Will you look at me? Social anxiety, naturalistic social situations, and wearable eye-trackers

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CHAPTER 2

A systematic review of visual avoidance of faces in socially anxious individuals: Influence of severity, type of social situation, and development

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ABSTRACT

Although visual avoidance of faces is a hallmark feature of social anxiety disorder (SAD) on clinical and theoretical grounds, empirical support is equivocal. This review aims to clarify under which conditions socially anxious individuals display visual avoidance of faces. Through a systematic search in Web of Science and PubMed up to March 2019 we identified 61 publications that met the inclusion criteria. We discuss the influence of three factors on the extent to which socially anxious individuals avoid looking at faces: (a) severity of social anxiety symptoms (diagnosed SAD versus High Social Anxiety levels in community samples [HSA] or related characteristics [Shyness, Fear of Negative Evaluation]), (b) three types of social situation (computer face-viewing tasks, speaking tasks, social interactions), and (c) development (age-group). Adults with SAD exhibit visual avoidance across all three types of social situations, whereas adults with HSA exhibit visual avoidance in speaking and interaction tasks but not in face-viewing tasks. The relatively few studies with children and adolescents suggest that visual avoidance emerges during adolescence. The findings are discussed in the context of cognitive-behavioral and skills-deficit models. Suggestions for future research include the need for developmental studies and more fine-grained analyses of specific areas of the face.

INTRODUCTION

Social anxiety disorder (SAD) is a prevalent, debilitating anxiety disorder, characterized by an intense fear or anxiety, as well as avoidance of social situations (American Psychiatric Association, 2013). Given the key features of SAD and the fact that faces convey cues about scrutiny and negative social evaluation, visual avoidance of faces may be a behavioral marker of social anxiety disorder. Relations with eye-contact have been proposed in theoretical models of SAD developed by clinicians. Firstly, cognitive models state that people with SAD interpret social situations in more threatening ways than people without SAD (e.g., Clark & Wells, 1995; Hofmann, 2007). Gaze avoidance then serves as a safety-seeking behavior aimed to avoid feared social outcomes without completely withdrawing from social situations. Secondly, social skills deficit models argue that persons with SAD are featured by actual skills deficits (see Levitan & Nardi, 2009 for a review). This model postulates that people with SAD have failed to acquire social skills, which leads to unpleasant social experiences and hence to social anxiety. In this view, people with SAD may not have learned to make appropriate eye-contact. In line with these clinical perspectives, inadequate eye-contact is a supporting feature of the diagnosis in the DSM (APA, 2013, p. 204). Indeed, both adults (Schneier, Rodebaugh, Blanco, Lewin, & Liebowitz, 2011) and children diagnosed with SAD (Kley, Tuschen-Caffier, & Heinrichs, 2012) report that they avoid eye-contact themselves.

Although avoidance is a hallmark feature of SAD on clinical and theoretical grounds, experimental findings have provoked a debate on whether visual attention towards facial stimuli is fundamentally reduced, normal, or even increased in socially anxious individuals. There have been three previous reviews of gaze behavior in social anxiety, but none of them focused primarily on avoidance. Bantin, Stevens, Gerlach, and Hermann (2016) systematically reviewed studies using facial dot-probe tasks to evaluate the hypothesis that socially anxious individuals show an attentional bias *toward* threatening facial stimuli (i.e., by looking more at them). Their review supports this hypothesis, and noted that the results are inconsistent with avoidance of threat in this particular task. Schulze, Renneberg, and Lobmaier (2013) primarily reviewed studies on gaze perception, concluding that patients with SAD are more inclined to think that others are looking at them. In addition, they noted that although patients with SAD showed a severe fear of eye contact, studies did not consistently show avoidance. They suggested that contradictory findings might be explained by a hypervigilance-avoidance model of attention. According to this two-stage model, anxious people are initially vigilant for threat, but subsequently avoid it (e.g., Mogg, Bradley, Miles, & Dixon, 2004). In the third review, Chen and Clarke (2017) evaluated the evidence for this model. They concluded that social anxiety is associated with a mixed visual

pattern involving vigilance (i.e., increased attention) as well as avoidance. However, they also concluded that the data were inconsistent with the proposed model, because the time-course from vigilance to avoidance could not consistently be identified from the reviewed studies. To date, it is still unresolved why "several studies observe vigilance, while several others observe avoidance" (Chen & Clarke, 2017, p. 59).

The present paper aims to evaluate whether socially anxious individuals avoid looking at eyes and faces. It extends previous reviews by considering studies that used various tasks and multiple measures of gaze behavior with eye-tracking and observer ratings. Based on the empirical literature, we identified three factors that may influence the relation between social anxiety and visual avoidance: level of social anxiety, type of social situation, and development.

Firstly, it is worth noting that social anxiety (SA) varies along a continuum from very low levels, through normal levels, to very high levels. Although people diagnosed with SAD often score at the high end of the continuum, high levels of social anxiety and SAD are not synonymous. A diagnosis of SAD also requires substantial interference with daily life (Spence & Rapee, 2016). Hence, there is a possibility that different degrees of interference result from different behavioral patterns (such as gaze patterns) in people diagnosed with SAD versus individuals with high social anxiety scores but no diagnosis. Previous reviews have distinguished between studies of these two groups, but only within a specific experimental context (Bantin et al., 2016; Chen & Clarke, 2017). The focus of these reviews did not allow for a comparison of gaze behavior across tasks within a particular level of social anxiety. In the present review, the level of social anxiety is the main organizing principle. We will discuss research on a) persons with diagnosed SAD, b) people with high self-reported levels of social anxiety but no diagnosis (High Social Anxiety; HSA), and c) people reporting characteristics associated with social anxiety: high fear of negative evaluation and shyness.

Secondly, studies have been conducted in very different social situations, ranging from face-viewing tasks of being presented with (emotional) faces on a computer screen, to naturalistic social situations, namely, structured and unstructured social situations of public speaking and social interaction (Levitan & Nardi, 2009; Voncken & Bögels, 2008). The DSM definition of SAD suggests that avoidance of eye-contact would occur *in situations in which one may be scrutinized by others*. The social skills deficit literature indicated that deficits are more often observed in unstructured situations than in predictable situations (Levitan & Nardi, 2009; Voncken & Bögels, 2008), although these findings are based on global performance ratings rather than specific gaze behavior. Chen and Clarke (2017) looked specifically at naturalistic social situations in their review and concluded that they provided evidence for visual

avoidance of faces. However, their review was restricted to eye-tracking studies and hence the conclusion of visual avoidance was based on only three studies. The present review includes eye-tracking studies that have appeared recently as well as older social interaction studies using observer ratings. To clarify the role of the social situation, we will distinguish between face-viewing tasks, public speaking and social interaction.

Thirdly, developmental differences have so far received little attention. Few studies have been done with non-adult samples and they have been combined with adult studies in previous reviews (Chen & Clarke, 2017; Schulze et al., 2013). The developmental literature indicates that adolescence is an important period for the development of social anxiety and avoidance behavior. Existing longitudinal data indicated that social fear levels become fairly stable across development (Miers, Blöte, De Rooij, Bokhorst, & Westenberg, 2013), but that socially anxious youth increasingly avoid social situations (Miers, Blöte, Heyne, & Westenberg, 2014). These findings suggest that avoidance of eye-contact might also increase with development in socially anxious individuals, particularly during adolescence. In contrast, results from social skills studies suggest that deficits are more often observed in children and adolescents than in adults with social anxiety (Levian & Nardi, 2009). The present study will explore whether and how visual avoidance of faces differs by age group.

In summary, while technological advances in eye-tracking systems have spurred a rapid accumulation of evidence from both fundamental and intervention studies, there is a growing need for clarification of the divergent findings. Hence, a comprehensive review might clarify to what extent socially anxious individuals display gaze avoidance and whether this tendency is influenced by severity of social anxiety, type of social situation, and development.

METHOD

Inclusion criteria

Based on the purposes of this review, the following eligibility criteria were used for the procedure of screening and selection: (1) the article must be available, peer-reviewed, full-text, and published in English, (2) the article must report original empirical results, (3) the article must investigate human participants, (4) the article uses a reliable tool to measure social anxiety symptoms (structured diagnostic interview, self-report and parent-report), (5) the study compares participants with different levels of social anxiety symptoms; studies investigating the effects of another variable in a single group of SAD patients are excluded, (6) the study provides information about effects

of social anxiety that are distinguishable from effects of other variables; the study is excluded if it investigates an interaction between social anxiety and a manipulated variable, and does not include or report the results for social anxiety in the control condition of the manipulated variable, and (7) the article reports results with respect to objective gaze behavior while the participant is presented with facial stimuli.

Literature sources and search strategy

The literature search of this systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). The PRISMA diagram is displayed in Figure 1. Several alternative search terms were used that combined: (1) *social anxiety symptoms* and (2) *gaze behavior*. Titles and abstracts were set as search fields for articles prior to March 29, 2019. No language restriction was applied. Two electronic databases: Web of science (Web of Science Core Collection as well as MEDLINE) and PubMed were searched concurrently by using the following search phrase: *(*"Social anxiety" OR "social anxiety disorder" OR "social anxiety disorders" OR "social phobia" OR "social phobias" OR "shyness" OR "speech phobia") AND *(*"gaze behavior" OR "eye movements" OR "eye contact" OR "eye movement" OR "eye gaze" OR "eye tracking"). This resulted in a total of 468 records. After duplicates had been removed, the 343 remaining records were screened based on their titles and abstracts.

During the screening process, obviously irrelevant records (n=275) were subsequently excluded based on the following criteria: (1) The study was not published in English (n=7), (2) The study was not empirical (n=69). We excluded review, case reports, questionnaire studies, qualitative studies (e.g., thematic analysis), conference abstracts, etc. (3) The study did not investigate a human population (n=3), (4) The study did not measure social anxiety symptoms (e.g., trait and state anxiety, depression, Williams syndrome, separation anxiety, chronic pain disorder (... n=151), (5) The study did not compare participants with different levels of social anxiety (n=4), (6) The outcomes of the study were not comprised of gaze behavior variables (n=42). For example, studies which measured non-behavioral responses (e.g., neural or psychophysiological), subjective gaze perception/judgement, or reaction time (without any information about gaze behavior) were removed. These studies seemed to have been identified by our search terms because they used eye gaze as experimental stimuli rather than outcomes.

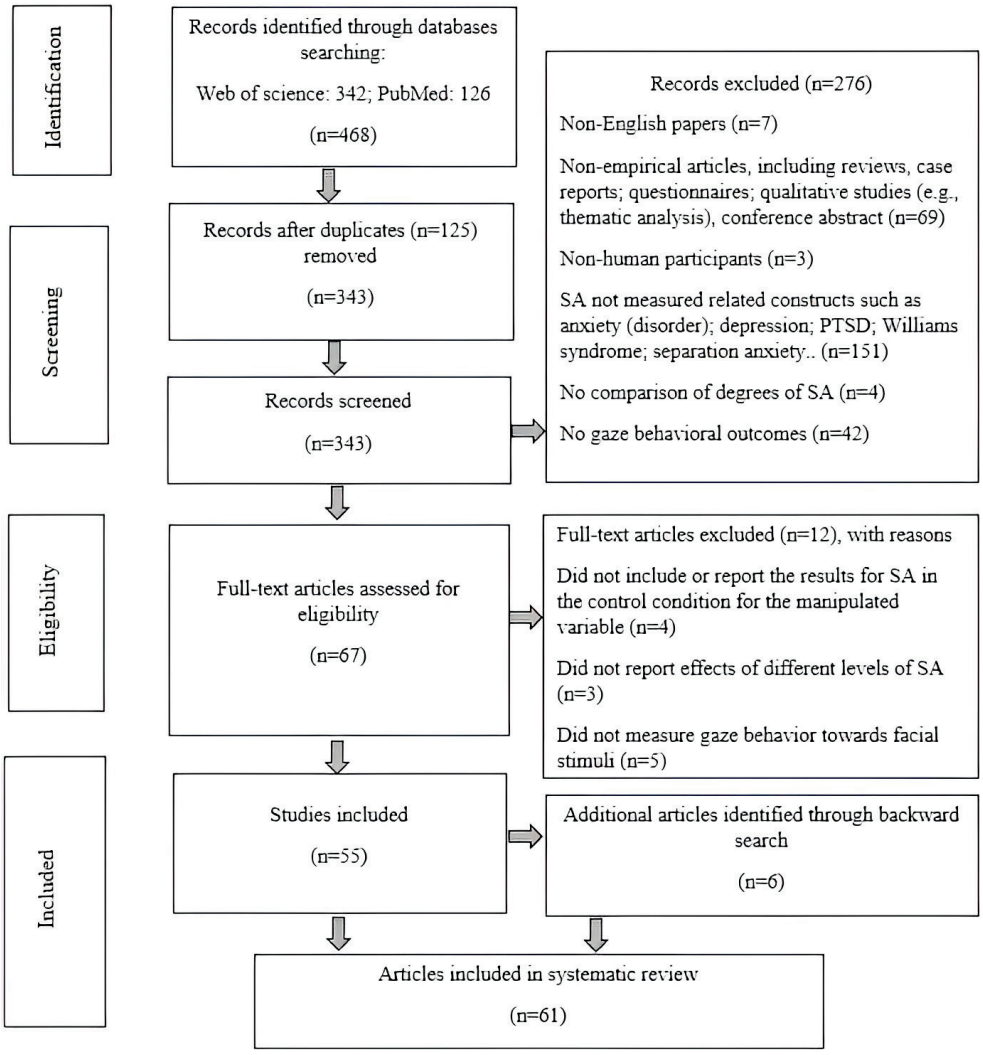

Figure 1. *Selection flow chart*

Afterwards, we further examined 67 remaining articles for eligibility. Twelve articles were excluded after examining the methods and results. They were excluded for the following reasons: (1) Three studies did not include or report the results for social anxiety in the control condition of the manipulated variable (Enter, Terburg, Harrewijn, Spinhoven, & Roelofs, 2016; Finch, Iverach, Menzies, & Jones, 2016; Van Dillen, Enter, Peters, van Dijk, & Rotteveel, 2017). (2) Four studies investigated the effects of other variables (alcohol, communication impairments, age of face) in a single group of participants with SAD. Therefore, these studies do not provide an

answer to the question of whether SAD affects gaze behavior (Battista, MacDonald, & Stewart, 2012; Capriola-Hall, Wieckowski, Ollendick, & White, 2018; Wieckowski, Capriola-Hall, Elias, Ollendick, & White, 2019). (3) Five studies were excluded because they did not measure gaze behavior towards facial stimuli. Specifically, two studies did not present clear facial stimuli, presenting either no faces (Baggett, Saab, & Carver, 1996) or degraded faces as distractors in search task (Ruth Doherty, Patai, Duta, Nobre, & Scerif, 2017). The other three studies did not measure eye gaze on facial stimuli (Haller et al., 2017; Stevens, Rist, & Gerlach, 2011; Terburg et al., 2016). The remaining 55 studies were included in this review.

Subsequently, we performed a backwards literature search, manually searching the references cited in the included articles. Five articles were identified based on the eligibility criteria mentioned above. One additional article was identified through a backwards search of those five articles. These six articles had not been identified in the main search, because gaze behavior was not the only outcome variable and more general key words were used, such as "behavioral assessment", "social skills" and "submissiveness". In total, 61 articles were included in the final sample.

Data extraction

The following variables were extracted from each included article and the findings are reported in Table 1. Basic information: first author surname and publication year. Participant information: sample size (N), mean age, and percentage of female participants. Social anxiety symptoms (i.e. social anxiety disorder, social anxiety, fear of negative evaluation, shyness). Instruments used for social anxiety assessment. Types of social situations (i.e. facial-viewing, public speaking and interaction). Gaze behavior variables (i.e., total fixation count, total dwell time). The main outcomes are presented in Table 1, more details are discussed below.

Synthesis of results

The included studies were primarily stratified by severity of social anxiety: individuals with a diagnosed social anxiety disorder (SAD), individuals with high levels of social anxiety in community samples (HSA), and people with characteristics related to social anxiety (fear of negative evaluation, shyness). Under each social anxiety level, studies were grouped by type of social situation to further explore the variability of gaze behavior within each level of social anxiety. Finally, the relatively few studies with youth samples were analyzed separately to examine developmental effects on visual avoidance of faces.

Type of participants

Of the 51 studies with adult participants, 22 included participants with SAD, 19 included participants with high levels of social anxiety from community samples and 10 included participants with characteristics related to social anxiety (high fear of negative evaluation in nine studies and shyness in one study). SAD was determined with a structured diagnostic interview in most studies. High SA, fear of negative evaluation and shyness were generally measured by self-report questionnaires. Of the ten studies with minors (including infancy, childhood, and adolescence), six included participants with SAD, two included participants with high levels of social anxiety from community samples, and two studies examined shyness. SAD was determined with a structured diagnostic interview, SA with self-report questionnaires, and shyness with parent- or self-report questionnaires.

Type of social situation

The studies also used three different types of situations: 41 used facial-viewing tasks, five used public speaking tasks and 15 used interaction tasks.

Facial-viewing tasks. In all facial-viewing task studies, eye-tracking technology was used to continuously register on which part of the stimuli the eyes were fixated. The facial-viewing tasks included passive viewing, preferential looking, visual search, emotion classification and face recognition.

In the passive viewing studies, participants were typically presented with static pictures of faces with emotional expressions for ten seconds. Some studies presented facial stimuli dynamically using video clips or virtual reality. In preferential looking studies, participants were simultaneously presented with two or more pictures of faces displaying different emotions (e.g., happy, angry, disgusted, neutral). A few studies compared gaze behavior to facial and non-facial stimuli. In emotion classification studies, participants were required to indicate which emotion was expressed by facial stimuli or face-body compounds. In the visual search tasks, participants were presented with circles of eight faces with different expressions (positive, negative and neutral). Their task was to decide whether the target face was different from the others. Finally, in face recognition tasks, participants were instructed to indicate whether the presented face was new or old.

Public speaking. Public speaking studies required participants to give a short speech (3 – 10 minutes), either in front of a live audience, a prerecorded audience or a virtual audience. The speech in front of the live audience was recorded on video and eye-contact was subsequently assessed by two raters. The other studies used eye-tracking technology.

Interaction. The interaction studies usually included having a conversation. In one study, participants sat facing each other, but were not instructed to talk. In another study, the participant talked while the confederate only listened. Most conversations were with one or more real-life conversation partner: confederates or someone the participant knew well. In few studies, the confederates were prerecorded or virtual interaction partners. In some other studies, the life conversation was channeled through an indirect communication set-up like Skype. The studies using VR or an indirect communication set-up were able to use eye-tracking technology. In the other studies eye-contact was assessed by raters.

RESULTS

Visual avoidance of faces in adults with social anxiety disorder

A majority of studies (16/22) on adult SAD patients found a gaze pattern consistent with avoidance of faces, and this was observed across all three types of social situations. Six studies did not observe greater avoidance in persons with SAD. The proportion of positive findings did not substantially vary across the three social situations. Firstly, 10 out of 14 studies with facial-viewing tasks observed visual avoidance. Avoidance of faces and the eye-region in particular was found in all passive viewing (Horley, Williams, Gonsalvez, & Gordon, 2003; Horley, Williams, Gonsalvez, & Gordon, 2004; Moukheiber et al., 2010; Moukheiber, Rautureau, Perez-Diaz, Jouvent, & Pelissolo, 2012; Staugaard & Rosenberg, 2011; Weeks, Howell, & Goldin, 2013), and in three (Byrow, Chen, & Peters, 2016; Chen, Clarke, MacLeod, & Guastella, 2012; Schofield, Inhoff, & Coles, 2013) out of five preferential looking studies (not in Gamble & Rapee, 2010; Lazarov, Abend, & Bar-Haim, 2016), as well as in one (Wermes, Lincoln, & Helbig-Lang, 2018b) of two visual search studies (not in Wermes, Lincoln, & Helbig-Lang, 2018a). One study using an emotion classification task (Boll, Bartholomaeus, Peter, Lupke, & GamLer, 2016) presented evidence against avoidance: increased dwell times to the eyes relative to the mouth in SAD patients. Secondly, the three public speaking studies all reported that participants with SAD showed significantly less visual attention to faces than healthy controls in video-based situations (Chen, Clarke, MacLeod, Hickie, & Guastella, 2016; Chen, Thomas, Clarke, Hickie, & Guastella, 2015) and in a virtual environment (Kim et al., 2018) when giving a speech. Thirdly, considering interaction paradigms, three (Baker & Edelmann, 2002; Langer, Lim, Fernandez, & Rodebaugh, 2017; Monti et al., 1984) out of five studies reported that SAD patients exhibited avoidance of eye contact during naturalistic interaction (except Hofmann, Gerlach, Wender, & Roth, 1997; Vriends, Meral, Bargas-Avila, Stadler, & Bögels, 2017). Notably, the results of

several studies indicated that SAD patients avoid looking at faces in general, regardless of emotional valence (Byrow et al., 2016; Chen et al., 2016; Chen et al., 2015; Horley et al., 2003, 2004; H. Kim et al., 2018; Weeks et al., 2013).

As was noted, six studies were not in line with an avoidance pattern. Four of these studies used facial-viewing tasks. One visual search study reported that SAD patients showed increased fixation counts on faces than healthy controls in anxiety-provoking conditions (no difference in control conditions), where specific task requirements that participants need to search for certain facial stimuli may account for the greater frequency for ensuring correctness (Wermes et al., 2018a). Discrepant results from other three studies may be explained by relatively short presentation times. Whereas most studies presented facial stimuli for about 10 seconds, Boll et al. (2016) presented faces for three seconds and found that participants with SAD tended to focus longer on the eye-regions. Lavarov et al. (2016) presented matrices of 16 faces containing neutral and disgusted expressions for 6 seconds and observed longer dwell time on disgusted faces in SAD patients and participants with high but subclinical levels of social anxiety. Gamble and Rapee (2012) showed paired faces for 5-s and found initial vigilance for negative faces in SAD persons, but no group-differences in the later stage. Interestingly, Staugaard and Rosenberg (2011) also found different results with different presentation times. With a 3-s presentation duration, Staugaard and Rosenberg (2011) found increased attention to threatening faces in patients with SAD compared to controls, but this attentional bias was no longer shown when stimulus presentation duration was prolonged. In a 10-second trial, participants with SAD fixated less on threat than controls. Therefore, individuals with SAD seem to direct their attention to threat-related social cues while viewing faces when presentation times are relatively short.

The last two studies that were not in line with the avoidance pattern used an interaction paradigm and found no difference between SAD patients and controls in visual attention to social partners (Hofmann et al., 1997; Vriends et al., 2017). The results may be influenced by the specific measures and conditions of these studies. In the study by Hofmann et al. (1997), eye-contact was scored by an observer. Although three other studies found significant differences between SAD patients and controls with this method (Baker & Edelmann, 2002; Langer et al., 2017; Monti et al., 1984), it may be less precise than eye-tracking. Vriends et al. (2017) used a particular experimental set-up to investigate self-focused attention. Participants were simultaneously presented with a video of their interaction partner and a life-recording of themselves. Accordingly, SAD participants spent more time looking at themselves than control participants, whereas there was no group difference in confederate-regions.

Specific conditions were also relevant in two other interaction studies. Baker and Edelmann (2002) found that individuals with SAD made significantly less eye contact while talking in comparison to a non-anxious group, whereas no difference was observed while they were listening. Langer and colleagues (2017) asked participants to invite a close friend or romantic partner to take part in a set of social tasks together. The tasks consisted of three 10-minute conversations, respectively primed for social support, social conflict and social support. Their results showed that participants with SAD only made less eye contact than controls when the conversation was primed for conflict; no gaze avoidance was found in supportive conversations.

In summary, most studies with SAD patients show that they avoid looking at faces regardless of the type of social situation. The exceptions to this pattern were mostly due to much shorter presentation times and specific methodological factors. In social interactions, SAD patients may show normal eye-contact in specific social conditions.

Visual avoidance of faces in individuals with high levels of social anxiety

In contrast with the consistent results of studies with SAD patients across the three types of social situations, the results of studies with HSA individuals from community samples are more variable. Across all three types of social situations, nine out of 19 studies report a positive result for HSA and visual avoidance. Positive findings were most consistently found in studies with public speaking and interaction tasks, whereas negative findings were overrepresented in studies using facial-viewing tasks.

Firstly, three out of 12 studies with facial-viewing tasks observed the avoidant pattern. Five preferential looking studies found evidence for attentional bias to threat (i.e. faces expressing (negative) emotions) in HSA participants (Buckner, Maner, & Schmidt, 2010; Çek, Sánchez, & Timpano, 2016; Fernandes et al., 2018; Lange et al., 2011; Schofield, Johnson, Inhoff, & Coles, 2012). Four other preferential looking studies and one passive viewing study found no difference in gaze pattern between high and low socially anxious participants (Berdica, Gerdes, Bublatzky, White, & Alpers, 2018; Gregory, Bolderston, & Antolin, 2019; Mühlberger, Wieser, & Pauli, 2008; Waechter, Nelson, Wright, Hyatt, & Oakman, 2014). The different outcomes do not seem to be related to presentation times in these studies. One preferential looking study provides partial support for visual avoidance of faces in HSA participants (Taylor, Kraines, Grant, & Wells, 2019). They found indirect correlations between social anxiety and visual avoidance of faces, mediated by excessive reassurance seeking. Two emotion classification studies presented participants with face-body compounds, and noted that HSA persons avoided looking at faces but attending to the body for making judgments about emotions (D. H. Kim & Lee, 2016; Kret, Stekelenburg, de Gelder, & Roelofs, 2017).

Secondly, public speaking tasks were used in two studies comparing participants with high and low levels of social anxiety. Both found that HSA participants avoided looking at faces with positive facial expressions (Lin, Hofmann, Qian, Kind, & Yu, 2016; Lowe et al., 2012). However, Lin et al. (2016) found that HSA participants looked more at faces with negative expressions than low socially anxious participants, which could be interpreted as an attentional bias to threat. Thirdly, four out of five interaction studies found that HSA participants looked less at the eyes or face of their interaction partner than low socially anxious participants (Dechant, Trimpl, Wolff, Mühlberger, & Shiban, 2017; Farabee, Ramsey, & Cole, 1993; Hessels, Holleman, Cornelissen, Hooge, & Kemner, 2018; Howell, Zibulsky, Srivastav, & Weeks, 2016). Only one study using a semi-structured role-play task found no difference (Weeks, Heimberg, & Heuer, 2011). The participants were all males, who had to join the conversation of a male and a female confederate in the context of a party. The participant had to compete with the male confederate for the attention of the female confederate. The obvious task demand to make eye-contact may have been sufficient to produce this behavior in socially anxious males in this study. Alternatively, the precision of measurement may have been limited, because eye-contact with the female confederate was rated from video recordings by observers.

In summary, in more naturalistic social tasks – public speaking and social interaction – HSA individuals showed fairly consistent avoidant pattern. In contrast, HSA persons show an inconsistent gaze patterns when confronted with facial-viewing tasks.

Visual avoidance of faces in adults with shyness or fear of negative evaluation

Studies investigating gaze behavior in people with characteristics related to social anxiety, such as shyness and fear of negative evaluation, have exclusively used face-viewing tasks. The findings were similar to what we found for individuals with HSA: only four out of 10 studies with facial-viewing tasks reported a positive result for visual avoidance of faces in passive viewing (Grisham, King, Makkar, & Felmingham, 2015; Wieser, Pauli, Grosseibl, Molzow, & Mühlberger, 2010) as well as preferential looking tasks used with FNE adults (Garner, Mogg, & Bradley, 2006), and a face recognition task with a shy sample (Wang, Hu, Short, & Fu, 2012). In contrast, three passive viewing studies (Calvo, Gutiérrez-García, & Fernández-Martín, 2018; Gutiérrez-García, Calvo, & Eysenck, 2018; Wieser, Pauli, Alpers, & Mühlberger, 2009) and one preferential looking study (Liang, Tsai, & Hsu, 2017) reported attentional bias to threat in participants scoring high on FNE. Finally, two studies on FNE samples using preferential looking tasks found no differences in gaze behavior (Singh, Capozzoli, Dodd, & Hope, 2015; Wieser, Pauli, Weyers, Alpers, & Mühlberger, 2009).

In two studies, avoidance only occurred in specific conditions. Garner et al. (2006) reported that visual avoidance of emotional faces in people with fear of negative evaluation was only true in an anxiety-provoking situation (i.e. when participants were informed that they had to give a speech after the viewing task). Wieser and colleagues (2010) noted that women with high fear of negative evaluation avoided eye-contact with a virtual male, but only in a very specific situation: when a male avatar looked at them directly while standing far away. Shuhama, Del-Ben, Loureiro, and Graeff (2008) argued that the distance to a threat is an important factor in the selection of defensive responses in humans and animals. Avoidance of eye-contact could be seen as hiding, which is a frequent response to distant threats.

In summary, studies using visual tasks to compare participants scoring high and low on shyness or fear of negative evaluation have produced mixed findings. In these participants, visual avoidance of faces may be observed most reliably when the facial-viewing task has to be performed in a context of a social-evaluative threat such as an anticipated speech task. Further research with other tasks is needed to clarify whether people with characteristics related to social anxiety show gaze behavior comparable to those with HSA and SAD in more naturalistic social situations.

Visual avoidance and social anxiety in children and adolescents

To examine developmental effects in the relatively few studies conducted with participants aged 0-18 years (n = 10) we have organized this section primarily by age-group. Overall, gaze avoidance was reported in only three out of ten studies.

One study has been conducted on infants aged 7 - 13 months with high and low levels of shyness (Matsuda, Okanoya, & Myowa-Yamakoshi, 2013). It reported a positive correlation between shyness and visual attention to eye regions. Six out of seven studies on children (generally aged 7 - 12) found no evidence for avoidance. Four studies did not find differences between SAD and healthy control groups in either preferential looking tasks (Schmidtendorf, Wiedau, Asbrand, Tuschen-Caffier, & Heinrichs, 2018; Seefeldt, Krämer, Tuschen-Caffier, & Heinrichs, 2014) or role-play tasks with peers (Alfano, Beidel, & Turner, 2006; Spence, Donovan, & Brechman-Toussaint, 1999). Two other studies demonstrated maintenance of visual attention on the eyes in a face recognition task used with shy children (Brunet, Heisz, Mondloch, Shore, & Schmidt, 2009) and a social interaction task used with HSA children (Morgan & Banerjee, 2006). Only one study identified an avoidant tendency in a passive viewing task (Keil et al., 2018). Children with SAD looked less at the eyes in the last two seconds of a 10-s presentation duration than healthy and mixed anxiety disorder control groups, but the difference was only significant for girls. Finally, three studies focused on adolescents. Two studies found that adolescents with SAD (Alfano, Beidel,

& Turner, 2008) and HSA high school students (Daly, 1978) made significantly less eye contact in a face-to-face interaction compared to a healthy control group and LSA students, respectively. In contrast, Alfano et al. (2006) found no difference between adolescents with and without SAD in role-play tasks.

In summary, although gaze behavior in youth has received relatively little empirical attention, the available findings suggest that age possibly moderates the association between gaze patterns and social anxiety. That is, the gaze avoidant pattern may become more prominent during adolescence, whereas greater visual attention to faces may be more typical during early developmental periods.

DISCUSSION

The current review has examined the influence of three factors (i.e. severity of social anxiety, type of social situation, and development) on the relation between social anxiety and visual avoidance of faces. Four key results were found. First, adults with SAD exhibit visual avoidance of faces across all social situations. Second, in HSA persons, avoidance of faces depended on the type of situation. This group displayed consistent avoidance in public speaking and social interaction situations, but mixed results were found with face-viewing tasks. Third, facial-viewing tasks showed relatively consistent avoidance of faces in people with SAD, but not in people with high social anxiety or related characteristics. Fourth, although developmental data are scarce, the relation between social anxiety and visual avoidance of faces seems to emerge in adolescence. Some studies with socially anxious infants and children showed increased attention to faces instead.

Adults with SAD

Regarding people with SAD, visual avoidance of faces was remarkably consistent across the different types of social situations. Of the few studies that were not in line with this pattern, three reported attentional bias to threat in facial-viewing tasks (Boll et al., 2016; Gamble & Rapee, 2010; Lavarov et al., 2016). This may be related to their relatively short presentation times: 3 - 6 seconds, whereas the presentation times in the other studies varied from ten seconds to minutes. These findings complement a review of dot-probe studies with presentation times of no more than 1250 ms, which found evidence for attentional bias to threat in socially anxious individuals, but not for avoidance (Bantin et al., 2016). Although Chen and Clarke (2017) pointed out that no presentation time is exclusively associated with either vigilance or avoidance, the pattern found for adults with SAD in the present study is in line with the general

hypothesis that initial vigilance for threat is followed by avoidance (Schulze et al., 2013).

Severity of social anxiety

Visual avoidance of faces was less consistently observed in high socially anxious people from a community sample and people with characteristics related to social anxiety (i.e., strong fear of negative evaluation and shyness). Moreover, the type of situation seems to matter. In people with HSA, avoidance was observed in both public speaking studies and all but one social interaction study. In the facial-viewing tasks, however, vigilance, avoidance and no difference were found in equal proportions. As noted by Clark and Chen (2017), these results seemed unrelated to presentation times. Our findings suggest that people with HSA (without DSM diagnosis) differ from people with diagnosed SAD in that they only show avoidance of faces in naturalistic social situations.

A similar pattern may be hypothesized for people with characteristics related to social anxiety. Although their results on visual tasks were as divergent as in the HSA group, two of the studies that found avoidance of faces seem to have used facial-viewing tasks with heightened social threat (Garner et al., 2006; Wieser et al., 2010). This suggest that avoidance may be more likely to occur in naturalistic social situations. However, this possibility remains to be tested. As people with high FNE or shyness have not been studied in such situations, it is as yet unclear whether and to what extent their gaze behavior differs from people with HSA or SAD.

Type of social situation

The finding that people with SAD consistently avoid looking at faces in each type of situation suggests that they may lack the ability to make appropriate eye-contact, which is in line with social skill deficits theory (Levitan & Nardi, 2009). Such consistence across public speaking and social interaction, however, seems not to support the proposed distinction between structured and unstructured social situations (Levitan & Nardi, 2009; Voncken & Bögels, 2008). For example, Voncken and Bogel (2008) reported that patients with SAD were featured by actual social skills deficits during conversations but not in speaking tasks. Additionally, two interaction studies indicated that people with SAD did not avoid looking at faces during a conversation in a supportive atmosphere (as opposed to one primed for conflict; Langer et al., 2017) and when they only had to listen instead of doing the talking (Baker & Edelmann, 2002). These situations seem to pose minimal risk of negative evaluation. This flexibility of the gaze pattern could be taken as evidence against a strong version of the social skills deficit hypothesis. It is more in line with explanations concerning safety behavior (see Piccirillo, Taylor Dryman, & Heimberg, 2016 for a review). Alden and Bieling

(1998) demonstrated that another safety behavior, avoidance of self-disclosure, was demonstrated by people with SAD when they expected a high chance of negative evaluation, but not when they expected a low chance of negative evaluation (i.e. high versus low social-evaluative threat).

The level of social-evaluative threat may also explain the pattern of results found for HSA adults, who tended to show avoidance in naturalistic social situations, but not in facial-viewing tasks. Public speaking tasks and conversations often require people to disclose some personal information to strangers and they usually involve (the suggestion of) being watched by real people. Myllyneva and Hietanen (2015) noted that participant's knowledge of being the target of another individual's attention caused significantly greater autonomic and brain reactions compared to situations where participants believed others could not see them. Consequently, these situations would significantly enhance levels of anxiety and fear in HSA persons, leading to visual avoidance. Therefore, visual avoidance may be a temporary result of anxiety-provoking situations, which is in line with explanations concerning safety behavior (Piccirillo et al., 2016).

The results of a study including both SAD and HSA groups suggest that adults with HSA may be more sensitive to the level of social-evaluative threat than SAD patients. Vriends et al. (2017) used a conversation task in which the behavior of the confederate was friendly in some phases and critical in others. Gaze behavior of participants with SAD differed from that of control participants throughout the conversation, whereas HSA participants differed from low anxious participants when the confederate was being critical or had to led the conversation. In SAD patients, the threshold for perceiving social-evaluative threat may be so low that they show safety behavior in all but the safest situations. Yet this does not explain why they avoid looking at faces in non-interactive visual tasks. A general avoidant tendency might result from negative reinforcement learning, when they perceive not being overtly rejected as a consequence of not making eye-contact. Further research is needed to answer this question.

Development

Our review of studies on infants and children provided little evidence for visual avoidance of faces in relation to social anxiety. Some studies even demonstrated that shy or socially anxious infants and children tend to maintain attention on the eye-region. In a social interaction study, this was partly interpreted as excessive reassurance seeking from the adult confederate (Morgan & Banerjee, 2006). These findings suggest that gaze avoidance is not a manifestation of social anxiety in the early years. Regarding adolescence, however, two out of three studies provided evidence that socially anxious individuals avoid looking at faces during social interaction. These findings suggest

that the tendency of socially anxious adults to avoid faces may emerge in adolescence, which would be in line with longitudinal (Miers et al., 2014) and cross-sectional data (Sumter, Bokhorst, & Westenberg, 2009) concerning the development of avoidant tendencies at a general behavior level. However, more research is needed to draw any final conclusions about the development of visual avoidance of faces in socially anxious people.

Limitations and future directions

The present review complements previous ones by including studies from various experimental paradigms and by distinguishing between different levels of social anxiety and different age groups. In addition to eye-tracking studies, the current review included some interaction studies that used observer ratings of eye-contact. Visual avoidance of faces by people with SAD was found in 74% of eye-tracking studies and 75% percent of studies using observer ratings. Although the estimate is based on a smaller number of studies for observer ratings, it gives an indication that these studies add valid information about a type of social interaction situation that is underrepresented in eye-tracking studies and has relatively high ecological validity. The type of social situation seems to be an important factor in visual avoidance of faces, in particular for HSA adults.

Despite its merits, some limitations of this review should be noted. First, the review was restricted to fixation-based eye movement data (i.e., dwell time and fixation counts). These eye movement parameters were selected because they have been widely and consistently measured in relevant studies. However, other gaze parameters may be informative as well. Besides time-course parameters such as initial attention, gaze aversion may offer insights for understanding gaze behavior in socially anxious individuals. For example, Walters and Hope (1998) recorded the frequency with which participants looked away from each other's faces in social interactions. Future research could consider alternative parameters to derive a full profile of gaze behaviors related to social anxiety.

Second, the current review could not distinguish between visual avoidance of faces and avoidance of eye-contact in particular. There are some indications that these phenomena may not be equivalent (e.g., Dechant et al., 2017). In the current literature, however, few studies have measured fixations on the eye-region specifically. As the development of eye-tracking technology continues, opportunities to do so may arise in future.

Third, comparatively little research has been done with infants, children and adolescents. As a consequence, the present review could not investigate the influence

of severity of social anxiety and type of social situation in these age groups and interpretations of the development of the relation between social anxiety and visual avoidance of faces are only tentative. More research on younger populations is needed.

Fourth, the present review focused on visual avoidance of faces, because of its clinical significance and the existence of recent reviews covering attentional bias to threat. Future research may go beyond establishing avoidance and address the question of what socially anxious people look at instead. For example, the results of two studies presenting participants with face-body compounds (D. H. Kim & Lee, 2016; Kret et al., 2017) suggest that HSA participants rely more on the body than on the face for making judgments about emotions. This might reflect a compensatory strategy that still allows socially anxious people to obtain important social information. This pattern has however not yet been studied in patients with SAD.

Finally, the current review only considered studies reported in English. Although few publications in other languages were available in the leading databases, the overrepresentation of participants from Western cultures may hamper generalization of research findings to other parts of the world.

Clinical implications

The findings discussed in this review may have some clinical implications. First, they indicate that visual avoidance of faces is a well-validated behavioral marker of adults with SAD across multiple types of social situations. This justifies listing inappropriate eye-contact as a supporting feature of the disorder in the DSM-5 (APA, 2013). However, our findings also suggest that different definitions of "inappropriate" may apply to adults and children. Whereas clinicians are most likely to observe avoidance of eye-contact in social interactions with adults, they may notice excessive eye-contact in socially anxious children.

Second, avoidance of eye-contact may warrant attention in treatment of SAD. It has been discussed as both a causal and a maintaining factor of the disorder. Spence and Rapee (2016) pointed out that withdrawn behavior, including avoidance of eye-contact, could trigger negative reactions from others. These negative social outcomes could cause fear (and further avoidance) of social situations. Furthermore, avoidance of eye-contact could maintain social anxiety, because it prevents socially anxious people from disconfirming their negative beliefs about an interaction partner's attitude towards them (Clarke & Wells, 1995). In view of these potential contributions to the disorder, it seems important to change the gaze behavior of socially anxious individuals. Cognitive behavioral treatment programs with a strong skills component,

such as SET (Beidel, Turner, & Morris, 2000) and SASS (Masia Warner, Colognori, & Lynch, 2018) already address this aim.

The finding that gaze avoidance may not occur in social interactions when patients feel safe, suggests that the problem may also be addressed by cognitive restructuring. More realistic thinking about the level of social-evaluative threat involved in an interaction may reduce the need to avoid eye-contact (and use other safety behaviors) in SAD patients. At least, these findings indicate that making appropriate eye contact is not impossible for them.

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Table 1. *Study characteristics*

First Author (Year)	Participants N (M/FP)	Social Anxiety Symptoms	Social Anxiety Assessments	Type of Social Situations (specific tasks)	Gaze Behavioral Variables	Main Outcomes
Horley (2003)	15 GSP (38.27/47%) vs. 15 HC (38.4/47%)	SAD	SCID	face-viewing (passive viewing)	fixation duration & counts	SAD showed avoidance of faces as well as facial features (eyes, nose, mouth), whereas HC showed no effect
Horley (2004)	22 GSP (40.45/41%) vs. 22 HC (40/41%)	SAD	SCID	face-viewing (passive viewing)	fixation duration & counts	SAD showed avoidance of faces as well as eyes, whereas HC showed no effect
Moukheiber (2010)	26 SP (27.4/42%) vs.24 HC (26.9/42%)	SAD	MINI	face-viewing (passive viewing)	fixation duration & counts	SAD showed gaze avoidance
Moukheiber (2012)	26 SAD-FB (27.4/46%) vs. 26 SAD+FB (26.9/ 53%) vs. 24 HC (27.1/ 45%)	SAD	MINI	face-viewing (passive viewing)	fixation duration & counts	Gaze avoidance in SAD-FB when compared to SAD+FB and controls
Weeks (2013)	20 SAD (18.90/75%) vs. 15 NSAC (18.87/80%)	SAD	ADIS-IV-SP	face-viewing (passive viewing)	eye contact counts & duration	SAD showed global gaze avoidance to both positive and negative facial stimuli
Keil (2018)	31 SAD (11.85/48%) vs. 30 MAD (11.93/50%) vs. 32 HC (11.70/44%)	SAD	Kinder-DIPS	face-viewing (passive viewing)	eye contact duration	Groups did not differ in their dwell time to angry or neutral faces over the entire presentation time. Further, SAD girls and MAD girls spent less time on the eye regions compared to HC girls, no difference in boys.
Staugaard (2011)	8 SP (29.4/63%) vs.34 CP (26.2/53%)	SAD	ADIS-IV	face-viewing (passive viewing & preferential looking)	fixation duration & counts	SAD tended to show increased attention to briefly presented threatening faces. Whereas shorter fixation durations to the eyes of neutral, sad, disgust faces compared to HC in prolonged presentation tasks
Chen (2012)	32 SAD (23.52/31%) vs. 30 NAC (19.17/60%)	SAD	ADIS-IV	face-viewing (preferential looking)	fixation duration	SAD showed avoidance for all emotional stimuli, relative to NAC
Byrow (2016)	90 SAD (32.18/48%) vs. 23 NC (26.04/49%)	SAD	ADIS-IV	face-viewing (preferential looking)	fixation counts	SAD showed avoidance for all emotional stimuli, relative to NC
Schofield (2013)	19 SP (29.6/58%) vs. 20 NC (29.7/55%)	SAD	ADIS-IV-L	face-viewing (preferential looking)	fixation duration	SAD showed avoidance for all emotional stimuli, relative to NC

Table 1. *Continued*

First Author (Year)	Participants N (M/FP)	Social Anxiety Symptoms	Social Anxiety Assessments	Type of Social Situations (specific tasks)	Gaze Behavioral Variables	Main Outcomes
Gamble (2010)	59 SP (33.15/49%) vs. 28 NP (36.36/43%)	SAD	ADIS-IV	face-viewing (preferential looking)	fixation counts	SAD looked more at angry faces (vigilance) only in the first 500ms of each 5000ms trail, no group difference in later presentation
Lazarov (2016)	20 SAD (35.15/60%) vs. 20 HSA (22.85/70%) vs. 20 LSA (22.05/70%)	SAD & SA	MINI & LSAS	face-viewing (preferential looking)	fixation duration	SAD and HSA looking longer at threated faces, relative to non-anxious group
Seefeld (2014)	30 SP (9.9/43%) vs. 42 HC(9.9/45%)	SAD	Kinder-DIPS	face-viewing (preferential looking)	fixation duration	No group differ over time. All children showed same pattern of attentional distribution over 3000 ms presentation.
Schmidtendorf (2018)	37 SAD(11.4/62.2%) vs. 42 HC (11.5/59.5%)	SAD	Kinder-DIPS	face-viewing (preferential looking)	fixation duration	There were no differences between groups
Wermes (2018b)	SAD: 36 without state anxiety (30.8/72%) & 31 with state anxiety (29.6/65%) vs. HC: 32 without (29.8/62%) & 30 with (29.8/70%)	SAD	SCID-I	face-viewing (visual search)	fixation duration	SAD showed avoidance for threatening faces, relative to HC
Wermes (2018a)	61 SAD: 30 without state anxiety (30.1/88%) & 30 with state anxiety (29.4/70%) vs. 60 HC: 30 without (30.1/63%) & 30 with (29.2/63%)	SAD	SCID-I	face-viewing (visual search)	fixation counts	Compared to HC, SAD showed increased fixation counts only in anxiety induction conditions. Whereas no difference in control conditions
Boll (2016)[a]	22 SP (32.18/45%) vs. 22 HC (31.91/45%)	SAD	ICD-10	face-viewing (emotion classification)	fixation duration	No evidence for a later avoidance of eye gaze during the entire 3 s stimulus presentation interval, SAD even exhibited more attention to the eyes relative to mouths
Chen (2015)	22 SAD (25.24/32%) vs. 19 CP (23.78/42%)	SAD	ADIS-IV	public speaking	fixation counts & duration	SAD showed a significantly increased attention towards background, suggesting avoidance of audience

Table 1. *Continued*

First Author (Year)	Participants N (M/FP)	Social Anxiety Symptoms	Social Anxiety Assessments	Type of Social Situations (specific tasks)	Gaze Behavioral Variables	Main Outcomes
Chen (2016)	SAD (25.24/26%) vs. CP (23.78/62%)	SAD	ADIS-IV	public speaking	fixation duration	SAD showed less total fixation time at emotional faces, while no differences in neutral or non-face regions
Kim (2018)	79 SAD (23.5/49.4%) vs. 51 HC (24/47.1%)	SAD	unknown	public speaking	fixation counts	SAD showed a marginal significance less at screen containing audience compared to HC
Hofmann (1997)	50 (46.4/59%): 24 SP + PSA vs. 25 NP	speech phobia	SCID	interaction	eye contact counts & duration	No group differences in the three tasks
Baker (2002)	18 SP (42.3/78%) vs. 18 AD (48.3/89%) vs. 18 NC (50.9/83%)	SAD	SCID 1	interaction	eye contact counts & duration	SP showed avoidance of eye contact while talking phrase but not listening phrase, relative to NC
Langer (2017)	114 (39.06/71.9%): 65 GSAD vs. 49 NOSAD	SAD	SCID-IV	interaction	fixation duration	SAD made less eye contact during a conversation primed for conflict (not in supportive circumstances)
Monti (1984)	27 male college students vs. 37 patients	SAD	unknown	interaction	rating scale	significant less eye-contact in patients, relative to healthy samples.
Vriends (2017)	Expe 1: 25 HSA (23.27/100%) vs. 26 LSA (23.24/100%). Expe 2: 32 SAD (22.41/100%) vs. 30 NOSAD (23/100%)	SA & SAD	SPS & DIPS	interaction	fixation duration	No any group differences in confederate-regions
Alfano (2006)	50 SP (11.94/ 44%) vs. 30 NC (11.87/ 57%)	SAD	ADIS-C	interaction	eye contact counts	No difference between age or group
Alfano (2008)	21 SP (14.05/43%) vs. 42 HC : 21 IMAG (13.43/48%) vs. 21 controls (13.29/62%)	SAD	ADIS-C/P	interaction	eye contact counts	SP made less eye-contact than HC during a social interaction.
Spence (1999)	27 SP (10.93/56%) vs. 27 NC (11/56%)	SAD	ADIS-C-P	interaction	eye contact counts	No significant differences between SP and NC for eye-contact
Gregory (2018)	105 (19.91/84%): 27 HSA vs. 27 LSA	SA	LSAS	face-viewing (passive viewing)	fixation duration & counts	No group difference in terms of fixation number, fixation duration over the whole trail.

Table 1. *Continued*

First Author (Year)	Participants N (M/FP)	Social Anxiety Symptoms	Social Anxiety Assessments	Type of Social Situations (specific tasks)	Gaze Behavioral Variables	Main Outcomes
Taylor (2019)	79 (19.79/57.5%)	SA	SIAS-6; SPS-6	face-viewing (passive viewing)	fixation duration	SA had an indirect effect on attention bias to disgust faces through increased reassurance seeking. Moreover, negative correlations between total fixation to sad and disgust faces, somehow indicating avoidance of threat
Bucker (2010)	46 (20.02/65%). 23 HSA vs. 23 LSA	SA	SIAS	face-viewing (preferential looking)	fixation duration	HSA tended to show disengagement difficulty from social threat
Cek (2016)	55 (19.13/45%)	SA	SIAS	face-viewing (preferential looking)	fixation duration	HSA tended to look at threatening faces
Schofield (2012)	42 (19.2/54.8%)	SA	SIAS	face-viewing (preferential looking)	fixation duration	Positive correlations between SA and attention to emotional faces over time, and difficulty disengagement from angry faces
Lange (2011)	43 (82.6%) : 22 SA (24.2) vs. 21 NAC (23.6)	SA	LSAS-A	face-viewing (preferential looking)	fixation duration & counts	SA tended to look at angry faces than NACs did.
Fernandes (2018)	19 HSA (21.11/89%) vs. 19 LSA (21.84/63%)	SA	AASPI	face-viewing (preferential looking)	fixation duration	No group difference in total dwell time, but HSA showed slower disengagement from happy faces in terms of time-course dwell time
Mulberger (2008)	26 (19-36/54%)	SA	SPAI	face-viewing (preferential looking)	fixation duration	No effects in terms of sustained attention
Waechter (2014)	40 LSA vs. 41 HSA	SA	SIAS	face-viewing (preferential looking)	fixation duration & counts	There were no significant differences
Berdica (2018)	70 (27.21/84%)	SA	SPIN	face-viewing (preferential looking)	fixation duration & counts	There were no any correlations between SA and eye movement indices
Kim (2016)	22 SA (22.05/50%) vs. 22 HC (20.64/50%)	SA	SADS & BFNE2	face-viewing (emotion classification)	fixation duration	SA looked less at faces and longer at body than HC
Kret (2017)	23 HSA (21.87/83%) vs. 23 LSA (22.29/43%)	SA	LSAS-A	face-viewing (emotion classification)	fixation duration	HSA tended to look at hand-regions compared to LSA
Lin (2017)	22 HSA (23.89/41%) vs. 22 LSA (22.75/59%)	SA	SIAS	public speaking	fixation counts & duration	HSA spent more time looking at negative audience and less time on positive ones, compared to LSA.

Table 1. *Continued*

First Author (Year)	Participants N (M/FP)	Social Anxiety Symptoms	Social Anxiety Assessments	Type of Social Situations (specific tasks)	Gaze Behavioral Variables	Main Outcomes
Lowe (2012)	16 stutter (36.7/18.8%) vs. 16 non-stutter (38.2/18.8%)	stutter	SPAI	public speaking	fixation counts & duration	Participants who stutter looked less time and less often to audience members on a television screen than controls
Dechant (2017)	18 HSA (20.44/83.3%) vs. 19 LSA (23.11/52.6%)	SA	LSAS	interaction	fixation duration	HSA looked shorter on faces than LSA
Hessels (2018)	96 (24.52/52%)	SA	SAS	interaction	fixation duration & counts	SAD traits was negatively correlated with total dwell time at the eyes
Howell (2016)	20 (19.15/100%)	SA	LSAS	interaction	fixation duration & counts	Trait social anxiety was inversely related to eye contact duration and frequency averaged across the 4-min interaction.
Farabee (1993)	20 HSA (unknown /100%) vs. 20 LSA (unknown/100%)	SA	social anxiety subscale of the Self-Consciousness Scale….	interaction	eye contact counts & duration	HSA looked less at the other participants both in terms of total gaze duration and average gaze duration, compared to LSA. Moreover, HSA tend to avoid looking at disagreeing confederate, while LSA tend to look at disagreeing people
Weeks (2011)	48 (20.27/0)	SA	SIAS-S	interaction	Eye contact duration	No difference in gaze avoidance indices
Daly (1978)	36 (seconds and third-year high school students/50%)	SA	SADS	interaction	eye contact duration	HSA tended to make less eye contact while talking, but no difference in listening phase between high and low SA groups
Morgan (2006)	28 HSA (12.8/57%) vs. 28 LSA (12.5/36%)	SA	SAS-A	interaction	eye contact counts	HSA made significantly more eye contact than LSA children, particularly on the negative scenarios
Matsuda (2013)	57 (9.8 month/60%)	shyness	CCTI	face-viewing (passive viewing)	fixation duration	Positive correlations between shyness and dwell time on eyes
Grisham (2015)	29 HSA (18.93/36%) vs. 28 LSA (20.68/23%)	FNE	BFNE	face-viewing (passive viewing)	fixation duration	HSA exhibited significantly shorter dwell time on faces (negative, neutral but not happy), compared to LSA

Table 1. *Continued*

First Author (Year)	Participants N (M/FP)	Social Anxiety Symptoms	Social Anxiety Assessments	Type of Social Situations (specific tasks)	Gaze Behavioral Variables	Main Outcomes
Calvo (2018)	24 HSA (19-25/63%) vs. 24 LSA (19-25/63%)	FNE	BFNE	face-viewing (passive viewing)	fixation counts	HSA looked longer at the eye region than LSA, who looked longer at mouth regions
Gutierrez-Garcia (2018)	25 HSA (21.71/60%) vs. 24 LSA (22.12/63%)	FNE	BFNE	face-viewing (passive viewing)	fixation counts & duration	HSA looked longer at the eye region than LSA, who looked longer at mouth region
Wieser (2009)	45 (21.5/100%): 21 LSA vs. 17 MSA vs.18 HSA	FNE	BFNE	face-viewing (passive viewing)	fixation duration	HSA looked longer at eye regions than MSA and LSA, regardless of gaze directions during free viewing condition.
Wieser (2010)	19 HSA (21.9/100%) vs. 20 LSA (22.3/100%)	FNE	BFNE	face-viewing (passive viewing)	fixation duration	HFNE showed avoidance of eye contact only in specific virtual condition
Singh (2015)	91 (20.4/52.7%)	FNE	BFNE	face-viewing (preferential looking)	fixation duration & counts	No group difference in terms of run count, dwell time as well as dwell time bias with/ without state anxiety induction
Wieser (2009)	HFNE (20.7/100%) vs. LFNE (24.6/100%)	FNE	BFNE	face-viewing (preferential looking)	fixation duration	HFNE looked at the emotional faces longer during the first second of stimulus exposure, whereas the avoided these faces in the consecutive time interval from 1 to 1.5 s. However, this avoidance did not sustain. There were no significance during the following time intervals (3 s trail)
Garner (2006)	Exper 1: 16 LSA (20.8/94%) VS. 16 HSA (20.3/87%). Exper 2: 16 LSA (21.7/67%) vs.16 HSA (22.4/94%)	FNE	BFNE	face-viewing (preferential looking)	fixation duration	HFNE showed reduced maintenance of attention on emotional faces compared to LFNE ones, who looked longer at emotional than neutral faces only in a anxiety-induction condition
Liang (2017)	32 SA (18.66/75%) vs. 30 NA (19.27/73.3%)	FNE	BFNE	face-viewing (preferential looking)	fixation duration	SA tended to look at angry faces than the NA group
Wang (2010)	30 (20.17/60%)	shyness	CBSS	face-viewing (face recognition)	fixation duration	Negative correlations between shyness level and fixation proportion on eyes

Table 1. *Continued*

First Author (Year)	Participants N (M/FP)	Social Anxiety Symptoms	Social Anxiety Assessments	Type of Social Situations (specific tasks)	Gaze Behavioral Variables	Main Outcomes
Brunet (2009)	28 (11.14/50%)	shyness	CCTI	face-viewing (face recognition)	fixation counts & duration	Positive correlations between shyness and dwell time on eyes

Note. AASPI = Scale of Anxiety and Avoidance in Social Performance and Interaction; AD = anxiety disorder but not social phobia; ADIS-C = Anxiety Disorders Interview Schedule for Children for DSM-IV; ADIS-C-P = Anxiety Disorders Interview Schedule for Children - Parent Version; ADIS-IV = Anxiety Disorder Interview Schedule for adults; ADIS-IV-L = Anxiety Disorders Interview Schedule; ADIS-IV-SP = Anxiety Disorders Interview Schedule for DSM-IV; Social Phobia subsection; BFNE = Brief Fear of Negative Evaluation scale; BFNE2 = Brief Version of the Fear of Negative Evaluation 2; CBSS = Revised Cheek and Buss Shyness Scale; CCTI = Colorado Children Temperament Inventory; CP = control participants; DIPS = Diagnostisches Interview bei psychischen Störungen; FNE = fear of negative evaluation; FP = female percentage; GSAD = generalized social anxiety disorder; GSP = generalized social phobia; HC = healthy controls; HFNE = high levels of fear of negative evaluation; HSA = high social anxiety; ICD 10 = 10th revision of the International Statistical Classification of Diseases and Related Health Problems; Kinder-DIPS = Anxiety Disorders Interview Schedule for children; LFNE = low levels of fear of negative evaluation; LSA = low social anxiety; LSAS = Liebowitz Social Anxiety Scale; LSAS-A = LSAS anxiety subscale; M = mean age; MAD = mixed anxiety disorders; MINI = Mini International Neuro-psychiatric Interview; MSA = medium social anxiety; N = sample size; NA = non-anxious; NAC = non-anxious controls; NC = nonclinical controls; NP = non phobic; NOSAD = nonsocial anxiety disorder; NSAC = non socially anxious controls; SA = social anxiety; SAD = social anxiety disorder; SADS = Social Avoidance and Distress Scale; SAD-FB = social phobia and no fear of blushing; SAD + FB = social phobia and fear of blushing; SAS = Social Anxiety Scale; SAS-A = Social Anxiety Scale for Adolescents; SCID = Structured Clinical Interview for DSM-IV; SCID-I = Structured Clinical Interview for DSM-IV; SCID-IV = Structured Clinical Interview for Diagnostic and Statistical Manual-IV; SIAS = Social Interaction Anxiety Scale; SIAS-6; SPS-6 = Social interaction anxiety scale and social phobia scale – short forms; SIAS-S = Social Interaction Anxiety Scale-Straightforward Scale; SP = social phobia; SP+PSA = social phobia with public speaking anxiety; SPAI = Social Phobia Anxiety Inventory; SPAI = Social Phobia and Anxiety Inventory; SPS = Social Phobia Scale; SPIN = Social Phobia Inventory.

[a] This study conducted two experiments. We only extracted the eye gaze data from reported experiment 1 because it examined gaze behavior towards faces while not in the second experiment.