



# Bidirectional relationships between interpretation biases, safety behaviors, and social anxiety

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Accepted: 22 February 2023 / Published online: 14 March 2023  
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## Abstract

Theoretical models of social anxiety (SA) propose bidirectional relationships between SA, interpretation biases, and safety behaviors (Safe-B). However, longitudinal studies evaluating these bidirectional relationships are scarce. The main objective of this study was to analyze the bidirectional relationships between interpretation biases (from ambiguous situations and ambiguous faces), Safe-B, and SA. A two-time longitudinal study was carried out with the participation of 575 vocational training students ( $M = 19.49$ ,  $SD = 2.41$ ). Both the interpretation biases measured through ambiguous situations and ambiguous faces and the Safe-B predicted higher levels of SA in the second time. In turn, a bidirectional relationship was found between SA and Safe-B. However, no bidirectional relationships were found between interpretation biases and Safe-B and between biases and SA. Among others, the limitations of the study include the high attrition rate (30.4%) and the high proportion of male students (62.1%). The findings highlight the role of interpretation bias and Safe-B in SA. In turn, as a new initiative, the study supports the bidirectional relationship between Safe-B and SA. Implications are discussed throughout the manuscript.

**Keywords** Interpretation bias · Safety behaviors · Social anxiety · Longitudinal design · Bidirectional relationships

## Introduction

Social anxiety (SA) is a common psychological problem in teenagers and young people, with 27% to 36% reporting high levels of SA (Jefferies & Ungar, 2020; Mekuria et al., 2017). SA tends to begin in adolescence (Fehm et al., 2008; Wittchen & Fehm, 2003), and the level of SA tends to decrease somewhat over time (Bruce et al., 2005). SA is associated with impairment in social and academic functioning (Chiu et al., 2021a; de Lijster et al., 2018). Several theoretical models that focus on the maintaining role of safety behaviors (Safe-B) and cognitive biases (Clark & Wells, 1995; Heimberg et al., 2014) in SA have been described. For example, the model of Clark and Wells (1995) proposes that SA is the result of erroneous beliefs about oneself and the world that lead to interpreting social situations in an excessively negative way. Further, engaging in Safe-B would have

the consequence of maintaining the negative interpretations and symptoms of SA.

Different biases have been associated with SA (e.g., Gómez-Ariza et al., 2013; Pergamin-Hight et al., 2015). Some of the most studied cognitive biases in the SA context are interpretation biases, which are defined as the tendency to negatively interpret ambiguous situations (Amir et al., 1998). These biases have been evaluated using techniques that employ verbal content or visual stimuli. The instruments that have evaluated biases through verbal content have mainly used phrases or imagination related to ambiguous scenarios (Badra et al., 2017; Miers et al., 2020) and have found a close relationship between the negative interpretation of ambiguous situations and symptoms of SA. Evaluation techniques using visual material have used images of models' faces expressing ambiguous emotions (aan het Rot et al., 2022). In general, the negative interpretation of ambiguous faces has been associated with higher levels of SA (Maoz et al., 2016). A recent meta-analysis examining the relationship between interpretation bias and SA found a large effect size among studies that assessed bias using scenarios and a medium effect size among studies that employed ambiguous face images (Chen et al., 2020).

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Safe-B has been defined as a dysfunctional emotional regulation strategy that is performed to reduce the likelihood of a feared negative outcome (Helbig-Lang & Petermann, 2010; Salkovskis, 1991). People with SA engage in Safe-Bs to reduce the probability of being judged or feelings of anxiety (Piccirillo et al., 2016). Safe-Bs include behaviors such as avoiding looking the speaker in the eye or attracting others' attention. Employing different techniques and methodologies, studies have shown that people with SA are more likely to engage in Safe-B (Dechant et al., 2021; Gray et al., 2019). In addition, Safe-B have negative consequences for those who engage in them, such as worse performance in social interactions (Langer & Rodebaugh, 2013; Okuno et al., 2021) and the maintenance of SA (Chiu et al., 2021a; Okajima et al., 2009).

Apart from the role of cognitive biases and Safe-B in the maintenance of SA, theoretical models also propose specific mediating mechanisms and describe a bidirectional relationship in the form of a vicious circle between cognitive biases, Safe-B, and SA (Clark & Wells, 1995; Heimberg et al., 2014). Specifically, Clark and Wells (1995) propose that the cognitive processes activated by a social situation would lead to engaging in Safe-B. In turn, the initiation of these behaviors—in addition to exacerbating SA—maintains negative interpretations by not allowing the denial of such predictions. There is partial evidence of what is hypothesized by the models. For example, it has been found that interpretation biases are associated with Safe-Bs (Prieto-Fidalgo & Calvete, 2022), and Safe-Bs are associated with greater SA (Gray et al., 2019). The implementation of Safe-B, by preventing individuals from experiencing what actually happens if they are not performed, does not allow them to correct the erroneous beliefs that led to the Safe-B (McManus et al., 2008). However, few studies have comprehensively analyzed the bidirectional relationships and mediations proposed by these models.

Specifically, several studies employing cross-sectional methodologies have reported compatible data on both the mediating role of interpretation biases in the relationship between Safe-B and SA (Viana & Gratz, 2012) and the mediating role of Safe-B in the relationship between interpretation biases and SA (Prieto-Fidalgo et al., 2022a). Although the cross-sectional nature of these studies does not allow the determination of the direction of the relationships, a longitudinal study on teenagers based on diaries found evidence supporting the mediating role of Safe-B (Prieto-Fidalgo & Calvete, 2022). The results showed that people with high levels of interpretation bias performed a greater number of Safe-B, and these led to higher levels of SA during the day.

Regarding the bidirectional relationship between variables, a longitudinal study aimed to analyze the bidirectional relationship between the fear of negative evaluation, anticipatory cognitive processes, and Safe-B (Campbell et al., 2016). To do this, the study collected more than five hundred diary responses from a sample

of 10 participants. Although the variables were related to each other on the same day, none of the variables predicted the level of the variables on the following day; therefore, no bidirectional relationships were found. According to the authors, the absence of a predictive relationship could be because the explanatory power of the events that occurred during the day is greater than the predictive capacity of the cognitive processes and Safe-B of the previous day. Another study that also used diaries found that the level of SA measured at baseline related to engagement in Safe-B, and Safe-B predicted a greater level of SA symptoms (Prieto-Fidalgo & Calvete, 2022). Although safety behaviors predicted higher levels of social anxiety on the same day, these types of behaviors did not predict higher SA levels at follow-up. Thus, the data partially supported the bidirectional relationship between SA levels and Safe-B. However, the data were insufficient to draw conclusions about the bidirectional relationship between the variables. Of the aforementioned studies, the first only had 10 participants, and the second did not set out to analyze the bidirectional relationships between variables (Prieto-Fidalgo & Calvete, 2022).

Although theoretical models do not hypothesize different functioning between men and women, a large number of studies have found that women report higher levels of SA (Asher & Aderka, 2018; Calvete et al., 2016). Caballo et al. (2008) evaluated gender differences in 512 different scenarios with a total of 16,940 participants from 18 cities in different countries. They found that in 89% of the scenarios, women reported significantly higher levels of SA than men. However, several studies reported that SA measurement models were invariant according to gender (Ingles et al., 2010; Nelemans et al., 2019). As with SA, women also tend to interpret ambiguous scenarios more negatively than men (Miers et al., 2008, 2020). Finally, the longitudinal relationships between SA and other variables, such as victimization and social comparison, were invariant with respect to gender (Rapee et al., 2020), showing that although women may have higher levels of SA, the association between variables related to SA function similarly in men and women. However, it remains to be seen whether this similar functioning in men and women also occurs in the relationship between interpretation bias, Safe-B, and SA.

## The present study

Few longitudinal studies have evaluated the bidirectional predictive relationships between interpretation bias, Safe-B, and SA. Knowing the relationship between these variables would allow the detection of risk situations and more precise actions to prevent the perpetuation of SA.

The main objective of this study was to explore the longitudinal relationships between interpretation biases (measured through ambiguous scenarios and through ambiguous face images), Safe-B, and SA under the hypothesis that several bidirectional relationships will exist. On the one hand, based on the idea that interpretation biases maintain SA and this, in turn, promotes the maintenance of interpretation biases, it is believed that there will be a bidirectional relationship between interpretation biases and SA. On the other hand, as the theoretical models explain, SA is associated with higher levels of Safe-B, and the realization of such behaviors maintains SA by not allowing the individual to experience what would happen without engaging in Safe-B. Therefore, a bidirectional relationship between Safe-B and SA is hypothesized. Moreover, previous studies have found that interpretation biases lead to more Safe-B (Prieto-Fidalgo & Calvete, 2022) and that engaging in Safe-B does not correct the erroneous beliefs that led to these behaviors (McManus et al., 2008). Thus, it is also believed that, in addition to interpretation biases predicting Safe-B, Safe-B will maintain interpretation biases.

A secondary objective was to evaluate potential indirect relationships between the variables. Specifically, the indirect effect of Safe-B on the relationship between interpretation bias and SA was evaluated. In addition to hypothesizing that the biases and Safe-B will independently predict the level of SA, it is believed that over time the biases will lead to the performance of more Safe-B, which will lead to greater SA.

Finally, another objective of this study was to determine whether there are gender differences in these relationships, taking into account previous studies that reported higher levels of SA (Asher & Aderka, 2018; Calvete et al., 2016) and interpretation biases (Miers et al., 2008, 2020) in women. Women, compared to men, are expected to have higher levels of bias, Safe-B, and SA. Despite these differences, some studies reported that the measurement structure associated with SA is invariant across gender (Ingles et al., 2010; Nelemans et al., 2019), and the models are invariant (Rapee et al., 2020). These findings suggest that the associations between variables do not differ between women and men, so no gender differences are expected in the predictive models.

To select a correct sample for the objectives of this work, the sample needs to have started adolescence, and their daily routines need to imply some social exposure. Vocational training sample—due to the fact that the methodology of vocational training is very practical, it is based on teamwork and challenges and covers ages from 14 years (basic grade)—fulfills both the criteria of being in adolescence (or an older stage) and have a daily routine that implies some social exposure.

## Method

### Participants

Eight hundred twenty-six vocational training students from nine training centers in the Bizkaia province of Spain responded to the measures in the first wave (W1) of the study. Of these, 575 (69.6%) also answered the measures in the second wave (W2) and were used for the analyses. The ages of the participants ranged between 14 and 28 years ( $M = 19.49$ ,  $SD = 2.41$ ). Men comprised the majority (62.1%) of the sample and had a mean age of 18.42 years ( $SD = 2.44$ ). The mean age of women was 19.74 ( $SD = 2.38$ ). Of the participants, 51.9% and 49.1% were primary-intermediate students and higher grade students, respectively. The minimum sample size to achieve a small effect size (0.20) with a power of 80% was determined to be 444 participants (Soper, 2022).

The educational level of the parents followed these distributions: 3.7% without education, 5.8% primary school, 38.81% high school, 29.5% vocational training, and 22% university studies. The distribution of the parents' professions, according to the criteria of the National Institute of Statistics of Spain, was as follows: restaurant and security service workers and salespeople (31.5%), scientific and intellectual professionals (19.8%), artisans and skilled workers in the manufacturing and construction industries (16.5%), technicians and support professionals (8.4%), accounting and administrative employees (7%), homemakers (2.1%), directors and managers (1.9%), elementary occupations (7%), machinery operators (4.1%), pensioners (0.8%), skilled workers in the agricultural, livestock, forestry, and fishing sectors (0.4%), and unemployed (0.2%).

### Procedure

A random cluster sampling was performed. Ten vocational training centers were selected randomly, considering the proportion of private/public centers. These centers were contacted to participate in the study. The directors of three of them declined to participate. Then, another two centers were randomly selected and contacted. The directors of these agreed to participate. The centers provided computers and facilitated access to the participants.

After obtaining permission from the directors of the centers, students were informed that their participation was voluntary and their answers would remain anonymous. In the case of minors, an informed consent form was also sent to parents, and they were given the option of refusing the participation of their children. The Qualtrics® platform was used for data collection. The participants used

a personal computer to complete the questionnaires in an ordinary classroom, and they took approximately 35 minutes to complete. The Ethics Committee of University of Deusto (ETK-4/20-21) approved the procedure of this study.

The participants completed measures of SA, interpretation biases of ambiguous scenarios, interpretation biases of ambiguous faces, Safe-B, and demographics at the beginning of the study (W1) and at the four-month follow-up (W2). The scales were presented in the same order for all participants. The mean differences in the main variables in W1 between participants who answered both waves and those who only responded in the first one were compared. No differences were found in SA ( $M=41.67$ ,  $SD=13.55$  vs.  $M=42.04$ ,  $SD=12.93$ , for noncompleters vs. completers, respectively,  $t(823)=0.40$ ,  $p=.69$ ), interpretation biases in ambiguous scenarios ( $M=28.54$ ,  $SD=10.00$  vs.  $M=29.09$ ,  $SD=9.46$ , for noncompleters vs. completers, respectively,  $t(819)=0.76$ ,  $p=.45$ ), interpretation biases with ambiguous faces ( $M=12.21$ ,  $SD=5.66$  vs.  $M=12.72$ ,  $SD=5.29$ , for noncompleters vs. completers, respectively,  $t(738)=1.17$ ,  $p=.12$ ), SB ( $M=17.93$ ,  $SD=8.00$  vs.  $M=18.16$ ,  $SD=7.55$ , for noncompleters vs. completers, respectively,  $t(823)=0.41$ ,  $p=.68$ ), or sex,  $\chi^2(1)=2.01$ ,  $p=.15$ . However, the noncompleters ( $M=19.99$ ,  $SD=2.71$ ) were older than the completers ( $M=19.50$ ,  $SD=2.42$ ), and this mean difference was statistically significant,  $t(823)=2.56$ ,  $p=.01$ , with a very low effect size ( $d=0.19$ ).

## Measures

The Spanish version (Olivares et al., 2005) of the Social Anxiety Scale for Adolescents (SAS-A, La Greca & Lopez, 1998) was used to measure SA (Garcia-Lopez et al., 2015). This scale consists of 18 items that measure SA (e.g., “I am ashamed to be surrounded by people I do not know”) and four distracting items. Each statement is rated on a five-point Likert scale ranging from 1 (*never*) to 5 (*all the time*). The measurement structure according to sex and age remained invariant according to sex and age (Ingles et al., 2010). Moreover, the structure of the measure of the Spanish version was invariant compared to that obtained with North American adolescents (Torregrosa et al., 2022). This scale has been chosen mainly for evaluating SA taking into account the academic environment. The Cronbach’s alpha coefficients were .93 and .94, respectively, for the SAS-A in W1 and W2.

The Spanish version of Social Phobia Safety Behaviors Scale was used to assess SB (SPSBS; Pinto-Gouveia et al., 2003, Spanish version: Prieto-Fidalgo et al., 2022a). The original version of the measure consists of a 17-item scale that assess the common SBs used by individuals with SA. However, considering the results of the Spanish adaptation (Prieto-Fidalgo et al., 2022a), we used the 15-item

version, which excludes items 12 and 17. Each statement (e.g., “Avoid attracting attention” or “Trying to look at ease”) is rated on a frequency-type scale ranging from 1 (*never*) to 4 (*almost always*). The Cronbach’s alpha coefficients were .82 and .84, respectively, in W1 and W2.

The Spanish version of the Adolescents’ Interpretation Bias Questionnaire 2.0 (AIBQ 2.0, Miers et al., 2020; Spanish version: Prieto-Fidalgo et al., 2022a) was used to measure IB in ambiguous scenarios. This instrument contains three types of ambiguous scenarios: five non-social situations (e.g., “You have received a new watch with stop-watch function but you can’t get it to work. Why can’t you get it to work?”), five offline situations (e.g., “You have invited a group of fellow students to your birthday, but a few have not yet said if they’re coming. Why haven’t they said something yet?”), and seven online situations (e.g., “You have been active on the new dating site MESH for a few weeks. You’ve received a few messages, and it hasn’t progressed any further than just chatting. Why have you not yet been on a date?”). Each situation is followed by a question (e.g., “Why have you not yet been on a date?”) and three types of interpretations: a neutral interpretation (e.g., “It takes a little while on most dating sites and a quick match isn’t guaranteed”), a negative interpretation (e.g., “I scare the other person off when chatting”), and a positive one (e.g., “It can’t be very long now until I go on my first date”). After imagining the situations, the participants rated the probability that each interpretation would pop into their mind on a five-point scale ranging from 1 (“*does not pop in my mind*”) to 5 (“*definitely pops up in my mind*”). As IB is understood as a negative perception (Miers et al., 2008), only data on negative interpretations were used. An overall measure with the online and offline components was employed because both components are highly correlated. The Cronbach’s alpha coefficients were .87 and .85, respectively, in W1 and W2.

The Ambiguous Faces Interpretation Task was employed to measure the IB of ambiguous faces (Prieto-Fidalgo et al., 2022b). This task includes 72 images of morphed faces of eight models (four men and four women) from the Chicago Face Database (Ma et al., 2015). The images contain models expressing emotions of anger or happiness with different levels of ambiguity. Specifically, half of the images combine intermediate expressions between a happy face and a neutral one. The other half were created by transforming intermediate images between an angry face and a neutral one. The task presents each image preceded by a (+) signal for 500 ms. For each image, participants used the keyboard to indicate whether the image seemed positive or negative. According to the findings (Prieto-Fidalgo et al., 2022b), the number of ambiguous faces marked as negative was used as the global index of the task. The test–retest Pearson correlation coefficient in this study was .62. To detect distractions, we

excluded the responses in which the reaction time was over  $\pm 3$  SD from the mean response time of each participant.

**Data analysis**

Two path analysis models were utilized to assess the bidirectional associations between interpretation biases, Safe-B, and SA using Mplus 8.2. The first model used Interpretation Bias Questionnaire scores as a measure of interpretation biases, whereas the second model used the Ambiguous Faces Interpretation Task as a measure. The models included cross-lagged associations between interpretation biases, Safe-B, and SA and autoregressive paths. In addition, studies have founded that there are differences according to sex and age in social anxiety (Caballo et al., 2008; Bruce et al., 2005). Therefore, sex (1 = boy) and age were included as covariates in W1. To assess the significance of indirect associations between variables, a bootstrapping procedure was used (N = 5000 samples).

Next, we examined whether these models were invariant for girls and boys. With this aim, first, a configural model that allowed the free estimation of longitudinal paths in boys and girls was examined. Second, a constrained model that fixed longitudinal paths to be equal for boys and girls was conducted. Third, both models were compared using chi-square scores (Byrne, 2013).

The models’ goodness of fit was evaluated using the Tucker–Lewis index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). CFI and TLI values of .95 or higher indicate excellent fit. Meanwhile, an RMSEA value of .08 or lower indicates acceptable fit while a value of .05 or lower reflects good fit (Little, 2013). Little’s MCAR test was significant,  $\chi^2(46) = 76.84, p = .003$ ,

indicating that the missing data were not random. Thus, multiple imputation (MI) was used to impute values for these missing data. Models were estimated using maximum likelihood. As a bootstrapping procedure is not recommended when performing MI in Mplus, FIML was used to test the indirect paths.

**Results**

Table 1 shows the descriptive analysis and correlation matrix of interpretation biases, Safe-B, SA, and age in both waves. Except for age, all variables were significantly and positively correlated, demonstrating a positive association across time. The correlations between the same variables across waves ranged between .62 and .79. The age of the participants only correlated significantly and positively with the interpretation biases of ambiguous faces in W1 and W2. Thus, older participants interpreted less ambiguous faces as negative.

Mean differences according to sex are reported in Table 2. As hypothesized, women scored significantly higher than men on the main variables in W1. Specifically, a medium effect was seen for SA levels and Safe-B, while a low effect size was found for both types of interpretation biases in W1. However, no sex differences were observed for both types of interpretation biases in W2. Additionally, no significant differences were found in age according to sex.

**Predictive model for interpretation biases in ambiguous scenarios**

Figure 1 presents the predictive model for SA, Safe-B, and interpretation biases in ambiguous scenarios. The fit indices

**Table 1** Descriptive analysis and correlation matrix of the variables of the study

	1	2	3	4	5	6	7	8	9
1.- SA W1	1								
2.- Safe-B W1	.68**	1							
3.- IB Scenarios W1	.48**	.48**	1						
4.- IB Faces W1	.17**	.17**	.22**	1					
5.- SA W2	.79**	.59**	.47**	.21**	1				
6.- Safe-B W2	.57**	.68**	.39**	.23**	.74**	1			
7.- IB Scenarios W2	.36**	.36**	.64**	.24**	.52**	.49**	1		
8.- IB Faces W2	.15**	.17**	.19**	.62**	.13**	.17**	.19**	1	
9.- Age	.08	.01	-.06	-.18**	.08	.02	-.07	-.14**	1
Mean	42.04	18.16	29.09	12.72	42.20	18.58	29.46	12.73	19.50
SD	12.93	7.55	9.46	5.29	13.01	7.72	9.33	5.29	2.42
n	575	575	575	520	575	574	572	527	575

SA social anxiety (SAS-A), IB Scenarios interpretation bias of ambiguous scenarios (AIBQ 2.0), IB Faces interpretation bias of ambiguous faces measured with the Ambiguous Faces Interpretation Task, Safe-B safety behaviors (SPSBS), W1 wave 1, W2 wave 2

\*  $p < .05$ ; \*\*  $p < .01$

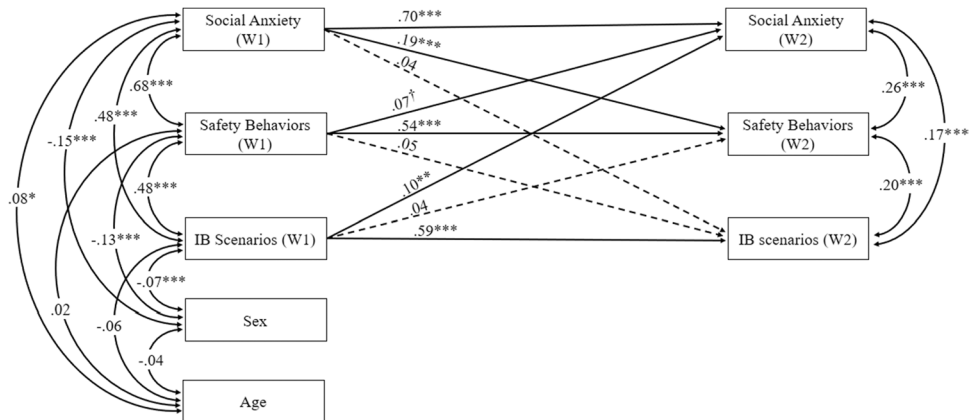
**Table 2** Mean differences of main variables according to sex

	Boys		Girls		<i>t</i>	<i>DF</i>	<i>p</i>	<i>d</i>
	M	SD	M	SD				
SA W1	39.02	10.76	47.15	14.60	7.09	354 <sup>a</sup>	< .001	.66
Safe-B W1	17.87	6.06	21.72	8.09	6.03	357 <sup>a</sup>	< .001	.56
IB scenarios W1	27.97	8.56	30.99	10.58	3.54	380 <sup>a</sup>	< .001	.32
IB facesW1	12.22	5.23	13.47	5.13	2.64	516	.009	.29
SA W2	40.09	11.99	45.79	13.90	5.00	400 <sup>a</sup>	< .001	.45
Safe-B W2	17.60	7.22	20.18	8.29	3.78	401 <sup>a</sup>	< .001	.34
IB scenarios W2	28.97	8.74	30.25	10.26	1.52	391 <sup>a</sup>	.13	–
IB facesW2	12.50	5.20	13.12	5.47	2.64	522	.19	–
Age	19.36	2.44	19.74	2.38	1.85	570	.065	–

SA social anxiety (SAS-A), IB Scenarios interpretation bias of ambiguous scenarios (AIBQ 2.0), IB Faces interpretation bias of ambiguous faces measured with the Ambiguous Faces Interpretation Task, Safe-B safety behaviors (SPSBS)

<sup>a</sup>Corrected degrees of freedom were reported because different variances were assumed between boys and girls

**Fig. 1** Standardized Coefficients of the Predictive Model for Social Anxiety, Safety Behaviors, and Interpretation Biases in Ambiguous Scenarios. Note. IB scenarios = interpretation bias of ambiguous scenarios (AIBQ 2.0); W1 = wave 1; W2 = wave 2. Sex is a dummy variable (boy = 1). † < .1; \* *p* < .05; \*\* *p* < .01; \*\*\* *p* < .001. The dashed lines represent non-significant paths



of the model were excellent,  $\chi^2(6, n = 575) = 10.18, p = .12, RMSEA = .035, CI 90\% [0; .07], CFI = .99, TLI = .99$ . All autoregressive paths were significant, that is, SA, Safe-B, and interpretation bias in ambiguous scenarios in W1 predicted, respectively, SA, Safe-B, and interpretation bias in W2. Safe-B predicted—marginally significant—and interpretation biases predicted greater levels of SA in W2, but interpretation biases did not predict Safe-B in W2. Interpretation biases were only predicted by biases in W1, so no bidirectional relationship appeared between biases and SA or between biases and Safe-B. The data showed a bidirectional relationship between Safe-B and SA. Specifically, SA in W1 predicted Safe-B in W2, and Safe-B in W1 predicted SA in W2.

These findings suggest indirect associations between variables. Specifically, the relationship between interpretation biases and Safe-B could be explained through SA (Interpretation biases → SA → Safe-B). For this purpose, the indirect association was estimated from

the paths of W1 interpretation biases to W2 SA and W1 SA to W2 Safe-B. The coefficient of this indirect path was .018, and the 95% confidence interval ranged between .006 and .034. Because the confidence interval did not contain zero, the path was considered significant.

To analyze sex invariance, first, a configural model was developed with all paths freely estimated. The fit indices of the unconstrained model were good,  $\chi^2(6, n = 575) = 7.49, p = .28, RMSEA = .029, CI 90\% [0; .09], CFI = .99, TLI = .99$ . Second, a constrained model was considered. The paths of this model were constrained to be equal in women and men. The fit indices of the constrained model were also good,  $\chi^2(15, n = 575) = 17.97, p = .26, RMSEA = .026, CI 90\% [0; .065], CFI = .99, TLI = .99$ . Third, the models were compared using the chi-square value. The comparison between models was not significant,  $\Delta\chi^2(9) = 10.48, p = .31$ . Thus, the data showed that the model was invariant with respect to sex.

### Predictive model for interpretation biases with ambiguous faces

Figure 2 shows the path diagram of the predictive models for interpretation biases with ambiguous faces. The fit indices of the model were excellent,  $\chi^2(6, n = 575) = 8.01, p = .24, RMSEA = .024$  CI 90% [0; .06],  $CFI = .99, TLI = .99$ . All autoregressive paths were significant, that is, SA in W1 predicted the SA level in W2, Safe-B in W1 predicted Safe-B in W2, and biases in W1 predicted biases in W2. No bidirectional relationships were found between biases and SA or between biases and Safe-B. Thus, interpretation biases in W1 predicted SA in W2, but neither SA nor Safe-B in W1 predicted biases in W2. However, a bidirectional relationship appeared between Safe-B and SA. Thus, SA in W1 significantly predicted Safe-B in W2, and Safe-B in W1 predicted the level of SA in W2.

Indirect associations were estimated because some of the relationships were consistent with a tentative mediation. Specifically, the indirect path between interpretation biases in ambiguous faces and SA through Safe-B (Interpretation biases  $\rightarrow$  Safe-B  $\rightarrow$  SA) was significant,  $b = .009$  95% CI [.001; .025]. Further, the indirect path between interpretation biases and Safe-B through SA (Interpretation biases  $\rightarrow$  SA  $\rightarrow$  Safe-B) remained significant in this model,  $b = .012$  95% CI [.001; 0.019].

In order to analyze the sex invariance of the model, first, a configural model was conducted allowing the free estimation of betas. The fit indices of the model were good,  $\chi^2(6, n = 575) = 4.85, p = .56, RMSEA = .000$  CI 90% [0; .068],  $CFI = 1, TLI = 1$ . Second, a constrained model was developed in which the beta coefficients were equal for women and men. The fit indices of this model were also good,  $\chi^2(15, n = 575) = 13.41, p = .57, RMSEA = .000$  CI 90% [0; .05],  $CFI = 1, TLI = 1$ . The comparison between models was not significant,  $\Delta\chi^2(9) = 8.56, p = .48$ , and therefore the models remained sex invariant.

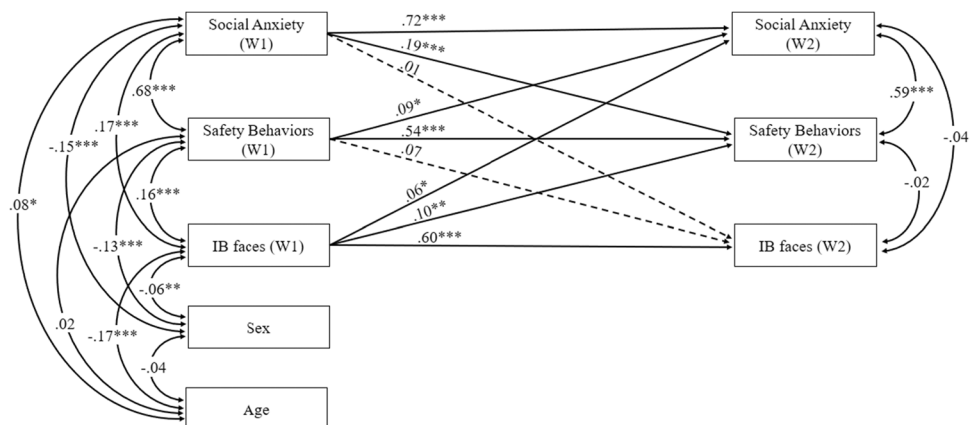
### Discussion

Theoretical models in SA propose bidirectional relationships between interpretation biases, Safe-B, and SA. However, few studies have focused on verifying this type of relationship. Accordingly, the main objective of this study was to analyze the bidirectional relationships between interpretation biases, Safe-B, and SA. Secondly, this study also aimed to assess potential indirect effects between the variables as well as to analyze whether there are gender differences in the relationship between variables. The main findings of the study are described below.

Regarding the objective of analyzing the bidirectionality of the variables, the results show that both interpretation biases and Safe-B predict higher levels of SA. These findings are consistent with studies that conclude that interpretation bias in scenarios (Beard & Amir, 2010; Chen et al., 2020) and Safe-B (Chiu et al., 2021b; van Uijen et al., 2018) lead to the development and maintenance of SA. Furthermore, in the case of Safe-B, the relationship was bidirectional. This result is consistent with the findings of a study that found that initial levels of SA preceded the performance of a greater number of Safe-B, which in turn predicted a higher level of perceived SA throughout the day (Prieto-Fidalgo & Calvete, 2022). Consistent with theoretical models (Clark & Wells, 1995; Heimberg et al., 2014), 2014), these data support the idea that Safe-B and SA feed off each other. That is, people with higher levels of SA perform more Safe-B, and performing these behaviors leads to higher levels of SA over time.

Concerning bidirectional relationships with interpretation bias, engagement in Safe-B is associated with a greater tendency to infer that a situation is threatening (Gangemi et al., 2012; van den Hout et al., 2014; van Uijen et al., 2018). However, contrary to what was hypothesized, neither Safe-B nor SA predicted higher levels of interpretation bias, and therefore no bidirectional relationships were found between interpretation bias and these variables. Although performing Safe-B could increase the perception of threat in a specific

**Fig. 2** Standardized Coefficients of the Predictive Model for Social Anxiety, Safety Behaviors, and Interpretation Biases with Ambiguous Faces. *Note.* IB Faces = interpretation bias of ambiguous faces measured with the Ambiguous Faces Interpretation Task; W1 = wave 1; W2 = wave 2. Sex is a dummy variable (boy = 1). The dashed lines represent non-significant paths. \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$



situation, at the level of longitudinal relationships, the data from this study could indicate that interpretation bias is a mechanism that occurs at a more initial stage than Safe-B and the symptoms of SA itself. Thus, interpretation biases would not be significantly influenced over time by engagement in Safe-B or SA, but they would influence the maintenance and appearance of Safe-B and SA.

Regarding the hypotheses about the indirect effects between the variables, it has been hypothesized that Safe-B would indirectly explain the relationship between interpretation bias and SA. In this study, this indirect relationship was only found for the interpretation biases of ambiguous faces. Thus, the negative interpretation of ambiguous faces would lead to Safe-B, and Safe-B would lead to higher levels of SA. These data are consistent with a diary study that found that daily Safe-B mediated the relationship between the baseline level of interpretation bias and experienced daily SA levels (Prieto-Fidalgo & Calvete, 2022). However, unlike our study, which found mediation with a face interpretation task, that study found mediation with a task based on the interpretation of ambiguous situations. It has also been found that the relationship between both types of interpretation bias and Safe-B could be explained through SA. In other words, interpretation biases would lead to higher levels of SA, and SA symptomatology would lead to more engagement in Safe-B. These data, combined with the bidirectional relationship between Safe-B and SA, could be interpreted to mean that, among the variables analyzed, interpretation biases serve as an initial link in the emergence of SA. However, since the methodology used is not the most appropriate for analyzing mediations, these data must be interpreted cautiously.

Concerning gender differences, in both waves—except in W2, where the differences were not significant for interpretation bias—women scored higher than men on SA, Safe-B, interpretation bias in ambiguous situations, and interpretation biases of ambiguous faces. These data coincide with studies reporting that women have higher SA scores (Caballo et al., 2014; Jalnapurkar et al., 2018) and interpretation bias in ambiguous situations (Miers et al., 2008). In addition, the present study found sex differences in Safe-B. However, in agreement with the hypothesis, the proposed predictive models were invariant according to gender. That is, the association between the study variables shows a similar behavior between men and women. Other studies have also shown invariance in models that evaluate the relationship between variables related to SA (Rapee et al., 2020).

The limitations of the study should be considered when analyzing the conclusions. First, preliminary data on the indirect associations between the variables and tentative, proposed mediating mechanisms have been provided. However, the present study included only two measurement times, but to obtain reliable conclusions about the mediations between the variables, a longitudinal study with at least

three times is required (Maxwell & Cole, 2007). A second limitation is related to high attrition. However, the low response rate in W2 could be explained by the characteristics of vocational training centers (high absence of students), and no significant differences were found in the main variables between those who answered and those who did not in W2. Possibly, those who did not answer have certain characteristics that could bias the results of the study. Finally, the percentage of male and female participants was 62.1% and 37.9%, respectively, due to the higher proportion of male students in vocational training centers. This disparity makes the data obtained slightly more representative for men.

## Conclusions and implications for interventions

This longitudinal study provides information about the predictive relationships between Safe-B, interpretation biases, and SA levels. The bidirectional relationship found between Safe-B and SA supports the importance of reducing Safe-B in psychotherapeutic interventions (Blakey & Abramowitz, 2016). The results further suggest that interpretation biases could play a relevant role in the maintenance of SA and, in the case of interpretation biases of ambiguous faces, in the maintenance of Safe-B. The data suggest that interpretation biases are a previous link to the bidirectional (circular) relationship between Safe-B and SA. In the absence of three-time longitudinal studies, these data have to be considered with caution. However, the results—together with intervention efficacy studies (Kampmann et al., 2016)—suggest that working on interpretation biases could improve psychotherapeutic interventions. In relation to gender, the findings do not justify that, within the framework of what was studied in this work, preventive programs or different interventions should be carried out according to gender.

**Funding** Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. This work was supported by the Research Training Grants Program for Pre-doctoral contracts from Basque Government (Ref PRE-2019-1-0034) and a grant from the Basque Government to the research team (IT1532-22).

**Data availability** The datasets generated during current study are available from the corresponding author on reasonable request.

## Declarations

**Ethical approval** The study was conducted with the consent of all the participants in the investigation and with the permission of the vocational centers' directors. The participation was voluntary and confidential. The project was approved by the IRB of University of Deusto (ETK-4/20-21). This manuscript describes original work and is not under review by any other journal. Both authors participated in the elaboration of this paper and approved both the manuscript and its

submission. National and International ethical guidelines were followed to protect the participants of this study.

**Conflict of interest** The authors declare no conflict of interest.

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