk (MTurk). MTurk provides an online crowdsourcing platform with access to large and diverse samples suitable for clinical research collecting mental health data (Chandler & Shapiro, 2016). Moreover, MTurk participants endorse higher SA symptoms compared to other non-clinical samples (Arditte et al., 2016). Thus, following Chandler et al. (2020), the inclusion criteria for the study were: being 18 years or older, being a resident of the United States, and having high-quality work on previous MTurk tasks (i.e., an acceptance ratio ≥ 95 %). Based on previous studies (Azoulay et al., 2020; Chandler et al., 2020), participants were excluded due to duplicate IP addresses and suspicious geolocations ($n = 39$), non-conscientious performance (filling in all items of the questionnaires, including the reversed items, with zero standard deviation; very short duration of survey completion; choosing avoidance or approach >80 % of trials, regardless of the feedback; $n = 49$). In addition, Participants who did not follow the task instructions automatically were not allowed to move on to the survey. Recent research suggests that this exclusion method increases data quality (Chandler et al., 2020). A total of 248 participants were included in the final analyses (demographic characteristics are presented in Table 1).

4.2.2. Measures

The Liebowitz Social Anxiety Scale - Self-Report version (LSAS-SR; Liebowitz, 1987).

Social Phobia Inventory (Connor et al., 2000).

The Beck Depression Inventory (Beck et al., 1996). A 21-item measure assesses depression severity over the past two weeks. Due to ethical concerns, the suicide item (question number 9) was not presented in the online sample.

4.2.3. The learning and updating of person-related information - revised

Several adaptations were made to simplify the original task and apply it to online participants. The task used in this study included only six males with happy, angry, or neutral emotional expressions. During the learning phase, three stimuli (happy, angry, and neutral) were associated with a positive outcome, and three were associated with a negative outcome. No stimuli were associated with a neutral outcome.

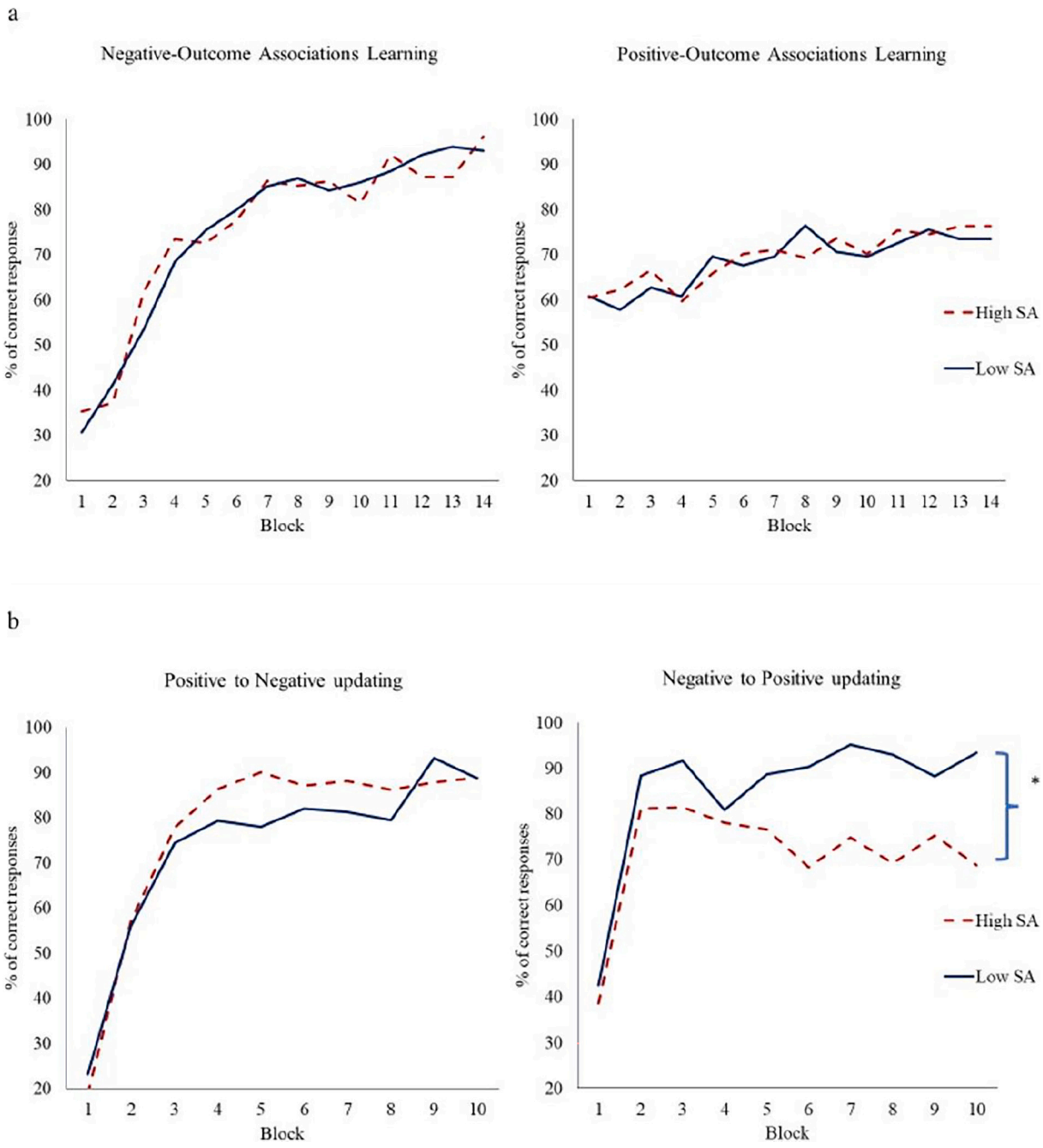

Fig. 2. a. Accuracy Patterns during Learning-Phase by Valence of Stimulus-Outcome associations and SA-group (High vs. Low), Study 1.
b. Accuracy Patterns during Updating-Phase by Updating-Direction and SA-group (High vs. Low), Study 1.
Note. The figures are presented based on a median split of SA symptoms for simplicity.

The positive and negative person-outcome associations were updated in the second phase. The learning and updating phases consisted of 10 blocks of 6 stimuli, resulting in 60 trials for each phase. At the end of the task, participants were paid proportionally for their performance (up to $2). Performance and reliability measures are presented in Table 1. The revised task can be found here: https://barilanpsychology.qualtrics.com/jfe/form/SV_51MvFETfnc4W4f3

4.2.4. Procedure

The procedure was identical to Study 1, adapted for online administration. The study was approved by Bar-Ilan University ethics committee.

4.3. Results

Accuracy levels were calculated as in Study 1. Based on these measures, we again calculated zero-order correlations on the associations between SA and accuracies during the learning and updating phases. Results mostly reflect those of Study 1, with one exception: in this sample, positive stimulus-outcome learning accuracy was positively correlated with negative updating. Again, SA was negatively associated with the decision accuracy of positive updating.

As in Study 1, to examine whether SA is associated with distinct learning patterns during the learning phase, we conducted a GLM repeated measures analysis with decision accuracy as the dependent variable. Outcome-valence (positive, negative), Expression (angry,

happy, neutral), and Block (1–10) were within-subjects variables, while SA (continuous) was a between-subjects variable. Depression and age served as covariates. Results indicated no effect of SA or SA*Expression (all $ps > 0.3$), suggesting that SA was not associated with differential learning patterns for various expressions (see Fig. 3a). The full analysis is presented in the supplementary materials (Table S3).

An identical analysis was conducted on decision accuracy during the updating phase. A main effect of SA was found ($F\,(1,244) = 6.31, p = .013, \eta 2 = .025$). Consistent with our inflexible positive updating in SA hypothesis and replicating Study 1, SA was associated with a deficit in negative-to-positive updating ($F\,(1,244) = 5.76, p = .017, \eta 2 = .023$), above and beyond the effect of depression and age. In contrast, SA was not associated with positive-to-negative updating ($F\,(1,244) = 0.91, p = .340$) (see Fig. 3b). Thus, results suggest that the difficulty in updating in SA was limited to positive updating. The full analysis is presented in the supplementary materials (Table S4).

5. General discussion

The current research aimed to examine whether SA is associated with biased learning and inflexible updating of beliefs about others. In contrast to our initial predictions and previous findings (Voegler et al., 2019), SA was not associated with any biases in the *learning* phase, nor was it associated with better learning of negative-outcome associations. Our results echo the findings of a meta-analysis suggesting that anxiety disorders are not related to enhanced learning of fear responses (Duits

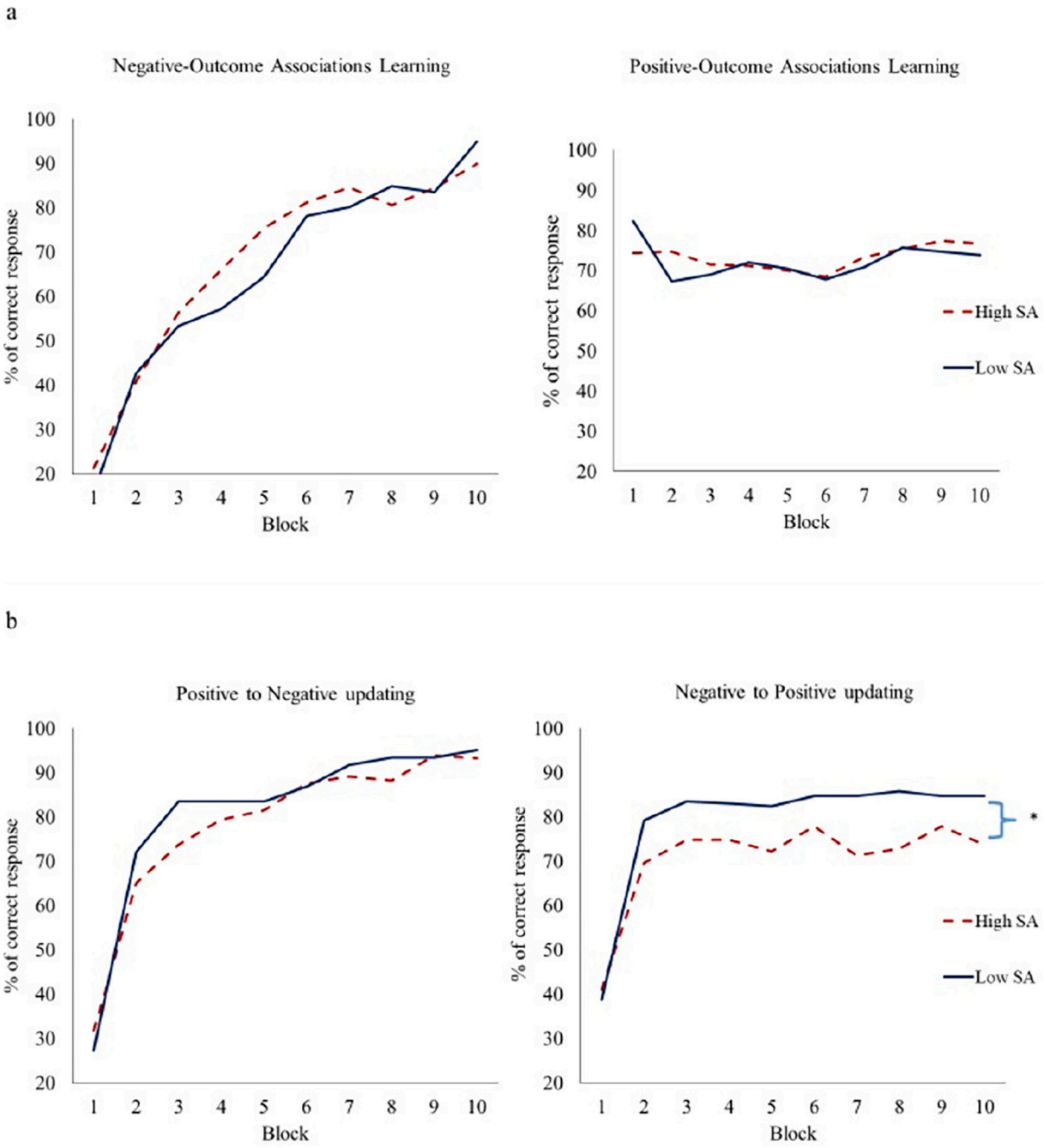

Fig. 3. a. Accuracy Patterns during Learning-Phase by Valence of Stimulus-Outcome associations and SA-group (High vs. Low), Study 2.
b. Accuracy Patterns during Updating-Phase by Updating-Direction and SA-group (High vs. Low), Study 2.
Note. The figures are presented based on a median split of SA symptoms for simplicity.

et al., 2015, but see Abraham & Hermann, 2015; Voegler et al., 2019 for other contradicting results). This discrepancy may be related to the nature of the stimuli-outcome associations: non-probabilistic (deterministic) in our studies and probabilistic in others (Abraham & Hermann, 2015; Voegler et al., 2019). Alternatively, it may be due to differences in the object of learning: beliefs about others in our studies and beliefs about the self in previous studies (Button et al., 2012; Koban et al., 2017). Indeed, a study comparing the learning of self- vs. non-self-related information reported a selective learning bias only in the self-condition (Button et al., 2015). Combined, current results may begin delineating the contexts in which SA is associated with enhanced biased learning of negative information.

In line with our prediction, SA was associated with difficulty in positive belief updating (learning that a person associated with a negative outcome in the past can be associated with a positive outcome in the future). Our data expands on previous findings that documented an SA-related difficulty in using positive information to update initial negative interpretations (Everaert et al., 2018, 2020). Results also lend additional support to the finding showing that SA is associated with persistent and inflexible avoidance of "negative" (punishing) social agents, despite a positive change in their observed "behavior" (Beltzer et al., 2019). Importantly, results show that the difficulty in positive updating is not accounted for by concurrent depressive symptoms.

Finally, in contrast to our hypothesis, facial expressions did not moderate the positive updating difficulty in SA. Hence, SA was associated with a struggle to approach individuals previously associated with a negative outcome, regardless of these individuals' facial expressions. This pattern of findings may be due to the SA-related tendency to perceive all facial expressions as threatening (Lange et al., 2012; Staugaard, 2010).

5.1. Theoretical and clinical implications

Our study suggests several theoretical and clinical implications. Theoretically, our findings extend the understanding of factors affecting SA maintenance, indicating that in addition to previously documented biased cognitive processes and avoidance mechanisms, impaired updating may contribute to the persistence of SA. Specifically, in everyday interpersonal interactions, the maladaptive resistance to change may impede individuals with elevated levels of SA from taking advantage of social opportunities and adapting to their dynamic social environment. For example, after receiving negative feedback from an acquaintance, a low-SA individual may be responsive to positive changes in the acquaintance's behavior, allowing further positive interactions. It is also possible that the low-SA individual is in a better mood, and therefore they can positively update their beliefs easily. In contrast, a high-SA individual may refrain from modifying their behavior, avoiding the acquaintance, and remaining isolated. Thus, inflexibility in positively updating negative beliefs about others may partially explain why, regardless of consistent naturalistic exposure to social interactions, SA persists for years and even decades (Blanco et al., 2011).

The inflexibility in the positive updating of negative beliefs also aligns with classical conditioning research. Individuals with high levels of rejection sensitivity (which is strongly correlated with SA) showed impaired extinction of conditioned fear responses to socially threatening faces (Olsson et al., 2013). More broadly, meta-analyses have found that anxiety disorders are associated with a tendency to show reduced extinction of fear response (Duits et al., 2015; Lissek et al., 2005).

Clinically, given the limited treatment response among individuals with SAD (Mayo-Wilson et al., 2014), the current research may suggest that treatments may be improved by training individuals with SA to engage in positive updating (Braem & Egner, 2018). In the long run, understanding updating difficulties may pave the way for tailored interventions for SAD. Such interventions may improve both SA symptoms and general interpersonal functioning and well-being (Azadi et al., 2021; Kashdan & Rottenberg, 2010).

5.2. Limitations and future directions

Our findings need to be interpreted in light of their limitations. First, our cross-sectional correlational design precludes conclusions regarding causality. We cannot determine whether inflexibility leads to SA, SA leads to inflexibility, or whether the variables exhibit a pattern of mutual causal associations. Longitudinal studies are needed to examine these causal relations. Second, because male facial expressions, especially angry expressions, have been found to exert stronger effects on both women and men than angry female expressions (Kret & de Gelder, 2012; Seidel et al., 2010), only male faces were used in our studies. Future studies may use both male and female faces to assess their impact on SA-related deficits. Third, to increase external validity and similarity to ecological interactions, the learning in our task was asymmetric, such that participants received feedback (that is, were made aware of stimulus-outcome associations) only when they approached a person. Thus, avoidance tendencies in SA may be, at least partially, responsible for the present pattern of results. Future research may aim to provide outcome information even when avoidance behavior is initiated. Fourth, our study was conducted with non-clinical populations. Clinically distressed individuals may present more extensive biases, such as enhanced negative learning or inflexible negative updating.

6. Conclusions

The social world is volatile. People's behavior changes over time, new information becomes available, and there is a constant need to update beliefs regarding others (Mende-Siedlecki & Todorov, 2016). The delineation of processes that govern learning new information and belief updating is crucial for understanding social functioning (Park & Young, 2020). Such an understanding appears to be especially important for high-SA individuals who exhibit significant social impairments (Alden & Taylor, 2010). Our studies began to examine the learning and updating of social information and enhance our understanding of how SA affects navigation in a dynamic social world. In the long run, such an understanding could deepen our insight regarding the paths for building and maintaining meaningful and stimulating relationships.

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CRediT authorship contribution statement

Reut Zabag: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data curation, Writing – original draft. **Roy Azoulay:** Data curation, Writing – review & editing. **Mike Rinck:** Conceptualization, Writing – review & editing. **Eni Becker:** Conceptualization, Writing – review & editing. **Einat Levy-Gigi:** Conceptualization, Methodology, Supervision, Resources, Funding acquisition, Writing - review & editing. **Eva Gilboa-Schechtman:** Conceptualization, Methodology, Supervision, Writing – review & editing, Resources, Funding acquisition.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2022.111993.

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