

# Die Relevanz emotionalen Lernens als Mechanismus für die Entstehung und Behandlung der Sozialen Angststörung

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Grainau, 21.02.2023

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# 1. Überblick

Zur Erforschung der Relevanz emotionaler Lernprozesse für die Entstehung und Behandlung der Sozialen Angststörung (SAD) werden in der vorliegenden Arbeit die Ergebnisse dreier Studien vorgestellt, die sich mit emotionalen Reaktionen und Verarbeitungsprozessen in Zusammenhang mit sozial bedrohlichen Erlebnissen beschäftigen. Während der zugrundeliegende Mechanismus des emotionalen Lernens selbst (z.B. in Form von Konditionierung) in dieser Arbeit nicht explizit untersucht wurde, stehen insbesondere begleitende und resultierende Reaktionen emotionaler Prozesse (z. B. aktuelles emotionales Erleben während der Imagination [auslösender] sozial bedrohlicher Erlebnisse) im Zentrum dieser Arbeit. Zunächst werden in der Einleitung die bisherigen Forschungsergebnisse überblicksartig zusammengefasst. Im Anschluss werden die Fragestellungen vorgestellt und vor dem Hintergrund der bisherigen Befundlage eingeordnet. Untersucht wurde die emotionale Reaktivität während der Imagination ätiologisch relevanter sozial bedrohlicher Erinnerungen bei PatientInnen mit SAD (Seinsche et al., 2023a), die Bedeutung retrospektiv berichteter dysfunktionaler Verarbeitungsstrategien nach sozial bedrohlichen Erlebnissen für die Entstehung sozialer Ängste in einer unselektierten Stichprobe (Seinsche et al., 2022) sowie die Veränderungen der emotionalen Reaktivität hinsichtlich sozial bedrohlicher Erinnerungen nach einer Sitzung der psychotherapeutischen Intervention Imagery Rescripting bei gesunden Personen (Seinsche et al., 2023b). Zunächst wird die Methodik der genannten Studien beschrieben sowie die Ergebnisse hinsichtlich der für diese Dissertation formulierten Fragestellungen dargestellt. Diese Ergebnisse werden in der abschließenden Diskussion vor dem Hintergrund der bisherigen Literatur eingeordnet und kritisch diskutiert.

## 2. Einleitung

Die SAD ist durch eine unverhältnismäßig starke Angst vor sozialen Situationen gekennzeichnet, in denen eine Beurteilung durch andere Personen erfolgen könnte (American Psychiatric Association, 2013). Mit einer Lebenszeitprävalenz von ca. 12 % ist sie eine der häufigsten psychischen Erkrankungen und sorgt aufgrund der funktionellen Beeinträchtigungen (wie erhöhte Schulabbruchraten, geringere Erwerbstätigkeit) nicht nur zu einem massiven Leidensdruck der Betroffenen, sondern auch zu einem hohen volkswirtschaftlichen Schaden (American Psychiatric Association, 2013; Bandelow & Michaelis, 2015; Kessler et al., 2005). Kognitive Erklärungsmodelle der SAD gehen davon aus, dass insbesondere negativ verzerrte Vorstellungsbil-

der von sich selbst eine entscheidende Rolle für die Entstehung und Aufrechterhaltung der Störung spielen (Clark & Wells, 1995; Heimberg et al., 2010). Die gedankliche oder tatsächliche Konfrontation mit sozialen Situationen führt zu einer Aktivierung dieser negativ verzerrten Vorstellungsbilder und erhöht schließlich die subjektive Wahrscheinlichkeit, von anderen Personen negativ bewertet zu werden (Clark & Wells, 1995; Heimberg et al., 2010). In der Folge setzen viele PatientInnen mit SAD dysfunktionale Bewältigungsmechanismen wie unter anderem eine ungünstige antizipatorische und nachträgliche Verarbeitung dieser Situationen ein, die schließlich zu einer Aufrechterhaltung der Störung beitragen (Clark & Wells, 1995; Heimberg et al., 2010).

Prozesse, die zur Entstehung der verzerrten Vorstellungsbilder beitragen, sind entsprechend auch für die Erforschung der multifaktoriellen Genese der SAD von großer Relevanz (z. B. Erwin et al., 2006; Norton & Abbott, 2017a). Ätiologische Modelle der SAD gehen davon aus, dass aversive sozial bedrohliche Erfahrungen im Kindes- und Jugendalter mit der Entwicklung von verzerrten Vorstellungsbildern in Zusammenhang stehen, die bis ins Erwachsenenalter persistieren (Beidel & Turner, 2007; Norton & Abbott, 2017a, 2017b; Rapee & Spence, 2004; Spence & Rapee, 2016). So berichten viele PatientInnen mit SAD, dass sie sozial bedrohliche Erfahrungen erlebt haben (wie z. B. von Gleichaltrigen gehänselt werden), die zeitlich mit dem Beginn der Störung zusammenhängen (Erwin et al., 2006; Hackmann et al., 2000; Norton & Abbott, 2017a; Öst & Hugdahl, 1981). Wie Intrusionen bei PatientInnen mit Posttraumatischer Belastungsstörung (PTBS) werden die mit diesen Ereignissen assoziierten negativ verzerrten Vorstellungsbilder häufig ungewollt wiedererlebt und insbesondere in sozialen Situationen getriggert (Bjornsson et al., 2020; Carleton et al., 2011; Erwin et al., 2006; Hackmann et al., 2000; Moscovitch et al., 2018). Emotionale Lernprozesse scheinen hier ähnlich wie bei der PTBS eine große Rolle zu spielen (Ehlers & Clark, 2000; Erwin et al., 2006; Hackmann et al., 2000). So wird vermutet, dass es während der auslösenden sozial bedrohlichen Situation zu einer assoziativen Verknüpfung zwischen der ursprünglich neutralen sozialen Situation und dem ausgeprägten negativen Empfinden kommt (Hackmann et al., 2000; Öst & Hugdahl, 1981; Stemberger et al., 1995). Bei einer erneuten Konfrontation mit sozialen Situationen werden assoziierte Emotionen und Kognitionen wieder hervorgerufen (Erwin et al., 2006; Hackmann et al., 2000). Auch eine veränderte Repräsentation der sozial bedrohlichen Erfahrung im Gedächtnis könnte ähnlich wie bei der PTBS einen weiteren kritischen Faktor für die Entstehung der verzerrten Vorstellungsbilder darstellen (Brewin et al., 1996; Foa & Kozak, 1986; Sansen

et al., 2015). So könnten die sozial bedrohlichen Erfahrungen nach Langs Bioinformationstheorie (1979) in Form eines assoziativen Netzwerks abgespeichert worden sein, wodurch es möglicherweise zu einer Reaktivierung der ursprünglichen emotionalen und physiologischen Reaktionen kommt, wenn das Netzwerk aktiviert wird (z. B. Sansen et al., 2015). Obwohl sozial bedrohliche Erlebnisse eine wichtige Rolle in der Ätiologie der SAD spielen, gibt es bisher nur wenige Studien, die sich mit der Repräsentation dieser Erlebnisse im Gedächtnis beschäftigen. Bisherige Studien konnten zeigen, dass PatientInnen mit SAD während der Erinnerung an diese Erlebnisse subjektiv mehr negative Gefühle und Belastung berichten sowie eine stärkere physiologische Erregung (in Form einer erhöhten Hautleitfähigkeit) zeigen (z. B. Bjornsson et al., 2020; Erwin et al., 2006; Moscovitch et al., 2018; Sansen et al., 2015). Diese erhöhte emotionale Reaktivität während der Reaktivierung der sozial bedrohlichen Erinnerung könnte einen Indikator für die vermutete ungünstige Gedächtnisrepräsentation in Form eines assoziativen Netzwerkes darstellen (z. B. Sansen et al., 2015). Eine Replikation bzw. weiterführende Untersuchung dieser Befunde sowie eine Untersuchung des Zusammenhangs dieser mit assoziierten posttraumatischen Stresssymptomen könnte weitere Hinweise auf die Repräsentation der sozial bedrohlichen Erlebnisse im Gedächtnis und deren Bedeutung für die Entstehung klinischer Symptome liefern.

Neben der mangelhaften Einspeicherung der traumatischen Erfahrungen im Gedächtnis spielen bei der PTBS insbesondere dysfunktionale Bewältigungsstrategien während und nach der traumatischen Erfahrung eine wichtige Rolle für die Entstehung der Symptomatik (Brewin et al., 2010; Ehlers & Clark, 2000; Ehlers & Steil, 1995; Turliuc et al., 2015). Diese Strategien dienen der kurzfristigen Ablenkung der Aufmerksamkeit von negativen Gefühlen, führen jedoch langfristig zu einer Verhinderung einer adäquaten Verarbeitung der Situation und schließlich der Integration ins Langzeitgedächtnis (Ehlers & Clark, 2000; Ehlers & Steil, 1995; Michael et al., 2007; Turliuc et al., 2015). Wie bereits im ersten Absatz beschrieben, nutzen auch PatientInnen mit SAD nach sozialen Situationen ungünstige Bewältigungsstrategien wie Rumination oder Gedankenunterdrückung, die meist unter dem Begriff "Post-event Processing" zusammengefasst werden und eine Aufrechterhaltung der Symptomatik fördern (Dannahy & Stopa, 2007; Kocovski et al., 2005; McEvoy & Kingsep, 2006; Mellings & Alden, 2000; Rachman et al., 2000). Ähnlich wie bei der PTBS scheint der Einsatz dysfunktionaler Verarbeitungsstrategien auch bei der SAD mit der Entwicklung von intrusivem Wiedererleben und negativen Kognitionen hinsichtlich aktueller sozial bedrohlicher Situationen einherzugehen (Abbott & Rapee, 2004; Makkar & Grisham, 2011; McEvoy & Kingsep, 2006;

Perini et al., 2006; Rachman et al., 2000). Aufgrund der Bedeutung von “Post-event Processing” für die Aufrechterhaltung der SAD sowie den ätiologischen Ähnlichkeiten zur PTBS liegt die Vermutung nahe, dass eine dysfunktionale Verarbeitung von sozial bedrohlichen Erfahrungen auch für die Entstehung der SAD eine Rolle spielen könnte. Bisher gibt es jedoch noch keine Studien, die diesen Zusammenhang untersucht haben.

Die Erforschung ätiologischer Faktoren für die Genese psychischer Erkrankungen führt nicht nur zu einem verbesserten Verständnis der jeweiligen Störungsbilder, sondern führt auch zu Innovationen in der psychotherapeutischen Behandlung (z. B. Stangier et al., 2003). So wurden zur Behandlung von Störungsbildern, in deren Ätiologie das Erleben aversiver oder sogar traumatischer Erfahrungen eine Rolle spielt, psychotherapeutische Interventionen wie z. B. Imagery Rescripting entwickelt (Arntz et al., 2007; Arntz & Weertman, 1999; Smucker & Niederee, 1995). Das Ziel dieser Intervention ist die Bearbeitung der aversiven Erinnerung, um deren Einfluss auf die aktuelle Symptomatik zu reduzieren (Arntz & Weertman, 1999). In einem dreistufigen Vorgehen werden die aversiven Erfahrungen zunächst möglichst lebhaft aus der Perspektive des früheren Ichs der PatientInnen wiedererlebt (z. B. Wild et al., 2007). In einer zweiten Phase stellen sich die PatientInnen vor, dass sie die gleiche Situation aus ihrer aktuellen Perspektive beobachten und haben schließlich die Möglichkeit, einzugreifen und die Situation so zu verändern, dass es ihrem früheren Ich dabei besser geht. Schließlich versetzen sich die PatientInnen in einer dritten Phase wieder in die Perspektive ihres früheren Ichs hinein und erleben die Situation diesmal mit den in der zweiten Phase etablierten Veränderungen. Bisherige Studien konnten zeigen, dass eine einzelne Sitzung Imagery Rescripting einer sozial bedrohlichen Erinnerung zu einer Reduktion der sozialen Ängstlichkeit bei PatientInnen mit SAD führt (z. B. Lee & Kwon, 2013; Nilsson et al., 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Wild et al., 2007, 2008). Obwohl bisher noch unklar ist, wie genau Imagery Rescripting wirkt, scheinen auch hier emotionale Lernprozesse eine große Rolle zu spielen. So nimmt die Theorie der Devaluation des unconditionierten Stimulus (Arntz, 2011; Davey, 1989) an, dass Imagery Rescripting zu einer veränderten Bedeutung der Repräsentation der sozial bedrohlichen Erinnerung im Gedächtnis führt. Diese könnte schließlich die Verknüpfung zwischen dem ursprünglich neutralen Stimulus (soziale Situation) und dem negativen emotionalen Empfinden auflösen oder abschwächen, sodass aktuelle soziale Situationen nicht mehr als Trigger für assoziierte emotionale und kognitive Prozesse fungieren. Entsprechend konnten bereits einige Studien zeigen, dass Imagery Rescripting zu einer Veränderung des subjektiven emotionalen Erlebens, wie z. B. einer Reduktion der Belastung hinsichtlich der

sozial bedrohlichen Erinnerung führt (Arntz et al., 2007; Kunze et al., 2019; Lee & Kwon, 2013; Nilsson et al., 2012; Romano et al., 2020; Siegesleitner et al., 2019; Strohm et al., 2019; Wild et al., 2007). Psychophysiologische Marker dieser Veränderungsprozesse wurden jedoch bisher nur in wenigen Studien untersucht, obwohl subjektive Beschreibungen von Gefühlszuständen von Inhibitionsprozessen, sozialer Erwünschtheit oder auch der mangelnden Wahrnehmung emotionaler Zustände beeinflusst werden können (Lang et al., 1983; Lang et al., 1993). Eine aktuelle Studie untersuchte die Effekte von Imagery Rescripting eines belastenden Lebensereignisses auf psychophysiologische Reaktionen während der Erinnerung an die bearbeitete Situation in einer gesunden Stichprobe (Strohm et al., 2021). Es konnte gezeigt werden, dass Imagery Rescripting zu einer Reduktion der physiologischen Erregung (Herzrate) und negativen Valenz (Aktivierung des Corrugator supercilii) führte, diese jedoch nicht stärker war als die Effekte einer Kontrollintervention (Imagination positiver Situationen). Welche Auswirkungen Imagery Rescripting einer sozial bedrohlichen Erinnerung auf die psychophysiologische Reaktivität während der Imagination der bearbeiteten Situation hat, wurde bisher noch nicht untersucht.

### 3. Fragestellungen

In der vorliegenden Dissertation werden drei Hauptfragestellungen bearbeitet, die in drei verschiedenen Studien untersucht wurden.

#### **Fragestellung 1:**

Viele PatientInnen mit SAD berichten von verzerrten Vorstellungsbildern von sich selbst, die mit sozial bedrohlichen Erlebnissen aus ihrer Kindheit/Jugend assoziiert sind und in aktuellen Situationen ungewollt wiedererlebt werden (Bjornsson et al., 2020; Erwin et al., 2006; Hackmann et al., 2000). Es wird vermutet, dass es ähnlich wie bei der PTBS zu einer ungünstigen Repräsentation der sozial bedrohlichen Erlebnisse im Gedächtnis kommt, die zur Entwicklung der verzerrten Vorstellungsbilder sowie weiterer posttraumatischer Stresssymptome beitragen (Bjornsson et al., 2020; Ehlers & Clark, 2000; Erwin et al., 2006; Hackmann et al., 2000; Sansen et al., 2015). Eine stärkere emotionale Reaktivität könnte einen Indikator für eine ungünstige Repräsentation der Erinnerung in Form eines assoziativen Netzwerkes darstellen (Lang, 1979). Inwieweit die Gedächtnisrepräsentation ätiologisch relevanter sozial bedrohlicher Erinnerungen bei PatientInnen mit SAD tatsächlich Auffälligkeiten im Vergleich zu gesunden Personen aufweist und ob diese mit posttraumatischen Stresssymptomen zusammenhängen, ist bisher jedoch noch unklar.

Hierzu wurde in Studie 1 (Seinsche et al., 2023a) folgende Fragestellung untersucht: Weisen PatientInnen mit SAD eine stärkere negative emotionale Reaktivität (Selbstbericht, Psychophysiologie) während der Reaktivierung der Erinnerung an ein ätiologisch relevantes sozial bedrohliches Erlebnis auf als gesunde Personen und ist diese Reaktion mit der Stärke posttraumatischer Stresssymptome hinsichtlich desselben Erlebnisses assoziiert?

### **Fragestellung 2:**

Obwohl sozial bedrohliche Erlebnisse als Risikofaktor für die Entstehung der SAD gelten (Rapee & Spence, 2004; Spence & Rapee, 2016), scheint das Erleben einer solchen Erfahrung nicht spezifisch für PatientInnen mit SAD zu sein, da auch viele gesunde Personen solche Erlebnisse berichten (Bjornsson et al., 2020; Erwin et al., 2006). Ähnlich wie bei der PTBS spielen möglicherweise bestimmte Begleitfaktoren, wie eine ungünstige Verarbeitung dieser Ereignisse eine wichtige Rolle für die Entstehung der Symptomatik (Ehlers & Clark, 2000). Ätiologische Modelle der PTBS gehen davon aus, dass dysfunktionale Verarbeitungsstrategien die adäquate Einspeicherung des Erlebnisses ins Langzeitgedächtnis verhindern und so die Entstehung von intrusivem Wiedererleben sowie Trauma-assoziierten negativen Kognitionen fördern (Ehlers & Clark, 2000; Ehlers & Steil, 1995). Bisher gibt es noch keine empirischen Befunde hinsichtlich dieser Zusammenhänge bei der SAD.

Studie 2 (Seinsche et al., 2022) beschäftigte sich dementsprechend mit folgender Fragestellung: Gibt es einen Zusammenhang zwischen dysfunktionalen Verarbeitungsstrategien nach ätiologisch relevanten sozial bedrohlichen Erlebnissen, der Entstehung von intrusivem Wiedererleben und sozialphobischen Kognitionen sowie Angst vor negativer Bewertung?

### **Fragestellung 3:**

Imagery Rescripting ist eine vielversprechende psychotherapeutische Intervention für die Behandlung der SAD (z. B. Norton & Abbott, 2016; Reimer & Moscovitch, 2015). Eine besondere Bedeutung könnte hierbei der Veränderung der emotionalen Repräsentation des sozial bedrohlichen Erlebnisses im Gedächtnis zukommen (Arntz, 2011). Bisherige Studien untersuchten bisher primär subjektive Korrelate emotionaler Veränderungsprozesse durch Imagery Rescripting (z. B. Norton & Abbott, 2016; Reimer & Moscovitch, 2015). Die Untersuchung psychophysiologischer Korrelate der Veränderung emotionaler Reaktionen hinsichtlich der bearbeiteten sozial bedrohlichen Erinnerung könnte neue Informationen hinsichtlich der emotionalen Verarbeitung des Erlebnisses auf verschiedenen Ebenen generieren und die bisherigen Ergebnisse weiter stützen.

In Studie 3 (Seinsche et al., 2023b) wurde deshalb folgende Fragestellung bearbeitet: Führt Imagery Rescripting eines sozial bedrohlichen Erlebnisses in einer gesunden Stichprobe zu einer Veränderung der emotionalen Reaktivität (Selbstbericht, Physiologie) hinsichtlich der bearbeiteten Situation und sind diese Veränderungen stärker als bei einer Kontrollintervention sowie zwei Kontrollerinnerungen (die nicht bearbeitet wurden)?

#### 4. Repräsentation sozial bedrohlicher Erlebnisse bei Sozialer Angststörung (Studie 1)

Um Besonderheiten in der Gedächtnisrepräsentation ätiologisch relevanter sozial bedrohlicher Erinnerungen bei der SAD näher zu beleuchten, wurden in der vorliegenden Arbeit emotionale Reaktionen während der Reaktivierung der sozial bedrohlichen Erinnerung und posttraumatische Stresssymptome hinsichtlich derselben Erinnerungen bei PatientInnen mit SAD sowie gesunden Kontrollpersonen untersucht. Hierfür wurden neben subjektiven Angaben der ProbandInnen auch die psychophysiologische Reaktivität während der Imagination der sozial bedrohlichen Erinnerung mithilfe einer Imaginationsaufgabe beleuchtet. Zur Überprüfung der Spezifität potentieller Auffälligkeiten hinsichtlich der emotionalen Reaktivität wurden zudem eine neutrale und eine nicht-sozial aversive Kontrollerinnerung untersucht. Es wurde vermutet, dass PatientInnen mit SAD veränderte subjektive Gefühle (stärkere negative Gefühle, Erregung und Belastung, geringere positive Gefühle und positive Valenz) sowie eine veränderte psychophysiologische Reaktivität (erhöhte Erregung, erhöhte negative Valenz und verringerte positive Valenz) spezifisch während der Imagination der sozial bedrohlichen Erinnerung im Vergleich zu beiden Kontrollerinnerungen aufweisen als gesunde Kontrollpersonen. Herzrate und Hautleitfähigkeit wurden als physiologische Indikatoren für Erregung und die Aktivität der expressiven Gesichtsmuskeln als physiologische Indikatoren für Valenz verwendet (Corrugator supercilii: negative Valenz; Zygomaticus major: positive Valenz; z. B. Fridlund & Cacioppo, 1986). Zudem wurde vermutet, dass PatientInnen mit SAD stärkere posttraumatische Stresssymptome hinsichtlich des sozial bedrohlichen Erlebnisses im Vergleich zu den gesunden Kontrollpersonen sowie keine Unterschiede hinsichtlich einer nicht-sozial aversiven Erinnerung berichten. Schließlich wurden signifikant positive Zusammenhänge zwischen den einzelnen Indikatoren der emotionalen Reaktivität und den posttraumatischen Stresssymptomen hinsichtlich der sozial bedrohlichen Erinnerung bei den PatientInnen mit SAD vermutet.

## 4.1 Methode

Zur Beantwortung der ersten Fragestellung wurden 85 PatientInnen mit SAD und 85 gesunde Kontrollpersonen (gematcht nach Alter und Geschlecht) untersucht. Nach einer ausführlichen Psychodiagnostik mithilfe von Interviews und Fragebögen wurde an einem ersten Termin das experimentelle Paradigma (Imaginationsaufgabe) für den nächsten Termin vorbereitet. Hierfür wählten die ProbandInnen je ein Schlüsselwort für eine ätiologisch relevante sozial bedrohliche Erinnerung sowie zwei Kontrollerinnerungen (neutral, nicht-sozial aversiv) aus. Zudem wurden posttraumatische Stresssymptome hinsichtlich der sozial bedrohlichen Erinnerung sowie der nicht-sozial aversiven Kontrollerinnerung mithilfe eines diagnostischen Interviews erhoben und die ProbandInnen füllten verschiedene Fragebögen z. B. hinsichtlich Depressivität und sozialen Ängsten aus. Im Anschluss wurden die ProbandInnen zu einem weiteren Termin eingeladen. Da die hier beschriebene Studie Teil eines größeren Projekts war, nahm ein Teil der ProbandInnen noch an weiteren Terminen teil, an denen unter anderem MRT-Messungen und eine psychotherapeutische Intervention stattfanden. An dem nächsten für diese Studie relevanten Termin wurde die Imaginationsaufgabe durchgeführt, während der die ProbandInnen auditiv via Kopfhörer die am ersten Termin ausgewählten Schlüsselwörter präsentiert bekamen. Nach der Präsentation der Schlüsselwörter erhielten die ProbandInnen die Aufgabe, sich die jeweilige Situation für 10 Sekunden (bis zu einem Signalton) möglichst lebhaft vorzustellen. Das nächste Schlüsselwort wurde nach einer fünf-sekündigen Pause präsentiert und jedes der drei Schlüsselwörter wurde insgesamt acht Mal präsentiert. Während der Imaginationsaufgabe wurden psychophysiologische Maße (Herzrate, Hautleitfähigkeit, Muskelaktivität im Gesicht) erhoben und direkt im Anschluss füllten die ProbandInnen ein Rating hinsichtlich ihres emotionalen Erlebens (negative Gefühle, positive Gefühle, Valenz, Erregung, Belastung) während der Imagination der jeweiligen Situationen aus. Unterschiede zwischen PatientInnen mit SAD und gesunden Kontrollpersonen hinsichtlich des subjektiven emotionalen Erlebens und der psychophysiologischen Reaktivität bezüglich der sozial bedrohlichen Erinnerung im Vergleich zu den Kontrollerinnerungen wurden mithilfe von Varianzanalysen mit Messwiederholungen sowie post-hoc *t*-Tests analysiert. Gruppenunterschiede bezüglich posttraumatischer Stresssymptome hinsichtlich der sozial bedrohlichen und nicht-sozial aversiven Erinnerung wurden mithilfe von *t*-Tests untersucht. Mithilfe einer Korrelationsanalyse wurde zudem der Zusammenhang zwischen emotionaler Reaktivität und posttraumatischen Stresssymptomen hinsichtlich der sozial bedrohlichen Erinnerung in der Gruppe der PatientInnen mit SAD ermittelt.

## 4.2 Ergebnisse

Hinsichtlich der subjektiven emotionalen Reaktivität zeigte sich, dass PatientInnen mit SAD während der Imagination der sozial bedrohlichen Erinnerung stärkere negative Gefühle, Erregung und Belastung im Vergleich zu den beiden Kontrollerinnerungen erlebten als gesunde Kontrollpersonen. Zudem berichteten die PatientInnen geringere positive Gefühle und positive Valenz hinsichtlich der sozial bedrohlichen Erinnerung. Ähnliche Effekte fanden sich für die psychophysiologische Reaktivität: PatientInnen mit SAD zeigten während der Imagination der sozial bedrohlichen Erinnerung im Vergleich zu den beiden Kontrollerinnerungen eine stärkere Hautleitfähigkeitsreaktion als gesunde Kontrollpersonen. Hinsichtlich der weiteren psychophysiologischen Maße (Herzrate, Muskelaktivität im Gesicht) gab es jedoch keine spezifischen signifikanten Unterschiede zwischen den Gruppen. Unterschiede zwischen den Gruppen fanden sich jedoch für posttraumatische Stresssymptome bezüglich der sozial bedrohlichen, allerdings auch für die nicht-sozial aversive Erinnerung. Die Korrelationsanalyse zeigte zudem positive Zusammenhänge zwischen dem emotionalen Erleben (Belastung) und posttraumatischen Stresssymptomen (intrusives Wiedererleben) hinsichtlich der sozial bedrohlichen Erinnerung.

## 4.3 Diskussion

In Studie 1 wurden emotionale Reaktionen sowie posttraumatische Stresssymptome hinsichtlich sozial bedrohlicher Erinnerungen bei PatientInnen mit SAD untersucht. Die Ergebnisse zeigen, dass PatientInnen mit SAD Auffälligkeiten hinsichtlich der Gedächtnisrepräsentation sozial bedrohlicher Erinnerungen aufwiesen, die sich mit den Befunden bisheriger Studien decken (Bjornsson et al., 2020; Erwin et al., 2006; Moscovitch et al., 2018; Sansen et al., 2015). Ähnlich traumatischer Erinnerungen bei der PTBS waren auch Erinnerungen an sozial bedrohliche Situationen bei der SAD mit einer stärkeren emotionalen Reaktivität sowohl subjektiv als auch physiologisch assoziiert. Zudem berichteten PatientInnen mit SAD auch stärker ausgeprägte posttraumatische Stresssymptome als gesunde Kontrollpersonen. Dies könnte einen Hinweis auf eine ungünstige Repräsentation sozial bedrohlicher Erlebnisse in Form eines assoziativen Netzwerks bei der SAD darstellen (siehe z. B. Lang, 1979; Sansen et al., 2015). Auch der positive Zusammenhang zwischen Belastung während der Reaktivierung der sozial bedrohlichen Erinnerung und intrusivem Wiedererleben könnte auf eine potentiell besondere Bedeutung der emotionalen Reaktionen für die Entstehung bzw. Existenz von verzerrten Vorstellungsbildern und weiteren Symptomen intrusiven Wiedererlebens hinweisen (siehe auch Theorien hinsichtlich der PTBS, z. B. Brewin et al., 1996; Foa & Kozak, 1986). Entgegen den Hypothesen

wiesen PatientInnen mit SAD im Vergleich zu gesunden Personen nicht nur stärkere posttraumatische Stresssymptome bezüglich der sozial bedrohlichen Erinnerung auf, sondern auch im Hinblick auf die nicht-sozial aversive Erinnerung. Möglicherweise könnten diese veränderten Verarbeitungs- bzw. Einspeicherungsprozesse also gar nicht spezifisch für die ätiologisch relevante sozial bedrohliche Erinnerung sein, sondern eher einen allgemeinen Vulnerabilitätsfaktor darstellen. Das Erleben einer sozial bedrohlichen Situation auf der Grundlage bereits veränderter Verarbeitungs- und Einspeicherungsprozesse könnte dann schließlich einen auslösenden Faktor für die Entstehung der Symptomatik darstellen. Keine spezifischen Unterschiede zwischen den Gruppen zeigten sich für die Herzrate sowie die Muskelaktivität im Gesicht während der Imagination der sozial bedrohlichen Erinnerung. Eine Erklärung hierfür könnte möglicherweise das Design der Imaginationsaufgabe darstellen (potentielle Vergleichseffekte zwischen den Erinnerungen aufgrund der zeitlich nahen Darbietung; mögliche Unterdrückung/Kontrolle der Mimik bei PatientInnen mit SAD, z. B. McTeague et al., 2009). Zudem sollten aufgrund des Studiendesigns (Querschnittstudie, retrospektive Informationen) die Ergebnisse hinsichtlich des Zusammenhangs bzw. der zeitlichen Abfolge der Entstehung der Symptome mit Vorsicht interpretiert werden. Weiterhin handelte es sich um eine Stichprobe mit einer hohen Anzahl an Komorbiditäten und einem nicht-repräsentativen Geschlechterverhältnis (20 % männlich). Zukünftige Studien sollten die Zusammenhänge zwischen einer ungünstigen Verarbeitung und schließlich Repräsentation der sozial bedrohlichen Erlebnisse und der Entstehung von posttraumatischen Stresssymptomen und Symptomen der SAD in einer Längsschnittstudie mit einer repräsentativen Stichprobe sowie einer klinischen Kontrollgruppe untersuchen.

## 5. Dysfunktionale Verarbeitung nach sozial bedrohlichen Erlebnissen (Studie 2)

In Studie 2 wurde ein erster Einblick in potentielle Zusammenhänge zwischen dysfunktionalen Verarbeitungsstrategien, intrusivem Wiedererleben, sozialphobischen Kognitionen und sozialer Ängstlichkeit gewonnen. Hierfür wurden der retrospektive Bericht über ungünstige Verarbeitungsstrategien („post-event processing“) nach der schlimmsten bisher erlebten sozial bedrohlichen Situation sowie die Intensität von Angst vor negativer Bewertung, einem Kernmerkmal sozialer Ängstlichkeit (z. B. Clark & Wells, 1995), in einer unselektierten Stichprobe untersucht. Die schlimmste bisher erlebte sozial bedrohliche Situation wurde in dieser unselektierten Stichprobe als Annäherung an eine ätiologisch relevante sozial bedrohliche Situation bei PatientInnen mit SAD verwendet. Es wurde vermutet, dass Personen, die retrospektiv mehr

„post-event processing“ nach dem sozial bedrohlichen Erlebnis berichten, aktuell angeben, mehr Angst vor negativer Bewertung zu haben. In einem weiteren Schritt wurde analog zu Modellen der PTBS der Zusammenhang zwischen „post-event processing“, aktuellem intrusiven Wiedererleben hinsichtlich der sozial bedrohlichen Erinnerung und sozialphobische Kognitionen sowie Angst vor negativer Bewertung untersucht. Es wurde angenommen, dass intrusives Wiedererleben und sozialphobische Kognitionen den positiven Zusammenhang zwischen „post-event processing“ und Angst vor negativer Bewertung medieren.

### 5.1 Methode

Zur Beantwortung dieser Fragestellung wurde eine unselektierte studentische Stichprobe (ohne Screening für psychische Erkrankungen) mit insgesamt 174 Personen mithilfe einer Online-Erhebung untersucht. Zunächst wurde den ProbandInnen eine Liste mit potentiell sozial bedrohlichen Erlebnissen (z. B. von anderen gehänselt worden sein, eine schlechte Leistung vor anderen erbracht zu haben) sowie einer offenen Antwortoption präsentiert. Anhand dieser Liste wurden sie gebeten, sich an das schlimmste sozial bedrohliche Ereignis zu erinnern, das sie je erlebt hatten. Im Anschluss füllten die ProbandInnen verschiedene Fragebögen unter anderem hinsichtlich „post-event processing“ nach der sozial bedrohlichen Situation, allgemeinen sozialphobischen Kognitionen, habitueller Emotionsregulation sowie Angst vor negativer Bewertung aus. Der Zusammenhang zwischen „post-event processing“ und Angst vor negativer Bewertung sowie die vermutete Mediation dieses Zusammenhangs durch intrusives Wiedererleben und sozialphobische Kognitionen wurden mithilfe von Strukturgleichungsmodellen in der Analysesoftware R (Version 4.0.2; R Core Team, 2017) mit dem R Packet lavaan (Version 0.6 – 7; Rosseel, 2012) analysiert.

### 5.2 Ergebnisse

Eine Korrelationsanalyse zeigte einen signifikanten positiven Zusammenhang zwischen „post-event processing“ und Angst vor negativer Bewertung: Personen, die retrospektiv berichten, dass sie vermehrt ungünstige Verarbeitungsstrategien („post-event processing“) nach der schlimmsten sozial bedrohlichen Erfahrung verwendeten, gaben an, aktuell eine stärkere Angst vor negativer Bewertung zu haben. Zudem zeigte sich eine signifikante einfache Mediation des Zusammenhangs zwischen „post-event processing“ und Angst vor negativer Bewertung durch sozialphobische Kognitionen, jedoch nicht durch intrusives Wiedererleben. Da retrospektive Berichte von „post-event processing“ durch Gedächtnisprozesse beeinflusst sein könnten, wurde zusätzlich der habituelle Einsatz von dysfunktionalen Emotionsregulationsstrategien (Rumination, Vermeidung) als Annäherung eines aktuellen Maßes für „post-event processing“

und deren Zusammenhang mit Angst vor negativer Bewertung, intrusivem Wiedererleben und sozialphobischen Kognitionen untersucht. Auch hier zeigte sich eine signifikante Mediation durch sozialphobische Kognitionen.

### 5.3 Diskussion

Diese Ergebnisse könnten einen ersten Hinweis auf die Bedeutung dysfunktionaler Verarbeitungsstrategien nach ätiologisch relevanten sozial bedrohlichen Erlebnissen für die soziale Ängstlichkeit darstellen. Ähnlich der PTBS (siehe z. B. Szabo et al., 2017) wurde der Zusammenhang zwischen „post-event processing“ und Angst vor negativer Bewertung durch sozialphobische Kognitionen erklärt, die möglicherweise aus der dysfunktionalen Verarbeitung der sozial bedrohlichen Situation resultierten. Diese könnten schließlich die Entstehung und Aufrechterhaltung von Angst vor negativer Bewertung als Kernaspekt sozialer Ängste gefördert haben. Eine Mediation durch intrusives Wiedererleben hinsichtlich der sozial bedrohlichen Erinnerung war entgegen den Hypothesen nicht signifikant. Ein Grund hierfür könnte sein, dass posttraumatische Stresssymptome ein Merkmal von Psychopathologie darstellen könnten und so in dieser unselektierten Stichprobe weniger stark ausgeprägt waren (z. B. Bjornsson et al., 2020; Erwin et al., 2006). Obwohl es bereits einige Studien gibt, die auf die Bedeutung sozial bedrohlicher Erlebnisse für die Entstehung der SAD hinweisen (z. B. Hackmann et al., 2000; Norton & Abbott, 2017a, 2017b), gibt es bisher noch keine Untersuchungen hinsichtlich potentiell dysfunktionaler Verarbeitungsstrategien nach ätiologisch relevanten sozial bedrohlichen Erlebnissen bei der SAD. Entsprechend wurde in Studie 2 als Annäherung zunächst eine unselektierte Stichprobe retrospektiv befragt. Die Ergebnisse stimmen mit der bisherigen Literatur hinsichtlich „post-event processing“ nach traumatischen Ereignissen bei der PTBS sowie nach aktuellen sozialen Ereignissen bei der SAD überein (z. B. Ehlers & Clark, 2000; Ehlers & Steil, 1995; Szabo et al., 2017; Turluc et al., 2015). Obwohl mit diesen Ergebnissen aufgrund der retrospektiven Erfassung und der unselektierten Stichprobe keine Aussage über tatsächliche Entstehungsbedingungen der SAD getroffen werden können, weisen sie jedoch auf die Bedeutung dieses Themenfeldes für die zukünftige Forschung hin.

## 6. Emotionale Veränderungsprozesse durch Imagery Rescripting (Studie 3)

Da die bisherige Studienlage noch kein aussagekräftiges Bild über die Effekte von Imagery Rescripting auf die emotionale Reaktivität hinsichtlich der bearbeiteten sozial bedrohlichen Er-

innerung erlaubt, wurde die zweite Fragestellung zunächst in einer gesunden Stichprobe (gescreent für psychische und schwerwiegende körperliche Erkrankungen) untersucht. In einem Within-Subject-Design durchliefen die ProbandInnen eine Kontrollintervention und im Anschluss eine Sitzung Imagery Rescripting. Die emotionale Reaktivität wurde mithilfe subjektiver und physiologischer Maße im Rahmen einer Imaginationsaufgabe jeweils vor und nach den Interventionen erhoben. Es wurde vermutet, dass Imagery Rescripting im Vergleich zu der Kontrollintervention zu einer Veränderung der subjektiven Gefühle (Reduktion der negativen Gefühle und der Erregung sowie Zunahme der positiven Gefühle und der positiven Valenz) sowie der psychophysiologischen Reaktivität (Reduktion der Herzrate, der Hautleitfähigkeit und der Aktivität des Corrugator supercillii sowie eine Zunahme der Aktivität des Zygomaticus major) hinsichtlich der sozial bedrohlichen Erinnerung führt. Um für basale Habituations- und Reihenfolgeeffekte zu kontrollieren, wurde neben der sozial bedrohlichen Erinnerung zusätzlich noch die emotionale Reaktivität hinsichtlich einer neutralen und einer nicht-sozial aversiven Kontrollerinnerung untersucht, die beide nicht mithilfe der Interventionen bearbeitet wurden. Zudem wurde beleuchtet, inwieweit eine einzelne Sitzung Imagery Rescripting in einer gesunden Stichprobe zu einer Reduktion der sozialen Ängstlichkeit und Angst vor negativer Bewertung führt. In weiteren Nebenfragestellungen wurden außerdem Effekte von Imagery Rescripting auf bestimmte Kognitionen und posttraumatische Gedächtnismerkmale hinsichtlich der sozial bedrohlichen Erinnerung analysiert, da diese ebenfalls als potentielle Wirkfaktoren in der Literatur diskutiert werden (z. B. Hagens & Arntz, 2012; Reimer & Moscovitch, 2015).

## 6.1 Methode

Zur Beantwortung der dritten Fragestellung wurden insgesamt 30 gesunde Personen untersucht, die an einer Experimentalsitzung sowie an einer online Follow-up Erhebung eine Woche später ( $n = 26$  ProbandInnen) teilnahmen. Während der Experimentalsitzung wurden zunächst im Rahmen eines Interviews die schlimmste sozial bedrohliche Erinnerung sowie zwei Kontrollerinnerungen (neutral, nicht-sozial aversiv) ausgewählt und beschrieben. Zudem füllten die ProbandInnen unter anderem Fragebögen zu sozialer Ängstlichkeit und zu verschiedenen Charakteristika der drei Erinnerungen (emotionale Reaktivität, posttraumatische Gedächtnismerkmale, Kognitionen) aus. Die emotionale Reaktivität hinsichtlich der drei Erinnerungen (sozial bedrohlich, neutral, nicht-sozial aversiv) wurde sowohl mithilfe eines Fragebogens als auch einer Imaginationsaufgabe (siehe Studie 1; Gefühle: subjektiv, physiologisch) untersucht. Im Anschluss an die Imaginationsaufgabe wurde die Kontrollintervention durchgeführt, bei der die

ProbandInnen drei Fragen zu der sozial bedrohlichen Erinnerung gestellt bekamen (1. allgemein alle Erinnerungen an die Situation, 2. alle Erinnerungen hinsichtlich der Umgebung/des Ortes, 3. alle Erinnerungen hinsichtlich der beteiligten Personen). Nach jeder Frage hatten die ProbandInnen drei Minuten Zeit, sich schriftlich Notizen zu machen. Während dieser Zeit verließ die Versuchsleiterin den Raum. Im Anschluss erzählten die ProbandInnen der Versuchsleiterin, was sie aufgeschrieben hatten. Nach der Kontrollintervention wurden die Imaginationsaufgabe ein zweites Mal durchgeführt sowie der Fragebogen zu den Charakteristika der Erinnerungen erhoben. Direkt im Anschluss wurde eine Sitzung Imagery Rescripting der sozial bedrohlichen Erinnerung mithilfe eines Protokolls durchgeführt, das bereits in früheren Studien verwendet wurde (z. B. Nilsson et al., 2012; Norton & Abbott, 2016; Wild et al., 2008). Auch nach der Sitzung Imagery Rescripting wurden die Imaginationsaufgabe und der Fragebogen zu den Charakteristika der Erinnerungen durchgeführt. Fünf bis sieben Tage nach der Experimentalsitzung nahmen die ProbandInnen an einer Follow-up Erhebung teil, bei der die ProbandInnen online Fragebögen zur sozialen Ängstlichkeit und der emotionalen Reaktivität hinsichtlich der drei Erinnerungen ausfüllten.

## 6.2 Ergebnisse

Mithilfe einer Varianzanalyse mit Messwiederholung wurde untersucht, inwieweit Imagery Rescripting zu einer Veränderung der emotionalen Reaktivität während der Imagination der sozial bedrohlichen Situation führte. Verglichen wurden diese Veränderungen mit den Effekten einer Kontrollintervention sowie den der beiden Kontrollerinnerungen, die nicht mithilfe einer Intervention bearbeitet wurden. Hinsichtlich der subjektiven Gefühle zeigte sich, dass die Imagery Rescripting Sitzung zu einer kurzfristigen Reduktion der negativen Gefühle und einer Zunahme der positiven Gefühle und der positiven Valenz hinsichtlich der sozial bedrohlichen Situation im Vergleich zu den beiden Kontrollerinnerungen führte. Obwohl die Kontrollintervention keinen signifikanten Effekt auf die subjektiven Gefühle hatte, zeigte sich nur für die Zunahme der positiven Gefühle ein signifikanter Unterschied zwischen den Interventionen. Auch eine Woche nach der Experimentalsitzung waren die negativen Gefühle im Vergleich zu vor der Imagery Rescripting Sitzung weiterhin reduziert und die positive Valenz war höher als vor der Intervention. Eine kurzfristige Veränderung des emotionalen Erlebens zeigte sich zum Teil auch in der psychophysiologischen Reaktivität auf die sozial bedrohliche Erinnerung: So führte die Sitzung Imagery Rescripting zu einer signifikanten Reduktion der Aktivität des *Corrugator supercillii* während der Imagination der sozial bedrohlichen Erinnerung, die stärker war als die

Effekte der Kontrollintervention sowie der beiden Kontrollerinnerungen. Hinsichtlich der Aktivität des *Zygomatikus major* und auch den psychophysiologischen Indikatoren für Erregung (Herzrate, Hautleitfähigkeit) zeigten sich jedoch keine signifikanten Effekte der Imagery Rescripting Sitzung. Zudem wurde untersucht, inwieweit Imagery Rescripting zu einer Veränderung der sozialen Ängstlichkeit und Angst vor negativer Bewertung eine Woche nach der Intervention führte. Es zeigte sich eine signifikante Reduktion der Angst vor negativer Bewertung, jedoch keine Effekte auf die soziale Ängstlichkeit. In weiteren Nebenfragestellungen wurde untersucht, inwieweit Imagery Rescripting spezifische Effekte auf bestimmte Kognitionen hinsichtlich der sozial bedrohlichen Erinnerung sowie posttraumatische Gedächtnischarakteristika (intrusives Wiedererleben, Disorganisation) aufweist. Es zeigte sich eine signifikante Zunahme des Empowerments (Gefühl der Ermächtigung/Stärke beim Gedanken an die Erinnerung) sowie eine signifikante Abnahme der Disorganisation der sozial bedrohlichen Erinnerung im Vergleich zu den Kontrollerinnerungen und der Kontrollintervention sowohl kurzfristig als auch eine Woche nach der Intervention.

### 6.3 Diskussion

Zusammenfassend weist die dritte Studie darauf hin, dass Imagery Rescripting zu einer Veränderung der emotionalen Reaktivität hinsichtlich der bearbeiteten sozial bedrohlichen Erinnerung führte, die sich nicht nur subjektiv, sondern zum Teil auch in psychophysiologischen Maßen (*Corrugator supercilii*) zeigte. Diese Ergebnisse stimmen mit den bisherigen Studien zu der Veränderung des emotionalen Erlebens (erhoben mit subjektiven Maßen) nach Imagery Rescripting bei der SAD überein (z. B. Lee & Kwon, 2013; Norton & Abbott, 2016; Reimer & Moscovitch, 2015). Die Veränderung des emotionalen Erlebens sowohl in subjektiven als auch in psychophysiologischen Maßen könnte ein weiterer Hinweis darauf sein, dass Imagery Rescripting tatsächlich zu einer emotionalen Umbewertung des konditionierten Stimulus führen könnte (Arntz, 2011). Fehlende Unterschiede zwischen der Imagery Rescripting Sitzung und der Kontrollintervention in manchen Maßen schwächen diese Vermutung jedoch. Eine mögliche Erklärung hierfür könnte sein, dass die Erinnerung während der Kontrollintervention ebenfalls aktiviert und mit der Versuchsleitung besprochen wurde. Dies könnte bereits zu einem Effekt auf das emotionale Erleben, z. B. in Form von Habituation geführt haben (z. B. Foa & Kozak, 1986). Eine weitere Erklärung könnte in der Untersuchung einer gesunden Stichprobe liegen, da gesunde Personen im Vergleich zu PatientInnen mit SAD schon zu Beginn weniger belastet durch die sozial bedrohliche Erinnerung sind (z. B. Bjornsson et al., 2020; Erwin et al., 2006). Dies könnte möglicherweise auch eine Erklärung für die geringen bzw. inkonsistenten

Effekte auf die Reduktion der sozialen Ängstlichkeit durch die Intervention darstellen. Zudem könnten Reihenfolge-Effekte durch das Within-Subject-Design einen zusätzlichen Einfluss auf die Effekte gehabt haben. Eine Replikation der Ergebnisse in einem Between-Subject-Design und einer klinischen Stichprobe sind notwendig, um eine potentielle Aussage zu Wirkmechanismen der Intervention bei PatientInnen mit SAD treffen zu können.

## 7. Zusammenfassende Diskussion und Ausblick

In der vorliegenden Arbeit wurde die Bedeutung emotionaler Lernprozesse für die Entstehung (Studie 1 und 2) und Behandlung (Studie 3) der SAD untersucht. In Studie 1 zeigte sich bei PatientInnen mit SAD im Vergleich zu gesunden Personen eine stärkere emotionale Aktivierung während der Imagination eines ätiologisch relevanten sozial bedrohlichen Erlebnisses, welche zusammen mit stärkeren posttraumatischen Stresssymptomen auf Auffälligkeiten im Hinblick auf die Repräsentation dieser Erinnerungen im Gedächtnis hinweist (z. B. Ehlers & Clark, 2000; Foa & Kozak, 1986; siehe Abbildung 1). Ähnlich wie bei PatientInnen mit PTBS könnten dysfunktionale Verarbeitungsprozesse, wie Vermeidung oder Rumination, die adaptive Einspeicherung und schließlich Gedächtnisrepräsentation der Ereignisse verhindert haben (Ehlers & Clark, 2000; Ehlers & Steil, 1995; Turliuc et al., 2015). Entsprechend weist Studie 2 darauf hin, dass in einer unselektierten Stichprobe Personen mit stärkeren sozialen Ängsten auch retrospektiv berichteten, vermehrt ungünstige Verarbeitungsstrategien nach einem ätiologisch relevanten sozial bedrohlichen Erlebnis angewandt zu haben. Diese führten möglicherweise unter anderem zu der Entstehung assoziierter dysfunktionaler Kognitionen, die schließlich ähnlich der PTBS (z. B. Ehlers & Clark, 2000) klinische Symptome (wie soziale Ängste) verstärkt haben könnten. Die Veränderung der ungünstigen Repräsentation der Erinnerung im Gedächtnis ist wiederum ein Ziel der Intervention Imagery Rescripting (z. B. Arntz, 2011). So zeigte sich in Studie 3 in einer gesunden Stichprobe eine Veränderung des emotionalen Erlebens im Hinblick auf die bearbeitete sozial bedrohliche Erinnerung durch eine einzelne Sitzung Imagery Rescripting. Dies könnte einen Hinweis auf eine Veränderung der Gedächtnisrepräsentation darstellen, die möglicherweise schließlich auch die Symptomatik der SAD beeinflusst (z. B. Hackmann et al., 2000; siehe Abbildung 1).

Besonderheiten dieses Dissertationsprojektes waren der Einbezug von Imagination und psychophysiologischen Maßen zur Erfassung der Ergebnisse emotionaler Lernprozesse sowie die Zusammenführung potentiell relevanter ätiologischer Prozesse und die Veränderung dieser durch eine therapeutische Intervention. Zur Untersuchung emotionaler Prozesse während der

Imagination autobiografischer Erinnerungen sowie deren potentielle Veränderungen durch eine Intervention wurde zunächst eine Imaginationsaufgabe entwickelt, die in den Studien 1 und 3 verwendet wurde (angelehnt an McTeague et al., 2009; Sansen et al., 2015). Während bisherige Studien in diesem Bereich vor allem Fragebögen und Interviews (und entsprechend eher kognitive Methoden; z. B. Erwin et al., 2006; Hackmann et al., 2000; Norton & Abbott, 2016) nutzten, war das Ziel dieser Arbeit, emotionale Prozesse mithilfe von Imagination unmittelbar sowohl auf physiologischer als auch auf subjektiver Ebene zu erfassen. Der Einbezug von Imagination aktiviert im Vergleich zu kognitiven Methoden vermehrt auch sensorische Komponenten der Erinnerungen und kann entsprechend ähnliche körperliche und neuronale Prozesse hervorrufen wie real existierende Bilder bzw. Situationen (z. B. O'Craven & Kanwisher, 2000). Neben der realitätsnahen Erfassung von Emotionen betonen die dargestellten Befunde zudem die Bedeutung des Einbezugs individueller ätiologischer Faktoren in die Behandlung psychischer Erkrankungen. Ein psychotherapeutisches Ansetzen an der veränderten Gedächtnisrepräsentation, die möglicherweise über ungünstige Einspeicherungs- und Verarbeitungsprozesse entstanden ist und ähnlich der PTBS Symptome verursacht und aufrechterhält, könnte eine vielversprechende Möglichkeit zur Behandlung der SAD darstellen (z. B. Arntz et al., 2007; Arntz & Weertman, 1999; siehe Abbildung 1). Bisherige verhaltenstherapeutische Ansätze beziehen sich insbesondere auf von kognitiven Modellen beschriebene aufrechterhaltende Faktoren wie z. B. „post-event processing“ (z. B. Clark & Wells, 1995; Stangier et al., 2003). Die Anwendung von Erkenntnissen zu Entstehungsprozessen der SAD könnte die Behandlung der SAD noch weiter verbessern (z. B. Wild et al., 2007, 2008). So könnte beispielsweise die Reduktion ungünstiger Verarbeitungsstrategien („post-event processing“) nicht nur hinsichtlich aktueller sozialer Situationen, sondern auch hinsichtlich ätiologisch relevanter sozial bedrohlicher Erlebnisse eine vielversprechende Möglichkeit darstellen, die Gedächtnisrepräsentation dieser Erlebnisse zu verändern und somit deren Einfluss auf die aktuelle Symptomatik zu reduzieren (z. B. Norton & Abbott, 2017a). Als Weiterführung von Imagery Rescripting könnte die Intervention auch die im Anschluss an das Ereignis stattgefundene (potenziell ungünstige) Verarbeitung umfassen. Dies könnte auf kognitiver Ebene zu der Erkenntnis führen, dass die Bedeutung und Bedrohlichkeit der Situation für das eigene Selbst aufgrund ungünstiger Verarbeitungsstrategien möglicherweise überschätzt wurden. Diese Erkenntnis könnte ähnlich der Bearbeitung aktueller sozialer Erlebnisse (z. B. Clark & Wells, 1995) eine Umbewertung der Situation und so auch schließlich der Bedrohlichkeit zukünftiger sozialer Situationen bewirken. Auf emotionaler Ebene könnte das imaginative Durchleben der Situation eine adaptive Verarbeitung der Situa-

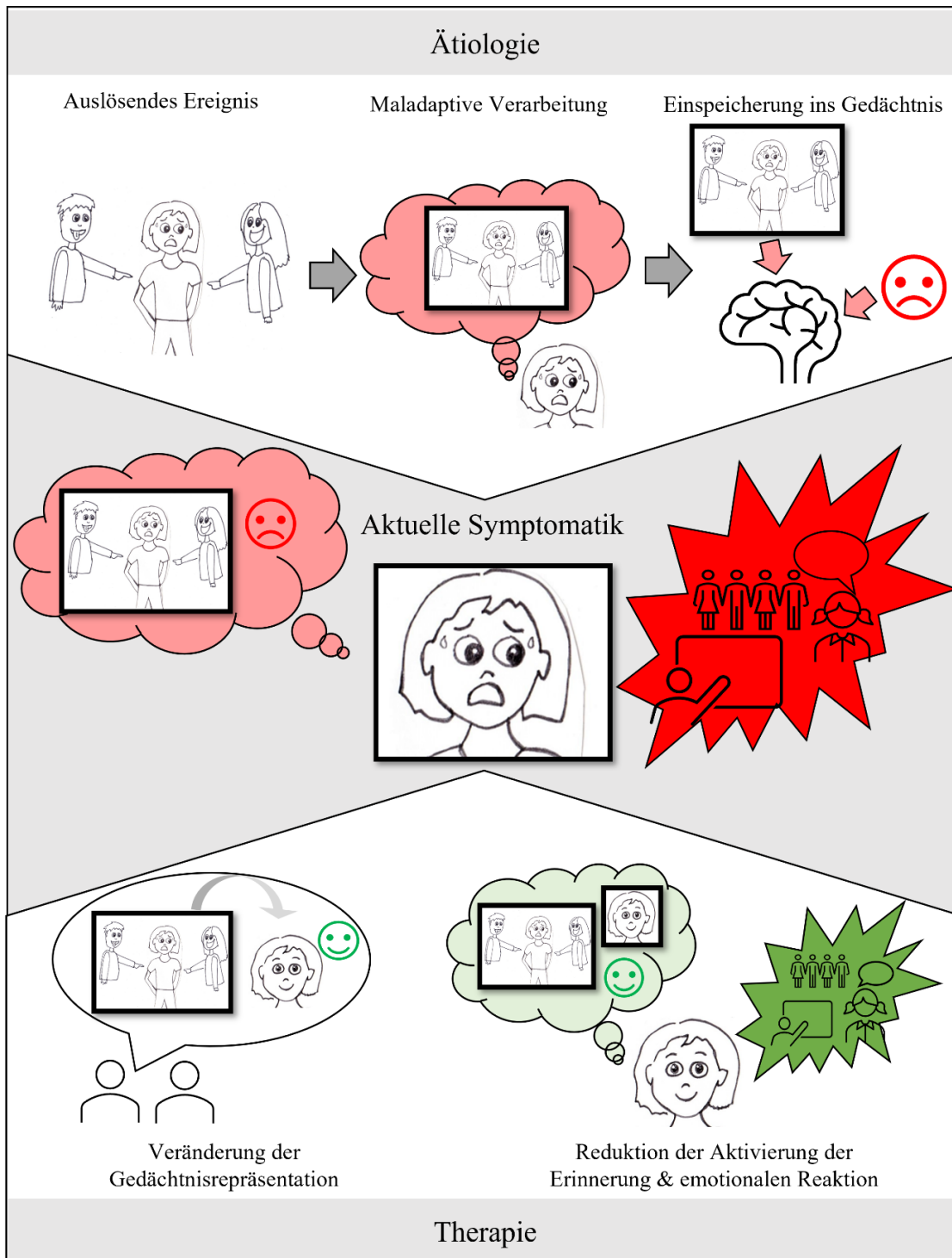
tion anregen und so die ungünstigen Verarbeitungsprozesse direkt nach dem Ereignis überschreiben. Diese oder ähnliche Kombinationen neuer wissenschaftlicher Erkenntnisse hinsichtlich ätiologischer Prozesse und therapeutischer Behandlungsmethoden haben das Potential die Behandlung der SAD in der Zukunft noch weiter zu optimieren, müssen jedoch in weiteren Studien überprüft werden. In einem nächsten Schritt könnten diese Prozesse ebenfalls auf andere Störungsbilder angewandt werden, da nicht nur PatientInnen mit SAD aversive Erinnerungen berichten und von der Behandlung dieser profitieren (siehe z. B. Morina et al., 2017). Die Erforschung transdiagnostischer Prozesse im Hinblick auf Verarbeitungs- und Einspeicherungsprozesse aversiver Erinnerungen könnte weitere Hinweise auf störungsübergreifende Vulnerabilitätsfaktoren geben, die schließlich auch in psychotherapeutische Interventionen umgesetzt werden könnten.

Die im Rahmen dieses Dissertationsprojekt durchgeführten Studien weisen Limitationen auf: So stellte die Auswahl an Parametern zur Erfassung der Ergebnisse emotionaler Lernprozesse eine Schwierigkeit dar. In der bisherigen Literatur wurde eine Vielzahl verschiedener Prozess- und Ergebnismaße wie z. B. selbstberichtete Angaben und psychophysiologische Marker hinsichtlich Parametern des emotionalen Erlebens, posttraumatische Stresssymptome, Kognitionen und Charakteristika der Erinnerung verwendet (siehe z. B. Erwin et al., 2006; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Romano et al., 2020). Diese Fülle an Parametern bildet zum einen die potentielle Bedeutung emotionaler Lernprozesse für verschiedene klinische Symptome ab, erschwert jedoch die experimentelle Erfassung dieser und limitiert so auch schließlich deren Aussagekraft (z. B. durch eine Überschätzung der statistischen Signifikanz; Rice, 1989). Auch die retrospektive und querschnittliche Erfassung der Ergebnisse emotionaler Lernprozesse limitiert die Aussagekraft der im Rahmen dieses Dissertationsprojekt durchgeführten Studien. So wurde angenommen, dass es einen Zusammenhang zwischen der aktuellen Repräsentation der sozial bedrohlichen Erfahrungen im Gedächtnis und ungünstigen Verarbeitungs- und Einspeicherungsprozessen (direkt) nach dem sozial bedrohlichen Erlebnis gibt, obwohl es hierfür aufgrund fehlender Längsschnittstudien keine belastbaren Befunde gibt. Zum anderen wird davon ausgegangen, dass sich die meisten Personen auch viele Jahre später noch an ihren Umgang mit den sozial bedrohlichen Erlebnissen erinnern können und diesen retrospektiv auch wahrheitsgemäß berichten, obwohl dieser von Gedächtnisprozessen beeinflusst sein könnte (z. B. Krans et al., 2014; Levine et al., 2009). Ohne Längsschnittstudien, die beide Annahmen unterstützen, sind die Aussagen der Studien entsprechend limitiert und müssen mit

Vorsicht interpretiert werden. Zudem sollte die Veränderung emotionaler Prozesse durch psychotherapeutische Interventionen in klinischen Stichproben untersucht werden, da Aussagen von Studien in gesunden Stichproben aufgrund potentiell veränderter psychopathologischer Prozesse (z. B. Erwin et al., 2006, Bjornsson et al., 2020) nicht eins zu eins auf klinische Stichproben angewandt werden können.

### *Zusammenfassung*

Zusammenfassend weist dieses Dissertationsprojekt auf die Bedeutung emotionaler Lernprozesse in Zusammenhang mit sozial bedrohlichen Erlebnissen für die Entstehung der SAD sowie deren Veränderung durch die psychotherapeutische Intervention Imagery Rescripting hin. Es wurde vermutet, dass sozial bedrohliche Erlebnisse ähnlich traumatischer Erfahrungen bei der PTBS ungünstig verarbeitet sowie im Gedächtnis eingespeichert werden und so im weiteren Verlauf posttraumatische Stresssymptome hervorrufen, die schließlich die Symptomatik der SAD weiter fördern (z. B. Hackmann et al., 1998; Hackmann et al., 2000; Norton & Abbott, 2017a; siehe Abbildung 1). Die in diesem Dissertationsprojekt dargestellten Befunde unterstützen diese Vermutungen. Eine stärkere emotionale Aktivierung der Erinnerung sowie stärkere posttraumatische Stresssymptome bei PatientInnen mit SAD weisen auf eine ungünstige Repräsentation der sozial bedrohlichen Erlebnisse im Gedächtnis hin. Diese könnte ein Resultat dysfunktionaler Verarbeitungsstrategien nach den Erlebnissen darstellen, die Personen mit stärkeren sozialen Ängsten retrospektiv vermehrt berichten. Die Anwendung von Erkenntnissen hinsichtlich ätiologischer Bedingungen für die Entstehung der Symptomatik psychischer Erkrankungen könnte die Entwicklung psychotherapeutischer Interventionen noch weiter verbessern. Tatsächlich wird der Bedeutung sozial bedrohlicher Erinnerungen bereits in Form psychotherapeutischer Interventionen wie Imagery Rescripting Rechnung getragen (z. B. Wild et al., 2007, 2008). Es wird vermutet, dass die Intervention zu einer Veränderung der emotionalen Bedeutung bzw. Repräsentation der sozial bedrohlichen Erinnerung im Gedächtnis führt, die schließlich in einer Reduktion der posttraumatischen Stresssymptome und Symptome der SAD resultieren könnte (z. B. Arntz, 2011; siehe Abbildung 1). Entsprechend zeigte sich im Rahmen dieses Dissertationsprojektes bei gesunden Personen eine Veränderung des emotionalen Erlebens der Imagery Rescripting Intervention, die auf eine Veränderung der Repräsentation der Erinnerung im Gedächtnis hinweisen könnte. Zukünftige Studien sollten den Zusammenhang zwischen ätiologischen Bedingungen, der aktuellen Symptomatik sowie Veränderungen dieser durch psychotherapeutische Interventionen in Längsschnittstudien noch weiter beleuchten.



*Abbildung 1.* Schematische Darstellung des vermuteten Zusammenhangs zwischen ätiologischen und psychotherapeutischen Prozessen in Zusammenhang mit emotionalem Lernen hinsichtlich ätiologisch relevanter sozial bedrohlicher Erinnerungen. Im Feld „Ätiologie“ wird dargestellt, dass das auslösende sozial bedrohliche Erlebnis (z. B. von andern gehänselt werden) aufgrund maladaptiver Verarbeitungsstrategien (z. B. Rumination) ungünstig im Gedächtnis eingespeichert werden könnte (z. B. durch die Verknüpfung des Ereignisses mit negativen Gefühlen). Das Feld „aktuelle Symptomatik“ zeigt, dass diese ungünstige Einspeicherung und schließlich Repräsentation des Ereignisses im Gedächtnis schließlich dazu führen könnte, dass posttraumatische Stresssymptome (z.B. negativ verzerrte Vorstellungsbilder von sich selbst) in aktuellen sozialen Situationen getriggert werden, die schließlich soziale Ängste und weitere Symptome der SAD fördern könnten. Im Feld „Therapie“ wird abgebildet, dass es durch die Bearbeitung der auslösenden sozialen Situation zu einer Veränderung der Gedächtnisrepräsentation kommen könnte und so schließlich die Erinnerung an die auslösende Situation und somit auch die assoziierten Gefühle weniger stark in aktuellen Situationen getriggert werden könnten. Dies wiederum könnte zu einer Reduktion der Symptomatik der SAD führen.

## 8. Literaturverzeichnis

- Abbott, M. J., & Rapee, R. M. (2004). Post-event rumination and negative self-appraisal in social phobia before and after treatment. *Journal of Abnormal Psychology, 113*(1), 136–144. <https://doi.org/10.1037/0021-843X.113.1.136>
- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Association.  
<https://doi.org/10.1176/appi.books.9780890425596>
- Arntz, A. (2011). Imagery Rescripting for Personality Disorders. *Cognitive and Behavioral Practice, 18*(4), 466–481. <https://doi.org/10.1016/j.cbpra.2011.04.006>
- Arntz, A., Tiesema, M., & Kindt, M. (2007). Treatment of PTSD: A comparison of imaginal exposure with and without imagery rescripting. *Journal of Behavior Therapy and Experimental Psychiatry, 38*(4), 345–370. <https://doi.org/10.1016/j.jbtep.2007.10.006>
- Arntz, A., & Weertman, A. (1999). Treatment of childhood memories: theory and practice. *Behaviour Research and Therapy, 37*, 715–740.
- Bandelow, B., & Michaelis, S. (2015). Epidemiology of anxiety disorders in the 21st century. *Dialogues in Clinical Neuroscience, 17*(3), 327–335.  
<https://doi.org/10.31887/DCNS.2015.17.3/bbandelow>
- Beidel, D. C., & Turner, S. M. (2007). *Shy children, phobic adults: Nature and treatment of social anxiety disorders (2nd ed.)*. American Psychological Association.  
<https://doi.org/10.1037/11533-000>
- Bjornsson, A. S., Hardarson, J. P., Valdimarsdottir, A. G., Gudmundsdottir, K., Tryggvadottir, A., Thorarinsdottir, K., Wessman, I., Sigurjonsdottir, Ó., Davidsdottir, S., & Thorisdottir, A. S. (2020). Social trauma and its association with posttraumatic stress disorder and social anxiety disorder. *Journal of Anxiety Disorders, 72*.
- Brewin, C. R., Dalgleish, T., & Joseph, S. (1996). A dual representation theory of posttraumatic stress disorder. *Psychological Review, 103*(4), 670–686.  
<https://doi.org/10.1037//0033-295X.103.4.670>
- Brewin, C. R., Gregory, J. D., Lipton, M., & Burgess, N. (2010). Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. *Psychological Review, 117*(1), 210–232. <https://doi.org/10.1037/a0018113>
- Carleton, R. N., Peluso, D. L., Collimore, K. C., & Asmundson, G. J. G. (2011). Social anxiety and posttraumatic stress symptoms: The impact of distressing social events. *Journal of Anxiety Disorders, 25*(1), 49–57. <https://doi.org/10.1016/j.janxdis.2010.08.002>

- Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg (Ed.), *Social phobia: Diagnosis, assessment, and treatment*. Guilford Press.
- Dannahy, L., & Stopa, L. (2007). Post-event processing in social anxiety. *Behaviour Research and Therapy*, *45*(6), 1207–1219. <https://doi.org/10.1016/j.brat.2006.08.017>
- Davey, G. C. (1989). UCS revaluation and conditioning models of acquired fears. *Behaviour Research and Therapy*, *27*(5), 521–528. [https://doi.org/10.1016/0005-7967\(89\)90086-7](https://doi.org/10.1016/0005-7967(89)90086-7)
- Ehlers, A., & Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy*, *38*, 319–345.
- Ehlers, A., & Steil, R. (1995). Maintenance of Intrusive Memories in Posttraumatic Stress Disorder: A Cognitive Approach. *Behavioural and Cognitive Psychotherapy*, *23*, 217–249.
- Erwin, B. A., Heimberg, R. G., Marx, B. P., & Franklin, M. E. (2006). Traumatic and socially stressful life events among persons with social anxiety disorder. *Journal of Anxiety Disorders*, *20*(7), 896–914. <https://doi.org/10.1016/j.janxdis.2005.05.006>
- Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin*, *99*(1), 20–35. <https://doi.org/10.1037/0033-2909.99.1.20>
- Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for Human Electromyographic Research. *Psychophysiology*, *22*(5).
- Hackmann, A., Clark, D. M., & McManus, F. (2000). Recurrent images and early memories in social phobia. *Behaviour Research and Therapy*, *38*, 601–610.
- Hackmann, A., Surawy, C., & Clark, D. M. (1998). Seeing yourself through others' eyes: a study of spontaneously occurring images in social phobia. *Behavioural and Cognitive Psychotherapy*, *26*(1), 3–12. <https://doi.org/10.1017/S1352465898000022>
- Hagenaars, M. A., & Arntz, A. (2012). Reduced intrusion development after post-trauma imagery rescripting: an experimental study. *Journal of Behavior Therapy and Experimental Psychiatry*, *43*(2), 808–814.
- Heimberg, R. G., Brozovich, F. A., & Rapee, R. M. (2010). A cognitive behavioral model of social anxiety disorder: update and extension. In S. G. Hofmann & P. M. DiBartolo (Eds.), *Social Anxiety: Clinical, Developmental, and Social Perspectives* (Vol. 2, pp. 395–422). Elsevier. <https://doi.org/10.1016/B978-0-12-375096-9.00015-8>

- Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, *62*(6), 593–602. <https://doi.org/10.1001/archpsyc.62.6.593>
- Kocovski, N. L., Endler, N. S., Rector, N. A., & Flett, G. L. (2005). Ruminative coping and post-event processing in social anxiety. *Behaviour Research and Therapy*, *43*(8), 971–984. <https://doi.org/10.1016/j.brat.2004.06.015>
- Krans, J., Bree, J. de, & Bryant, R. A. (2014). Autobiographical memory bias in social anxiety. *Memory (Hove, England)*, *22*(8), 890–897. <https://doi.org/10.1080/09658211.2013.844261>
- Kunze, A. E., Lancee, J., Morina, N., Kindt, M., & Arntz, A. (2019). Mediators of change in imagery rescripting and imaginal exposure for nightmares: evidence from a randomized wait-list controlled trial. *Behavior Therapy*, *50*(5), 978–993.
- Lang, P. J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, *16*(6), 495–512. <https://doi.org/10.1111/j.1469-8986.1979.tb01511.x>
- Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: affective, facial, visceral, and behavioral reactions. *Psychophysiology*, *30*(3).
- Lang, P. J., Levin, D. N., Miller, G. A., & Kozak, M. J. (1983). Fear behavior, fear imagery and the psychophysiology of emotion: The problem of affective response integration. *Journal of Abnormal Psychology*, *92*, 276–306.
- Lee, S. W., & Kwon, J.-H. (2013). The efficacy of imagery rescripting (IR) for social phobia: A randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry*, *44*(4), 351–360. <https://doi.org/10.1016/j.jbtep.2013.03.001>
- Levine, L. J., Lench, H. C., & Safer, M. A. (2009). Functions of remembering and misremembering emotion. *Applied Cognitive Psychology*, *23*(8), 1059–1075. <https://doi.org/10.1002/acp.1610>
- Makkar, S. R., & Grisham, J. R. (2011). Social anxiety and the effects of negative self-imagery on emotion, cognition, and post-event processing. *Behaviour Research and Therapy*, *49*(10), 654–664. <https://doi.org/10.1016/j.brat.2011.07.004>
- McEvoy, P. M., & Kingsep, P. (2006). The post-event processing questionnaire in a clinical sample with social phobia. *Behaviour Research and Therapy*, *44*(11), 1689–1697. <https://doi.org/10.1016/j.brat.2005.12.005>
- McTeague, L. M., Lang, P. J., Laplante, M.-C., Cuthbert, B. N., Strauss, C. C., & Bradley, M. M. (2009). Fearful imagery in social phobia: Generalization, comorbidity, and

- physiological reactivity. *Biological Psychiatry*, 65(5), 374–382.  
<https://doi.org/10.1016/j.biopsych.2008.09.023>
- Mellings, T. M. B., & Alden, L. E. (2000). Cognitive processes in social anxiety: the effects of self-focus, rumination and anticipatory processing. *Behaviour Research and Therapy*, 38, 243–257.
- Michael, T., Halligan, S. L., Clark, D. M., & Ehlers, A. (2007). Rumination in posttraumatic stress disorder. *Depression and Anxiety*, 24(5), 307–317.  
<https://doi.org/10.1002/da.20228>
- Morina, N., Lancee, J., & Arntz, A. (2017). Imagery rescripting as a clinical intervention for aversive memories: A meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry*, 55, 6–15. <https://doi.org/10.1016/j.jbtep.2016.11.003>
- Moscovitch, D. A., Vidovic, V., Lenton-Brym, A. P., Dupasquier, J. R., Barber, K. C., Hudd, T., Zabara, N., & Romano, M. (2018). Autobiographical memory retrieval and appraisal in social anxiety disorder. *Behaviour Research and Therapy*, 107, 106–116.  
<https://doi.org/10.1016/j.brat.2018.06.008>
- Nilsson, J.-E., Lundh, L.-G., & Viborg, G. (2012). Imagery rescripting of early memories in social anxiety disorder: An experimental study. *Behaviour Research and Therapy*, 50(6), 387–392. <https://doi.org/10.1016/j.brat.2012.03.004>
- Norton, A. R., & Abbott, M. J. (2016). The efficacy of imagery rescripting compared to cognitive restructuring for social anxiety disorder. *Journal of Anxiety Disorders*, 40, 18–28. <https://doi.org/10.1016/j.janxdis.2016.03.009>
- Norton, A. R., & Abbott, M. J. (2017a). Bridging the Gap between Aetiological and Maintaining Factors in Social Anxiety Disorder: The Impact of Socially Traumatic Experiences on Beliefs, Imagery and Symptomatology. *Clinical Psychology & Psychotherapy*, 24(3), 747–765. <https://doi.org/10.1002/cpp.2044>
- Norton, A. R., & Abbott, M. J. (2017b). The Role of Environmental Factors in the Aetiology of Social Anxiety Disorder: A Review of the Theoretical and Empirical Literature. *Behaviour Change*, 34(2), 76–97. <https://doi.org/10.1017/bec.2017.7>
- O'Craven, K. M., & Kanwisher, N. (2000). Mental imagery of faces and places activates corresponding stimulus-specific brain regions. *Journal of Cognitive Neuroscience*, 12(6), 1013–1023. <https://doi.org/10.1162/08989290051137549>
- Öst, L.-G., & Hugdahl, K. (1981). Acquisition of phobias and anxiety response patterns in clinical patients. *Behaviour Research and Therapy*, 19(5), 439–447.  
[https://doi.org/10.1016/0005-7967\(81\)90134-0](https://doi.org/10.1016/0005-7967(81)90134-0)

- Perini, S. J., Abbott, M. J., & Rapee, R. M. (2006). Perception of Performance as a Mediator in the Relationship Between Social Anxiety and Negative Post-Event Rumination. *Cognitive Therapy and Research*, *30*(5), 645–659. <https://doi.org/10.1007/s10608-006-9023-z>
- R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>
- Rachman, S., Grüter-Andrew, J., & Shafran, R. (2000). Post-event processing in social anxiety. *Behaviour Research and Therapy*, *38*, 611–617.
- Rapee, R. M., & Spence, S. H. (2004). The etiology of social phobia: Empirical evidence and an initial model. *Clinical Psychology Review*, *24*(7), 737–767. <https://doi.org/10.1016/j.cpr.2004.06.004>
- Reimer, S. G., & Moscovitch, D. A. (2015). The impact of imagery rescripting on memory appraisals and core beliefs in social anxiety disorder. *Behaviour Research and Therapy*, *75*, 48–59. <https://doi.org/10.1016/j.brat.2015.10.007>
- Rice, W. R. (1989). Analyzing Tables of Statistical Tests. *Evolution*, *43*(1), 223. <https://doi.org/10.2307/2409177>
- Romano, M., Moscovitch, D. A., Huppert, J. D., Reimer, S. G., & Moscovitch, M. (2020). The effects of imagery rescripting on memory outcomes in social anxiety disorder. *Journal of Anxiety Disorders*, *69*, 102169. <https://doi.org/10.1016/j.janxdis.2019.102169>
- Rosseel, Y. (2012). lavaan : An R Package for Structural Equation Modeling. *Journal of Statistical Software*, *48*(2). <https://doi.org/10.18637/jss.v048.i02>
- Sansen, L. M., Iffland, B., & Neuner, F. (2015). The trauma of peer victimization: Psychophysiological and emotional characteristics of memory imagery in subjects with social anxiety disorder. *Psychophysiology*, *52*(1), 107–116. <https://doi.org/10.1111/psyp.12291>
- Seinsche, R. J., Fricke, S., Neudert, M. K., Zehntner, R. I., Walter, B., Stark, R., & Hermann, A. (2023a). Memory representation of aversive social experiences in Social Anxiety Disorder. *Journal of Anxiety Disorders*, *94*(2), 102669. <https://doi.org/10.1016/j.janxdis.2023.102669>
- Seinsche, R. J., Fricke, S., Schäfer, A., Neudert, M. K., Zehntner, R. I., Stark, R., & Hermann, A. (2023b). Effects of imagery rescripting on emotional responses during imagination of a socially aversive experience. *Journal of Emotion and Psychopathology*, *1*(1), 113–128.

<https://doi.org/10.55913/joep.v1i1.12>.

- Seinsche, R. J., Walter, B., Fricke, S., Neudert, M. K., Zehtner, R. I., Stark, R., & Hermann, A. (2022). Social phobic beliefs mediate the relationship between post-event processing regarding the worst socially aversive experience and fear of negative evaluation. *Current Psychology (New Brunswick, N.J.)*, 1–10.  
<https://doi.org/10.1007/s12144-022-02805-9>
- Siegesleitner, M., Strohm, M., Wittekind, C. E., Ehring, T., & Kunze, A. E. (2019). Effects of imagery rescripting on consolidated memories of an aversive film. *Journal of Behavior Therapy and Experimental Psychiatry*, 62, 22–29.  
<https://doi.org/10.1016/j.jbtep.2018.08.007>
- Smucker, M. R., & Niederee, J. (1995). Treating incest-related PTSD and pathogenic schemas through imaginal exposure and rescripting. *Cognitive and Behavioral Practice*, 2(1), 63–92. [https://doi.org/10.1016/S1077-7229\(05\)80005-7](https://doi.org/10.1016/S1077-7229(05)80005-7)
- Spence, S. H., & Rapee, R. M. (2016). The etiology of social anxiety disorder: An evidence-based model. *Behaviour Research and Therapy*, 86, 50–67.  
<https://doi.org/10.1016/j.brat.2016.06.007>
- Stangier, U., Heidenreich, T., & Peitz, M. (2003). *Soziale Phobien: Ein kognitiv-verhaltenstherapeutisches Behandlungsmanual* (1. Aufl.). *Praxismaterial*. Beltz.
- Stemberger, R. T., Turner, S. M., Beidel, D. C., & Calhoun, K. S. (1995). Social phobia: An analysis of possible developmental factors. *Journal of Abnormal Psychology*, 104(3), 526–531. <https://doi.org/10.1037/0021-843X.104.3.526>
- Strohm, M., Siegesleitner, M., Kunze, A. E., Ehring, T., & Wittekind, C. E. (2019). Imagery Rescripting of Aversive Autobiographical Memories: Effects on Memory Distress, Emotions, and Feelings of Mastery. *Cognitive Therapy and Research*, 43(6), 1005–1017. <https://doi.org/10.1007/s10608-019-10021-2>
- Strohm, M., Siegesleitner, M., Kunze, A. E., Werner, G. G., Ehring, T., & Wittekind, C. E. (2021). Psychological and Physiological Effects of Imagery Rescripting for Aversive Autobiographical Memories. *Cognitive Therapy and Research*. Advance online publication. <https://doi.org/10.1007/s10608-021-10233-5>
- Szabo, Y. Z., Warnecke, A. J., Newton, T. L., & Valentine, J. C. (2017). Rumination and posttraumatic stress symptoms in trauma-exposed adults: A systematic review and meta-analysis. *Anxiety, Stress, and Coping*, 30(4), 396–414.  
<https://doi.org/10.1080/10615806.2017.1313835>

- Turliuc, M. N., Măirean, C., & Turliuc, M. D. (2015). Rumination and suppression as mediators of the relationship between dysfunctional beliefs and traumatic stress. *International Journal of Stress Management*, 22(3), 306–322.  
<https://doi.org/10.1037/a0039272>
- Wild, J., Hackmann, A., & Clark, D. M. (2007). When the present visits the past: Updating traumatic memories in social phobia. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 386–401. <https://doi.org/10.1016/j.jbtep.2007.07.003>
- Wild, J., Hackmann, A., & Clark, D. M. (2008). Rescripting early memories linked to negative images in social phobia: A pilot study. *Behavior Therapy*, 39(1), 47–56.  
<https://doi.org/10.1016/j.beth.2007.04.003>

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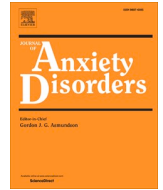
Schließlich gilt mein Dank noch Moritz, der mir auch in stressigen Zeiten immer ein Ausgleich und Anker war.

## Publikationen

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<https://doi.org/10.1016/j.janxdis.2023.102669>
- Seinsche, R. J.**, Fricke, S., Schäfer, A., Neudert, M. K., Zehntner, R. I., Stark, R., & Hermann, A. (2023). Effects of imagery rescripting on emotional responses during imagination of a socially aversive experience. *Journal of Emotion and Psychopathology*, *1*(1), 113-128. <https://doi.org/10.55913/joep.v1i1.12>
- Seinsche, R. J.**, Walter, B., Fricke, S., Neudert, M. K., Zehntner, R. I., Stark, R., & Hermann, A. (2022). Social phobic beliefs mediate the relationship between post-event processing regarding the worst socially aversive experience and fear of negative evaluation. *Current Psychology (New Brunswick, N.J.)*, 1–10.  
<https://doi.org/10.1007/s12144-022-02805-9>
- Doerig, N., **Seinsche, R. J.**, Moisa, M., Seifritz, E., Ruff, C. C., & Kleim, B. (2021). Enhancing reappraisal of negative emotional memories with transcranial direct current stimulation. *Scientific Reports*, *11*(1), 14760.  
<https://doi.org/10.1038/s41598-021-93647-1>
- Hermann, A., Neudert, M. K., Schäfer, A., Zehntner, R. I., Fricke, S., **Seinsche, R. J.**, & Stark, R. (2020). Lasting effects of cognitive emotion regulation: neural correlates of reinterpretation and distancing. *Social Cognitive and Affective Neuroscience*, *16*(1).  
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# Memory representation of aversive social experiences in Social Anxiety Disorder

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## ABSTRACT

Aversive social experiences are proposed to be a risk factor for developing Social Anxiety Disorder (SAD). Many patients with SAD report associated daily life symptoms, such as intrusive re-experiencing (e.g., negatively distorted images of oneself), avoidance, alterations in cognitions and mood, as well as hyperarousal, resembling symptom dimensions of Posttraumatic Stress Disorder (PTSD). These PTSD-like symptoms may result from maladaptive processing and representation of the aversive social experiences in memory. Emotional hyperreactivity during memory retrieval of aversive social experiences is another feature of SAD which was found in previous studies. This study aimed to further investigate PTSD-like symptoms and emotional reactivity associated with etiologically relevant aversive social experiences and shed more light on a potential relationship between both. Eighty-five patients with SAD and 85 healthy controls (HC) participated in this cross-sectional study. It comprised an imagination task with self-report and physiological measures to assess emotional reactivity during the cued recall of the aversive social experience and clinical interviews to assess PTSD-like symptoms. We expected increased emotional reactivity and more severe PTSD-like symptoms in response to the aversive social experience in patients with SAD compared to HC, as well as a positive correlation between emotional reactivity and PTSD-like symptoms in patients with SAD. Indeed, patients with SAD showed emotional hyperreactivity (self-report, physiology) during the cued recall of the aversive social experiences, also when compared to two control memory conditions (neutral, negative non-social) and HC. Patients with SAD furthermore reported more severe PTSD-like symptoms compared to HC and intrusive re-experiencing symptoms were positively correlated with distress during imagery of the social aversive event in patients with SAD. These results might point toward a maladaptive representation of aversive social experiences in memory. Similar to PTSD, this maladaptive memory representation might promote the development of PTSD-like symptoms such as intrusive re-experiencing (e.g., in the form of intrusive self-images in patients with SAD), which might finally lead to and maintain symptoms of SAD.

## General Scientific Summary

Patients with Social Anxiety Disorder report having experienced aversive social events in the past. Emotional hyperreactivity (self-report, physiology) to the cued recall of the aversive social event might indicate maladaptive processing and representation in memory. Maladaptive memory representation might, in turn, trigger symptoms similar to those of Posttraumatic Stress Disorder in daily life associated with the aversive social experience, which

were indeed found to be partly correlated with some measures of emotional reactivity.

## 1. Introduction

Etiological models of Social Anxiety Disorder (SAD) propose aversive social experiences to be an important environmental risk factor for the development of SAD (Beidel & Turner, 2007; pp, 2044; Norton &

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Abbott, 2017a; pp, 2044, 2017b; pp, 2044; Rapee & Spence, 2004; pp, 2044; Spence & Rapee, 2016; pp, 2044). Indeed, patients with SAD can readily recall memories of aversive social experiences, which are linked to distorted images of themselves – a central feature of the disorder (Erwin, Heimberg, Richard, Marx, & Franklin, 2006; pp, 2044; Hackmann, Clark, & McManus, 2000; pp, 2044; Norton & Abbott, 2017a; pp, 2044, 2017b; pp, 2044). These negatively distorted self-images occur spontaneously in social situations and increase anxiety and corresponding symptoms (Hackmann et al., 2000; Hackmann, Surawy, & Clark, 1998). The recurrent and intrusive nature of these self-images is reminiscent of intrusive re-experiencing in Post-traumatic Stress Disorder (PTSD, Bjornsson et al., 2020; Erwin et al., 2006). Moreover, patients with SAD also report symptoms similar to those of patients with PTSD such as intrusive thoughts/images, avoidance of stimuli associated with the event, alterations in cognition/mood, and hyperarousal in response to these aversive social experiences (Bjornsson et al., 2020; Erwin et al., 2006), although these events do not meet Criterion A for traumatic events which is necessary for the diagnosis of PTSD (American Psychiatric Association, 2013). Previous studies, however, show that PTSD-like symptoms such as intrusive re-experiencing may also develop in response to non-traumatic events (e.g. Bjornsson et al., 2020; Erwin et al., 2006; Larsen & Berenbaum, 2017; Larsen & Pacella, 2016). Even though preceding research emphasizes the importance of aversive social experiences for the development of clinical symptoms in SAD (like, e.g., distorted self-images), to date, there is only scarce evidence regarding the nature and impact of these aversive social experiences in memory.

Previous studies indicate differences between patients with SAD and healthy controls (HC) in the memory representation of aversive social experiences. In more detail, patients with SAD show emotional hyperreactivity when the memories are voluntarily recalled (Moscovitch et al., 2018; Sansen, Iffland, & Neuner, 2015). Compared to HC, patients with SAD experience stronger self-reported negative affect, as well as increased autonomic arousal (skin conductance responses [SCRs]) during the cued recall of aversive social experiences (Moscovitch et al., 2018; Sansen et al., 2015). Heart rate (HR, also indicating autonomic arousal) in turn did not differ between patients with SAD and HC, and facial mimetic musculature (corrugator supercilii "frowning muscle", zygomaticus major "smiling muscle, indicating valence) has not yet been investigated. In accordance with Lang (1979) bioinformational theory, Sansen and colleagues (2015) suggest that aversive social experiences might be stored in the form of an associative network linking the representation of the event to cognitive appraisals and original emotional as well as physiological responses. Similar to theories in PTSD (Brewin, Dalgleish, & Joseph, 1996; Foa & Kozak, 1986), the activation of the associative network and the corresponding (emotional) responses might, in turn, contribute to the development of PTSD-like symptoms. However, there are no studies up to date investigating the association of emotional hyperreactivity and PTSD-like symptoms in response to these aversive social experiences in SAD.

The current study aimed to improve our understanding of the nature and impact of aversive social experiences in SAD. Firstly, we aimed to replicate previous findings by Erwin and colleagues (2006), as well as Bjornsson and colleagues (2020), regarding PTSD-like symptoms in response to aversive social experiences in patients with SAD. We expected patients with SAD to report more severe PTSD-like symptoms regarding the aversive social event compared to HC. Our second aim was to investigate emotional hyperreactivity during the cued recall of the aversive social experiences. For this purpose, we aimed to replicate previous findings by Sansen and colleagues (2015), who examined physiological indicators of arousal especially in response to a peer victimisation experience. Extending these findings, we investigated responses to an etiologically relevant aversive social event and additionally examined physiological indicators of valence. We expected patients with SAD compared to HC to show increased autonomic arousal (HR, SCRs), differential responses regarding valence (corrugator supercilii, zygomaticus major), as well as stronger self-reported negative

and lower positive affect for the aversive social event compared to two control memory conditions. Thirdly, extending previous findings, we additionally hypothesized a positive association between emotional hyperreactivity and PTSD-like symptoms in response to the aversive social event in patients with SAD.

## 2. Material and methods

### 2.1. Participants

After a first telephone screening, 114 individuals interested in participating as patients with SAD and 98 as HC recruited from the university mailing list, the associated outpatient clinic, newspaper advertisements, websites and notices in public places (for a study on the processing of memories [HC] and social anxiety [patients with SAD]), were invited to the first session. Six potential patients with SAD did not meet the criteria for SAD, and eleven potential HC were excluded because they fulfilled the criteria for any mental disorder. Eleven patients with SAD were additionally excluded because they met further exclusion criteria (e.g. regular drug consumption in the past, for a detailed list of all inclusion and exclusion criteria for patients with SAD and HC, see Supplementary information A). In addition, 12 patients with SAD and two HC prematurely terminated study participation, leaving a final sample of 85 patients with SAD and 85 HC (age- and gender-matched; for a list of all exclusions, see Supplementary Table 1). In an a priori power analysis, a sample size of 70 participants per group was found to be sufficient to detect significant group differences (*t*-test) at a power of .9 for medium effect sizes of  $d = .5$  (G\*Power, Version 3.1.9.2, Faul, Erdfelder, Lang, & Buchner, 2007). To compensate for expected drop-outs (due to missing values, poor data quality etc.), we increased the sample size by 20 %. Diagnoses of SAD and further mental disorders were assessed with the Diagnostic Interview for Mental Disorders (Margraf, Cwik, Pflug, & Schneider, 2017; Margraf et al., 2017) and the Structured Clinical Interview for DSM-IV Axis II Personality Disorders (SCID-II, (First, 2014)). All patients with SAD included in this study fulfilled the DSM-5 criteria (American Psychiatric Association, 2013) for a primary diagnosis of SAD (preceding any comorbid diagnosis). Additional inclusion criteria for patients with SAD were exceeding cut-off values of 30 in the clinician-administered Liebowitz Social Anxiety Scale (LSAS-CA; Conbruch, Stangier, & Heidenreich, 2016; Fresco et al., 2001; Liebowitz, 1987) or cut-off values of 25 in the Social Phobia Inventory (SPIN; Connor et al., 2000; Susic, Gieler, & Stangier, 2008). Table 1 provides an overview of demographics, diagnoses and

**Table 1**  
Demographics, comorbid diagnoses and previous psychotherapeutic treatment of patients with SAD and HC.

Variable	SAD		HC	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age	26.18	7.52	25.73	6.10
	<i>n</i>	%	<i>n</i>	%
Gender				
Female	66	77.6	66	77.6
Male	19	22.4	19	22.4
Education level				
Less than high school	2	2.4	2	2.4
High school	59	69.4	49	57.6
College degree	24	28.2	34	40.0
None	45	52.9	85	100
One	30	35.3	0	0.0
Two or more	10	11.8	0	0.0
None	56	65.9	85	100
One	25	29.4	0	0
Two	4	4.7	0	0
Psychotherapeutic treatment in the past				
None	58	68.2	85	100
One or more	27	31.8	0	0

Note. SAD = Social Anxiety Disorder; HC = healthy controls.

psychotherapeutic treatment. No differences between patients with SAD and HC were found for age ( $t(168) = 0.43, p = .671$ ), gender ( $\chi^2(1) = 0.00, p = 1.00$ ) and education level ( $U = 3196.5, p = .122$ ). Patients with SAD and HC, however, differed with regard to social anxiety as well as depressive symptoms (see Table 2). Approximately half of all patients with SAD fulfilled the criteria for further comorbid diagnoses (without personality disorders, see Table 1): depression: 17 patients (dysthymia: 7 patients, recurrent depressive disorder: 7 patients, major depression: 3 patients), anxiety disorders: 17 patients (generalized anxiety disorder: 4 patients, separation anxiety: 2 patients, agoraphobia: 2 patients, specific phobia: 9 patients), obsessive-compulsive disorder: 2 patients, somatoform disorder: 3 patients, insomnia: 6 patients, eating disorder: 2 patients, sexual dysfunction: 1 patient, pathological gaming: 1 patient. In addition, approximately one-third of all patients with SAD fulfilled the criteria for a comorbid personality disorder diagnosis: avoidant personality disorder: 24 patients, obsessive-compulsive personality disorder: 5 patients, depressive personality disorder: 2 patients, dependent personality disorder: 1 patient. Participants received €8 – 10 per hour or course credit as compensation for their study participation, and all participants gave written informed consent. The study protocol was approved by the local Ethics Committee of the Faculty of Psychology and Sport Science at the Justus Liebig University Giessen.

## 2.2. Procedure

Data reported in this manuscript were collected during the first and fourth session of a larger project (see Supplementary information B). In the first session, diagnostic interviews and questionnaires were administered to assess participants' eligibility for the study and to gather more information, e.g. about clinical symptoms and three autobiographical events (see Section 2.3). Diagnostic interviews were conducted by two doctoral students with a Master's degree in clinical psychology who were in training to become licensed psychotherapists and were additionally trained to perform clinical interviews prior to the study conductance as well as supervised by a licensed psychotherapist. Within three to 15 days after the first session, the fourth session took place. In the fourth session, the imagination task was conducted (see Section 2.4), and participants were reimbursed and informed about the aims of the study.

## 2.3. Measures

At the first session, the *intensity of social anxiety* in the last week was

assessed with the Social Phobia Inventory (SPIN; Connor et al., 2000; Susic et al., 2008) as well as the clinician-administered Liebowitz Social Anxiety Scale (LSAS-CA; Fresco et al., 2001; Liebowitz, 1987; von Consbruch, Stangier, & Heidenreich, 2016). The SPIN is composed of 17 items, rated on a five-point scale from 0 (not at all) to 4 (extremely) and has demonstrated good psychometric properties (German version: Cronbach's  $\alpha = .91-.95$ , Susic et al., 2008). The clinician-administered Liebowitz Social Anxiety Scale (LSAS-CA; Liebowitz, 1987; German version: Consbruch et al., 2016) was used to assess the intensity of fear and avoidance of social situations in the previous week. Twenty-four items for fear and avoidance each were rated on a 4-point scale from 0 (not at all/never) to 3 (severe/usually). The interview is reported to have good psychometric properties, also in German samples (Cronbach's  $\alpha = .93$ ; Altmann et al., 2021, pp. 2513) and can be used to distinguish between patients with and without SAD (cut-off: 30, Glischinski et al., 2018, pp. 2179). To assess *depressive symptoms* in the last two weeks, we used the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996; Hautzinger, Keller, & Kühner, 2006). The BDI-II sum score comprises 21 items rated on a four-point scale (0 – 3) and showed good psychometric properties in the German version (Cronbach's  $\alpha \geq .84$ ; Kühner, Bürger, Keller, & Hautzinger, 2007). The Clinician-administered PTSD Scale for DSM-5 (CAPS-5; Cwik & Woud, 2015; Spies et al., 2020) was developed to assess a PTSD diagnosis as well as symptom severity. In this study, the interview was used to assess four subscales of PTSD-like symptoms in response to the aversive social and the negative non-social experience according to DSM-5: re-experiencing (five items, e.g. "In the last month, have you had unwanted memories of the event while you were awake, that is, without dreaming?"), avoidance (two items, e.g. "In the last month, have you tried to avoid thoughts or feelings of the event?"), alterations in cognitions or mood (seven items, e.g., "In the past month, have you had strong negative beliefs about yourself, other people, or the world?") and hyperarousal symptoms (six items, e.g., "In the past month, have you felt particularly alert or vigilant even when there was no immediate threat or danger?") in the last month, as well as a sum score of all subscales. The CAPS symptom severity score has demonstrated good psychometric properties (Cohen's  $\alpha = .88-.92$ ) in the German version (Schnyder & Moergeli, 2005).

### 2.3.1. Autobiographical memory interview

An autobiographical memory interview was conducted to select and gather information about three autobiographical experiences (social, negative, neutral). To select the *aversive social experience*, participants

**Table 2**  
Descriptive statistics and group differences (SAD vs HC) of psychometrics.

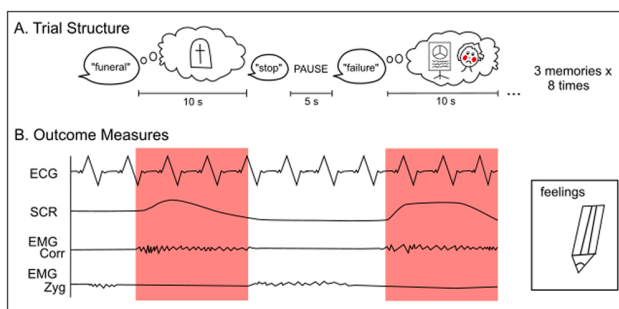
Variable	SAD		HC		Group differences			
	M	SD	M	SD	t	df	p	d
Social anxiety								
LSAS	64.17	20.78	10.06	7.37	22.12	162	< .001	3.48
SPIN	39.07	10.17	7.91	6.08	24.26	168	< .001	3.74
Depression								
BDI-II	12.36	7.99	3.28	3.79	9.22	159	< .001	1.46
PTSD-like symptoms (CAPS) – social event								
Re-experiencing	1.75	2.44	0.12	0.57	5.96	166	< .001	0.93
Avoidance	0.35	0.63	0.01	0.11	4.88	167	< .001	0.76
Cognition/mood	1.66	2.06	0.04	0.19	7.18	165	< .001	1.12
Hyperarousal	0.38	0.95	0.00	0.00	3.60	164	.001	0.56
Sum score	4.35	5.40	0.17	0.76	6.99	163	< .001	1.11
PTSD-like symptoms (CAPS) – negative event								
Re-experiencing	1.05	1.55	0.40	1.02	3.21	165	.002	0.50
Avoidance	0.62	1.00	0.10	0.37	4.52	164	< .001	0.71
Cognition/mood	0.84	1.68	0.05	0.22	4.29	164	< .001	0.67
Hyperarousal	0.26	0.73	0.01	0.11	3.04	165	.003	0.46
Sum score	2.77	3.65	0.56	1.27	5.24	164	< .001	0.82

Note. SAD = social anxiety disorder; HC = healthy controls; LSAS = Liebowitz Social Anxiety Scale; SPIN = Social Phobia Inventory; BDI-II = Beck Depression Inventory-II; CAPS-5 = Clinician-administered PTSD Scale for DSM-5; d = Cohen's d.

indicated the experience of aversive social situations in the past on a list adapted from Erwin et al. (2006). In the next step, participants were introduced to the concept of intrusive self-images. Forty-two patients with SAD and three HC reported the experience of intrusive self-images, and 25 patients with SAD and one HC remembered an associated aversive social experience. For those subjects who reported recalling an event related to the intrusive self-image, this situation was selected for the imagination task. For those who did not report an associated memory, the social event most associated with the beginning of the disorder (patients with SAD) or the worst social event participants have ever experienced was selected. The selected *neutral experience* neither induced strong positive nor negative feelings (e.g. grocery shopping), and the *negative experience* was the worst non-social and non-traumatic event participants had ever experienced (e.g. death of a pet).

#### 2.4. Imagination task

An adapted version of the script-driven imagination tasks already used in several previous studies was applied (McTeague et al., 2009; Sansen et al., 2015). The participants chose one keyword for each memory, reminding them of the assigned event during the autobiographical memory interview in the first session. The keywords were presented via headphones (experimenter's voice) in a pseudorandomized order eight times each with the restriction of no more than two times the same memory in succession (see Fig. 1). Participants were instructed to imagine the indicated event as vividly as possible for 10 s. After the imagination period, a 5 s break indicated by an auditory signal was implemented. Before the task, participants received written instruction (description of the procedure, repetition of the keywords and instruction to imagine the situations as vividly as possible), and a training trial was conducted. During the task, psychophysiological data were recorded. After the imagination task, participants filled in five rating scales concerning their positive and negative feelings, valence (not reported here), arousal, and distress during mental imagery of each situation during the task. The ratings were indicated using the Self-Assessment Manikin (Bradley & Lang, 1994) on a bipolar scale from 0 (unpleasant/relaxed) to 8 (pleasant/aroused) for valence and arousal. Negative as well as positive feelings and distress were rated on 9-point scales ranging from 0 (not at all) to 8 (extremely). In addition, participant's imagery ability was rated ("How well did you manage to put yourself in the situation?") on a 9-point scale from 0 (not at all) to 9 (very good).



**Fig. 1.** Schematic representation of trial structure and outcome measures of the imagination task. Note. ECG = electrocardiogram; SCR = skin conductance response; EMG = electromyogram; Corr = corrugator supercilii; Zyg = zygomaticus major. Panel A presents the trial structure of the imagination task: auditory presentation of the keyword (example: funeral), followed by 10 s imagination phase, followed by auditory stop signal and 5 s pause, followed by next keyword (example: failure) etc. The three keywords were presented in a randomized order eight times each. Panel B presents a schematic description of outcome measures of the imagination task: psychophysiological measures and self-report data (feelings). The red rectangles indicate the 10 s imagination phase.

#### 2.5. Psychophysiological data assessment, reduction and analysis

##### 2.5.1. Data assessment

Psychophysiological data were recorded with the actiChamp Plus amplifier and the Brain Vision Recorder software (Brain Products Gilching, Germany; sampling rate = 1000 Hz). Facial muscle activity of the corrugator supercilii and the zygomaticus major of the left side of the face was assessed using 4-mm electrodes placed according to the recommendations of Fridlund and Cacioppo (1986). Skin conductance responses were obtained through 9-mm electrodes placed on the non-dominant hand, and heart rate was recorded using three disposable electrodes (7.5 mm) applied on the left chest and the left flank.

##### 2.5.2. Data reduction and analysis

Data preprocessing and analysis were performed using Brain Vision Analyzer 2 (Brain Products, Gilching, Germany) and the MATLAB R2018B (The MathWorks, Natick, MA, USA) toolbox Ledalab 3.4.4 ([www.ledalab.de](http://www.ledalab.de)). Raw data were screened, and artefacts were corrected manually. Data were baseline corrected (−1000 to 0 ms), and an average activity was determined for each memory condition. Facial muscle activity data of the *corrugator supercilii* and *zygomaticus major* were filtered (high-pass 30 Hz), rectified, and smoothed (high cut-off = 8 Hz, fourth-order Butterworth filter). For HR analysis, the ECG was converted to interbeat intervals (IBI) using MATLAB scripts, according to Mueller and colleagues (Mueller et al., 2013). *Skin conductance responses* raw data were downsampled and smoothed and participants with less than one SCR during the imagination task (response > 0.01  $\mu$ S) were classified as non-responders and excluded from SCR data analyses ( $n_{SAD} = 7$ ;  $n_{HC} = 14$ ). Trough-to-peak (TTP) analysis in Ledalab 3.4.4 (Benedek & Kaernbach, 2010) was used to extract the response with the maximum amplitude starting during the imagination phase (analysis time window: 0.8 – 10 s).

#### 2.6. Analytical strategy

Differences between patients with SAD and HC in PTSD-like symptoms regarding the social and negative event, respectively, were analyzed using independent *t*-tests. Repeated-measures ANOVAs were used to analyze interaction effects of the between-subject factor *group* (patients with SAD vs HC) and the within-subject factor *memory condition* (social vs neutral, social vs negative) in self-reported affect and physiological responses (*imagination task*). Significant interaction effects were followed by post-hoc *t*-Tests. Separate analyses for comparison of the social event with each of the two control memory conditions were conducted due to the different research questions (1. neutral memory as control condition for baseline differences between the groups; 2. negative memory for specificity analysis). Several control analyses were administered regarding imagery ability, depressiveness, comorbid diagnoses, and prior treatment. To analyze potential associations between emotional reactivity and PTSD-like symptoms regarding the social event in the SAD group, correlational analyses were conducted. The level of significance was determined at  $\alpha = .05$  (two-tailed) with Bonferroni-Holm correction for family-wise error (FWE) for self-reported affective responses, as well as physiological indicators of arousal (HR and SCRs), respectively. Statistical analyses were performed using the Statistical Package for the Social Sciences Software 24.0 (SPSS software 24.0; IBM Corporation, Armonk, NY, USA) for Windows. Missing data were excluded list-wise.

### 3. Results

#### 3.1. PTSD-like symptoms

Patients with SAD reported more severe symptoms of intrusive re-experiencing, avoidance, cognition/mood and hyperarousal regarding the social but also the negative memory condition compared to HC (see

Table 2).

3.2. Emotional reactivity during the cued recall of the aversive social event

3.2.1. Self-reported affect

**Social vs neutral memory condition.** Repeated-measures ANOVAs revealed that patients with SAD experienced stronger negative feelings, arousal and distress, as well as lower positive feelings and valence for the social, compared with the neutral memory condition compared with HC (interaction effects; see Table 3 and Fig. 2, for main effects see Supplementary Table 2). Post-hoc *t*-tests showed that patients with SAD experienced stronger negative affect and lower valence with regard to the social event compared to HC, and both groups did not differ regarding the neutral memory condition (except for arousal, see Supplementary Table 3). In addition to that, both groups experienced stronger negative affect and lower positive affect with regard to the social event compared to the neutral memory condition (see Supplementary Table 4).

**Social vs negative memory condition.** Repeated-measures ANOVAs revealed that patients with SAD also experienced stronger negative feelings, arousal and distress, as well as lower valence for the social, compared with the negative memory condition compared with HC (interaction effects; see Table 3 and Fig. 2, for main effects, see Supplementary Table 5). Post-hoc *t*-tests revealed significant differences between the groups for affective responses regarding the social event (except for positive feelings) and no differences for the negative memory condition (see Supplementary Table 3). In addition to that, affective responses did not differ significantly between the social and negative memory condition in the SAD group, while HC reported significantly lower negative feelings, arousal and distress, as well as greater valence for the social, compared to the negative memory condition (see Supplementary Table 4).

3.2.2. Physiological responses

**Social vs neutral memory condition.** Patients with SAD showed higher HR (lower IBI) and SCRs during mental imagery of the social compared with the neutral event compared with HC (interaction effects, see Table 3 and Fig. 2, for main effects, see Supplementary Table 2). Post-hoc *t*-tests revealed that patients with SAD and HC did not differ significantly in HR regarding the social and neutral memory condition (see Supplementary Table 3). However, patients with SAD experienced greater SCRs in response to the social memory condition compared to HC (see Supplementary Table 3). In addition to that, patients with SAD showed higher HR and SCRs regarding the social compared to the neutral memory condition, while HC did not show any difference between the memory conditions (see Supplementary Table 4). Regarding

facial EMG reactivity (corrugator supercillii, zygomaticus major), repeated-measures ANOVAs revealed no significant differences between patients with SAD and HC for the social compared with the neutral memory condition (see Table 3, Fig. 2, for main effects, see Supplementary Table 2).

**Social vs negative memory condition.** Repeated-measures ANOVAs revealed that patients with SAD showed higher HR and SCRs during mental imagery of the social compared with the negative memory condition compared with HC (see Table 3 and Fig. 2, for main effects, see Supplementary Table 5). Post-hoc *t*-tests revealed no differences in HR between the groups for the social and negative memory condition, respectively (see Supplementary Table 3). However, for SCRs, significant differences between the groups were found for the social (greater SCRs for patients with SAD) and no differences for the negative memory condition. In addition to that, patients with SAD showed no differences in HR between the social and negative memory condition, while HC showed lower HR for the social compared to the negative memory condition (see Supplementary Table 4). SCRs did not differ significantly between the social and negative memory condition in the SAD group, while in the HC group, SCRs were significantly lower during mental imagery of the social compared with the negative memory condition (see Supplementary Table 4). Regarding facial EMG reactivity (corrugator supercillii, zygomaticus major), repeated-measures ANOVAs revealed no significant interaction effects between patients with SAD for the social compared with the negative memory condition (see Table 3 and Fig. 2, for main effects see Supplementary Table 2).

3.2.3. Control analyses

**Imagery ability.** Patients with SAD and HC did not differ significantly in their perceived imagery ability during mental imagery of the social ( $t(167) = 1.02, p = .312, \text{Cohen's } d = 0.16$ ), negative ( $t(167) = -0.62, p = .539, \text{Cohen's } d = 0.10$ ) and neutral memory condition ( $t(167) = 0.33, p = .742, \text{Cohen's } d = 0.05$ ).

**Depressive symptoms.** The consideration of the BDI-II as a covariate did not change the results for self-reported affect, except for positive feelings (social vs neutral) and arousal (social vs negative), which were no longer significant (see Supplementary Table 6). For physiological responses, the interaction effects for SCRs and HR (social vs neutral) were no longer significant when the BDI-II was added as a covariate (no differences for other physiological responses, see Supplementary Table 6).

**Comorbid diagnoses.** Control analyses revealed no significant differences between patients with and without comorbid diagnoses in self-reported affective and physiological responses during the recall of the social compared to both control memory conditions, respectively (see Supplementary Table 7).

**Prior treatment.** No significant differences between patients with

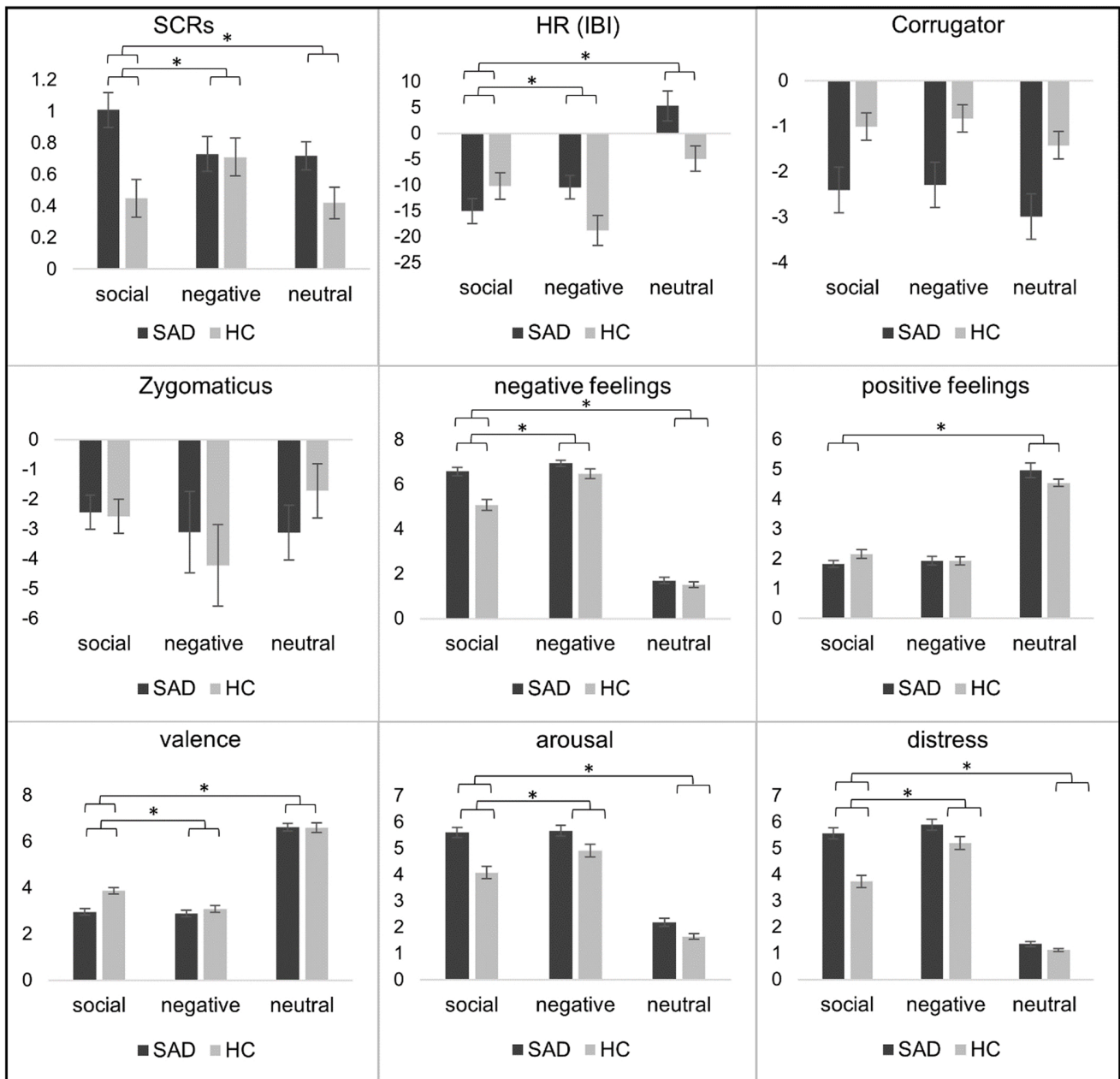
Table 3

Analyses of differences between patients with SAD and HC in responses to the social compared to the negative and neutral memory condition (interaction effects).

Variable	Social vs Negative				Social vs Neutral			
	<i>F</i>	<i>df</i>	<i>p</i>	partial $\eta^2$	<i>F</i>	<i>df</i>	<i>p</i>	partial $\eta^2$
Self-reported affect								
Negative feelings	9.21	1, 167	.003*	.05	14.66	1, 167	< .001*	.08
Positive feelings	2.09	1, 167	.150	.01	4.55	1, 167	.034*	.03
Valence	12.15	1, 167	.001*	.07	7.83	1, 167	.006*	.05
Arousal	6.03	1, 167	.015*	.04	9.39	1, 167	.003*	.05
Distress	11.37	1, 167	.001*	.06	26.79	1, 167	< .001*	.14
Psychophysiology								
HR (IBI)	10.39	1, 161	.002*	.06	6.55	1, 161	.011*	.04
SCRs	9.70	1, 158	.002*	.06	5.05	1, 154	.026*	.03
Corrugator supercillii	0.77	1, 163	.380	.01	0.23	1, 163	.630	.00
Zygomaticus major	0.29	1, 163	.588	.00	1.82	1, 162	.179	.01

Note. SAD = social anxiety disorder; HC = healthy controls; Social = aversive social memory; Negative = negative non-social memory; Neutral = neutral memory; HR = heart rate; IBI = interbeat interval; SCRs = skin conductance responses.

\**p* < .05 after Bonferroni-Holm correction for self-reported affect and psychophysiological indices of arousal (HR, SCRs), respectively.



**Fig. 2.** Differences between patients with SAD and HC in self-reported affect and physiological responses to the social vs negative and social vs neutral memory condition. Note. SAD = Social Anxiety Disorder; HC = healthy controls; SCR= skin conductance responses, HR = heart rate, IBI = interbeat interval. Error bars represent standard errors. \*  $p < .05$  after Bonferroni-Holm correction for self-reported affect and physiological indicators of arousal (HR, SCRs), respectively.

and without prior treatment were found for self-reported affective responses to the recall of the social compared to both memory conditions (see [Supplementary Table 8](#)). However, patients with and without prior treatment differed in their HR regarding the neutral memory condition, with participants with prior treatment showing lower HR during mental imagery of the neutral memory condition (no differences for other physiological responses, see [Supplementary Table 8](#)).

### 3.3. Association between emotional reactivity and PTSD-like symptoms in response to the aversive social event in patients with SAD

Correlational analyses of emotional reactivity (self-reported affect and physiological responses) and PTSD-like symptoms regarding the social event in the SAD group revealed a significant association between

distress and re-experiencing symptoms (see [Table 4](#)). Small associations between negative feelings, valence, distress, SCRs and re-experiencing symptoms, as well as between distress and avoidance ( $r > .2$ ) were in the expected direction but did not reach significance.

## 4. Discussion

This study aimed to shed more light on the nature and impact of aversive social experiences in SAD by investigating associated PTSD-like symptoms and emotional hyperreactivity during the cued recall of the events. As expected, patients with SAD reported more severe PTSD-like symptoms regarding the aversive social event but also regarding a negative non-social experience compared to HC. In addition to that, patients with SAD also showed stronger self-reported negative affect and

**Table 4**

Correlation between PTSD-like symptoms and emotional reactivity regarding the aversive social event in patients with SAD.

	Re-experiencing		Avoidance		Cognition/mood		Hyperarousal	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Self-reported affect								
Negative feelings	.224	.042	.016	.887	.115	.305	.152	.175
Positive feelings	-.109	.328	-.093	.405	-.082	.464	-.153	.173
Valence	-.270	.014	-.151	.172	-.089	.428	-.178	.111
Arousal	.049	.657	.121	.276	-.013	.907	-.071	.531
Distress	.295	.007*	.203	.066	.130	.243	.061	.589
Psychophysiology								
HR (IBI)	-.023	.842	-.134	.235	.015	.898	.022	.851
SCRs	.251	.026	.155	.173	.132	.250	.147	.201
Corrugator supercilii	.102	.360	.098	.379	-.046	.683	.008	.942
Zygomaticus major	-.014	.902	-.083	.459	-.088	.439	-.031	.784

Note. Psychophysiological data for the aversive social memory is contrasted with the neutral memory condition. HR = heart rate; IBI = interbeat interval; SCRs = skin conductance responses.

\* $p < .05$  after Bonferroni-Holm correction for self-reported affect and psychophysiological indices of arousal (HR, SCRs), respectively.

physiological arousal (SCRs) during mental imagery of the aversive social experience, also in comparison to a negative non-social and a neutral control memory condition. Correlational analyses furthermore revealed a significant positive association between distress during imagery of the aversive social event and re-experiencing symptoms regarding the same event.

Our findings are in line with previous results showing stronger self-reported negative affect and SCRs during the reactivation of the aversive social memory in patients with SAD compared to HC (Moscovitch et al., 2018; Sansen et al., 2015). This emotional hyperreactivity, which was evident both in self-report and partly in physiological markers, might indicate a potential activation of an associative network eliciting original emotions that were present during the experience of the event (Lang, 1979; Sansen et al., 2015). It is, however, important to note that some of the effects (social vs neutral: positive feelings, SCRs, HR; social vs negative: arousal) were no longer significant when participants' depressiveness was considered as a covariate so that these measures have to be interpreted cautiously. Consistent with previous findings (Bjornsson et al., 2020; Erwin et al., 2006), patients with SAD also reported more severe PTSD-like symptoms regarding the aversive social event compared to HC.

Theories in PTSD suggest that posttraumatic stress symptoms may develop as a result of maladaptive storage processes in the form of an associative network eliciting strong emotional responses when the network is activated (Brewin et al., 1996; Foa & Kozak, 1986). To further explore this potential association in patients with SAD, we investigated the relationship between emotional reactivity and PTSD-like symptoms regarding the aversive social experience and indeed found a positive correlation between both. More specifically, we found a significant association between distress and re-experiencing symptoms, which might point towards a special importance of emotional responses for the development/existence of e.g., distorted self-images (further non-significant associations between indices of emotional responses and re-experiencing symptoms were in the same direction). These results may indicate a link between the suggested maladaptive storage processes and PTSD-like symptoms, even though further studies conducting mediation analyses are necessary in order to make a statement regarding the causality or direction of the relationship (Kazdin, 2007).

In addition to examining the relationship between emotional reactivity and PTSD-like symptoms, this study also revealed new information regarding specificity with respect to the aversive social event by administering a negative non-social control memory condition. Analyses revealed significant differences between patients with SAD and HC regarding their emotional responses to the recall of the aversive social memory and no differences for the negative non-social memory condition. However, contrary to our hypotheses, patients with SAD did not

experience stronger negative emotional responses during recall of the aversive social compared to the negative non-social memory condition. Previous studies assumed that the aversive social memory was accompanied by differential responses and symptoms, indicating a special relevance for patients with SAD (e.g. Bjornsson et al., 2020; Erwin et al., 2006; Hackmann et al., 2000; Moscovitch et al., 2018), even though no negative non-social memory was investigated as a comparative control condition. Although our results also point to differences between patients with SAD and HC, the lack of differences in the emotional reactivity between the aversive social and the negative non-social memory in the SAD group may indicate that the responses may not be as specific to the social memory as previously thought. Similarly, patients with SAD did not only experience more severe PTSD-like symptoms with regard to the social but also the negative non-social memory condition compared to HC, generally pointing towards more severe PTSD-like symptoms regarding aversive events in SAD. In line with these findings, previous studies on the comorbidity of SAD and PTSD indicate more post-traumatic stress symptoms in response to traumatic events in patients with SAD (with comorbid PTSD, e.g. Kashdan, Barrios, Forsyth, & Steger, 2006; McMillan & Asmundson, 2016). Accordingly, there are already some theoretical considerations regarding a shared vulnerability for PTSD and SAD, e.g., due to unspecific vulnerability factors such as adverse childhood experiences or genetic factors (e.g. Collimore et al., 2010). These shared vulnerabilities and processes might also represent a significant transdiagnostic feature (for an overview, see Brewin, Gregory, Lipton, & Burgess, 2010), as there is growing evidence regarding PTSD-like symptoms in various mental disorders, such as specific phobia (e.g. Jongh, van der Burg, van Overmeir, Aartman, & van Zuuren, 2002; Jongh, Holmshaw, Carswell, & van Wijk, 2011, pp. 680; van Houtem, van Wijk, & Jongh, 2015), panic disorder (e.g. Hagenaaers, van Minnen, Hoogduin, & Verbraak, 2009; O'Toole, Watson, Rosenberg, & Berntsen, 2016; Pfaltz, Michael, Meyer, & Wilhelm, 2013), depression (e.g. Birrer, Michael, & Munsch, 2007; Reynolds & Brewin, 1998), or obsessive-compulsive disorder (e.g. Dykshoorn, 2014; Speckens, Hackmann, Ehlers, & Cuthbert, 2007). Further investigation of these underlying factors is of great importance in order to gain a better understanding of the circumstances that lead to the development of PTSD-like symptoms, which are considered to be a potential maintaining factor for the specific symptomatology of the disorders (e.g. Hackmann et al., 1998; Hackmann et al., 2000).

In addition to these largely consistent results, we did not find any or only inconsistent effects with regard to facial EMG reactivity and HR. We investigated the activity of the facial muscles corrugator supercilii and zygomaticus major as physiological indicators of valence but did not find any differences between patients with SAD and HC during mental imagery of the aversive social event compared to the control memory conditions. These findings partly coincide with self-reported affective

responses, which indicated no specific differences between patients with SAD and HC regarding positive affect. Potentially no differences became evident because the examined events primarily triggered negative emotions, and no positive control memory was used. With regard to the activity of the corrugator supercilii, however, results do not match data regarding self-reported negative affect. Possibly, patients with SAD might control their facial expressions to avoid showing vulnerability (McTeague et al., 2009), complicating the examination of facial EMG reactivity in patients with SAD. Similarly, HR did not differ significantly between patients with SAD and HC for the aversive social event, as well as for both control memory conditions.

## 5. Limitations

Despite the positive aspects of this study with an experimental paradigm using self-report and physiological measures, as well as clinical interviews, there are some limitations worth mentioning. Due to the cross-sectional design and retrospective information about etiological processes, we cannot make a statement on causal relationships between emotional hyperreactivity and the development of PTSD-like symptoms as well as SAD. Longitudinal studies are necessary to verify the presented findings. In addition to that, we did not examine a clinical control group, limiting the interpretability of our results regarding specificity for patients with SAD. This limitation is of particular importance in light of the large number of comorbidities in this study. Especially regarding the transdiagnostic relevance of mental imagery for various mental disorders, also referred to in the previous section, comorbid diagnoses might have an impact on mental imagery of the (aversive) memory conditions and thus might have influenced the results (e.g. Hirsch & Holmes, 2007; Holmes, Blackwell, Burnett Heyes, Renner, & Raes, 2016), even though control analyses revealed no differences in emotional responses between patients with and without comorbid diagnoses. However, differences in effects were found when patients' depressiveness was considered, so results regarding these measures should be interpreted cautiously (even though SAD was the primary diagnosis in all patients). The high number of comorbidities, however, corresponds to representative studies in large samples of patients with SAD reporting that approximately two-thirds of all patients with SAD have at least one other comorbid diagnosis (e.g., Wittchen, Stein, & Kessler, 1999). In addition to that, approximately 30 % of all patients with SAD have undergone prior treatment in the past, which might have affected the results (e.g., due to prior experience in a therapeutic setting or therapeutic interventions targeting negative self-images, e.g., Gordon, Wong, & Heimberg, 2014; Heimberg & Richard, 2002). However, none of the participants has reported that he or she has undergone an intervention directly targeting the aversive social memory (such as Imagery Rescripting) and control analyses did not reveal differences between patients with and without prior treatment (except for HR). Furthermore, to assess PTSD-like symptoms we administered a clinical interview, which was designed to diagnose PTSD and has not yet been used in a sample of patients with SAD with regard to non-traumatic events, so that no statement can be made about the validity of the results. In addition to that, during clinical interviews, no data regarding interrater reliability were assessed, limiting the interpretability of the results. Further limitations are the gender ratio with only 20 % male subjects in our sample (equally distributed within both groups), as well as the low variability regarding age and education level (predominant student sample), which does not reflect the prevalence rates in natural populations (Bandelow & Michaelis, 2015), limiting the transferability of results. In addition, we did not collect information on the race of the subjects, so we cannot make any statement about the distribution of these.

## 6. Conclusions

Etiological models of SAD propose aversive social experiences to be

an important environmental risk factor for the development of SAD. However, the mechanisms or mediating factors still remain unclear. The current study replicated previous findings regarding emotional hyperreactivity (self-report, physiological) during the cued recall of the aversive social experience, as well as corresponding PTSD-like symptoms in patients with SAD compared to HC. In addition to that, positive associations were found between emotional reactivity and particularly re-experiencing with regard to the aversive social event. These results might point towards a maladaptive memory representation of the aversive social experience in the form of an associative network in patients with SAD, which might result in the development of PTSD-like symptoms (see PTSD theories, e.g., Brewin et al., 1996; Foa & Kozak, 1986). Moreover, patients with SAD also experienced stronger negative emotional responses and more severe PTSD-like symptoms with regard to the negative non-social memory condition, potentially indicating a proneness to maladaptive processing or memory representation of aversive events in general. These results further point toward the potential of targeting memory representations of etiologically relevant aversive experiences, e.g., through interventions such as Imagery Rescripting, to reduce PTSD-like symptoms and, finally, social anxiety in psychotherapeutic treatments of SAD (Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Wild & Clark, 2011). Future studies should examine causal relationships between emotional reactivity and PTSD-like symptoms in longitudinal studies and investigate the extent to which psychotherapeutic interventions such as Imagery Rescripting lead to changes in emotional responses and PTSD-like symptoms related to aversive social events in patients with SAD.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.janxdis.2023.102669](https://doi.org/10.1016/j.janxdis.2023.102669).

## References

- Altmann, U., Nodop, S., Dinger, U., Ehrenthal, J. C., Schauenburg, H., Dymel, W., ... Strauss, B. M. (2021). Differential effects of adult attachment in cognitive-behavioural and psychodynamic therapy in social anxiety disorder: A comparison between a self-rating and an observer rating. *Clinical Psychology & Psychotherapy*, 28(2), 373–383. <https://doi.org/10.1002/c>
- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Association. <https://doi.org/10.1176/appi.books.9780890425596>
- Bandelow, B., & Michaelis, S. (2015). Epidemiology of anxiety disorders in the 21st century. *Dialogues in Clinical Neuroscience*, 17(3), 327–335. <https://doi.org/10.31887/DCNS.2015.17.3/bbandelow>
- Beck, A. T., Steer, R. A., & Brown, G. K. (1996). Manual for the Beck Depression Inventory-II. *Psychological Corporation*. <https://doi.org/10.1037/t00742-000>
- Beidel, D. C., & Turner, S. M. (2007). *Shy children, phobic adults: Nature and treatment of social anxiety disorders (2nd ed.)*. American Psychological Association. <https://doi.org/10.1037/11533-000>
- Benedek, M., & Kaernbach, C. (2010). A continuous measure of phasic electrodermal activity. *Journal of Neuroscience Methods*, 190(1), 80–91. <https://doi.org/10.1016/j.jneumeth.2010.04.028>
- Birrer, E., Michael, T., & Munsch, S. (2007). Intrusive images in PTSD and in traumatised and non-traumatised depressed patients: A cross-sectional clinical study. *Behaviour*

- Research and Therapy*, 45(9), 2053–2065. <https://doi.org/10.1016/j.brat.2007.03.005>
- Bjornsson, A. S., Hardarson, J. P., Valdimarsdottir, A. G., Gudmundsdottir, K., Tryggvadottir, A., Thorarindottir, K., ... Thorisdottir, A. S. (2020). Social trauma and its association with posttraumatic stress disorder and social anxiety disorder. *Journal of Anxiety Disorders*, 72, Article 102228. <https://doi.org/10.1016/j.janxdis.2020.102228>
- Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, 25(1), 49–59. [https://doi.org/10.1016/0005-7916\(94\)90063-9](https://doi.org/10.1016/0005-7916(94)90063-9)
- Brewin, C. R., Dalgleish, T., & Joseph, S. (1996). A dual representation theory of posttraumatic stress disorder. *Psychological Review*, 103(4), 670–686. <https://doi.org/10.1037/0033-295X.103.4.670>
- Brewin, C. R., Gregory, J. D., Lipton, M., & Burgess, N. (2010). Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. *Psychological Review*, 117(1), 210–232. <https://doi.org/10.1037/a0018113>
- Connor, K. M., Davidson, J. R., Churchill, L. E., Sherwood, A., Foa, E., & Weisler, R. H. (2000). Psychometric properties of the Social Phobia Inventory (SPIN). New self-rating scale. *The British Journal of Psychiatry: The Journal of Mental Science*, 176, 379–386. <https://doi.org/10.1192/bjp.176.4.379>
- Consrbruch, K., Stangier, U. [U.], & Heidenreich, T. [T.]. (2016). *Soziale Angst-Skalen (SOZAS)*. SIAS, SPS, SPIN, LSAS. Hogrefe.
- von Consrbruch, K., Stangier, U. [Ulrich], & Heidenreich, T. [Thomas] (2016). *Skalen zur Sozialen Angststörung*. Hogrefe.
- Cwik, J. C., & Woud, M. L. (2015). Deutsche Übersetzung Der CLINICIAN-ADMINISTERED PTSD scale for DSM-5 (CAPS-5). *Health Research and Treatment Center*.
- Dykshoorn, K. L. (2014). Trauma-related obsessive-compulsive disorder: A review. *Health Psychology and Behavioral Medicine*, 2(1), 517–528. <https://doi.org/10.1080/21642850.2014.905207>
- Erwin, B. A., Heimberg, R. G., Richard, G., Marx, B. P., & Franklin, M. E. (2006). Traumatic and socially stressful life events among persons with social anxiety disorder. *Journal of Anxiety Disorders*, 20(7), 896–914. <https://doi.org/10.1016/j.janxdis.2005.05.006>
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G\*power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175–191. <https://doi.org/10.3758/BF03193146>
- First, M. B. (2014). Structured Clinical Interview for the DSM (SCID). In R. L. Cautin, & S. O. Lilienfeld (Eds.), *The Encyclopedia of Clinical Psychology* (pp. 1–6). John Wiley & Sons, Inc. <https://doi.org/10.1002/9781118625392.wbcp351>
- Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin*, 99(1), 20–35. <https://doi.org/10.1037/0033-2909.99.1.20>
- Fresco, D. M., Coles, M. E., Heimberg, R. G., Liebowitz, M. R., Hami, S., Stein, M. B., & Goetz, D. (2001). The Liebowitz Social Anxiety Scale: A comparison of the psychometric properties of self-report and clinician-administered formats. *Psychological Medicine*, 31(6), 1025–1035. <https://doi.org/10.1017/S0033291701004056>
- Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for Human Electromyographic Research. *Psychophysiology*, 22(5).
- Glischinski, M., von Willutzki, U., Stangier, U., Hiller, W., Hoyer, J., Leibing, E., ... Hirschfeld, G. (2018). Liebowitz Social Anxiety Scale (LSAS): Optimal cut points for remission and response in a German sample. *Clinical Psychology & Psychotherapy*, 25(3), 465–473. <https://doi.org/10.1002/c>
- Gordon, D., Wong, J., & Heimberg, R. G. (2014). Cognitive-Behavioral Therapy for Social Anxiety Disorder: The State of the Science. In J. W. Weeks (Ed.), *Wiley online library. The Wiley Blackwell handbook of social anxiety disorder* (pp. 475–497). Wiley Blackwell. <https://doi.org/10.1002/9781118653920.ch22>
- Hackmann, A., Clark, D. M., & McManus, F. (2000). Recurrent images and early memories in social phobia. *Behaviour Research and Therapy*, 38, 601–610.
- Hackmann, A., Surawy, C., & Clark, D. M. (1998). Seeing yourself through others' eyes: A study of spontaneously occurring images in social phobia. *Behavioural and Cognitive Psychotherapy*, 26(1), 3–12. <https://doi.org/10.1017/S1352465898000022>
- Hagenaars, M. A., van Minnen, A., Hoogduin, C. A. L., & Verbraak, M. (2009). A transdiagnostic comparison of trauma and panic memories in PTSD, panic disorder, and healthy controls. *Journal of Behavior Therapy and Experimental Psychiatry*, 40(3), 412–422. <https://doi.org/10.1016/j.jbtep.2009.04.001>
- Hautzinger, M., Keller, F., & Kühner, C. (2006). *Das Beck Depressionsinventar II. Deutsche Bearbeitung und Handbuch zum BDI II*. Harcourt Test Services.
- Heimberg, R. G., & Richard, G. (2002). Cognitive-behavioral therapy for social anxiety disorder: current status and future directions. *Biological Psychiatry*, 51(1), 101–108. [https://doi.org/10.1016/S0006-3223\(01\)01183-0](https://doi.org/10.1016/S0006-3223(01)01183-0)
- Hirsch, C. R., & Holmes, E. A. (2007). Mental imagery in anxiety disorders. *Psychiatry*, 6(4), 161–165. <https://doi.org/10.1016/j.mppsy.2007.01.005>
- Holmes, E. A., Blackwell, S. E., Burnett Heyes, S., Renner, F., & Raes, F. (2016). Mental Imagery in Depression: Phenomenology, Potential Mechanisms, and Treatment Implications. *Annual Review of Clinical Psychology*, 12, 249–280. <https://doi.org/10.1146/annurev-clinpsy-021815-092925>
- Jongh, A. de, van der Burg, J., van Overmeir, M., Aartman, I., & van Zuuren, F. (2002). Trauma-related sequelae in individuals with a high level of dental anxiety. Does this interfere with treatment outcome? *Behaviour Research and Therapy*, 40(9), 1017–1029. [https://doi.org/10.1016/S0005-7967\(01\)00081-X](https://doi.org/10.1016/S0005-7967(01)00081-X)
- Jongh, A. de, Holmslaw, M., Carswell, W., & van Wijk, A. (2011). Usefulness of a trauma-focused treatment approach for travel phobia. *Clinical Psychology & Psychotherapy*, 18(2), 124–137. <https://doi.org/10.1002/c>
- Kashdan, T. B., Barrios, V., Forsyth, J. P., & Steger, M. F. (2006). Experiential avoidance as a generalized psychological vulnerability: Comparisons with coping and emotion regulation strategies. *Behaviour Research and Therapy*, 44(9), 1301–1320. <https://doi.org/10.1016/j.brat.2005.10.003>
- Kazdin, A. E. (2007). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical Psychology*, 3, 1–27. <https://doi.org/10.1146/annurev.clinpsy.3.022806.091432>
- Kühner, C., Bürger, C., Keller, F., & Hautzinger, M. (2007). Reliabilität und Validität des revidierten Beck-Depressionsinventars (BDI-II). Befunde aus deutschsprachigen Stichproben [Reliability and validity of the Revised Beck Depression Inventory (BDI-II). Results from German samples]. *Der Nervenarzt*, 78(6), 651–656. <https://doi.org/10.1007/s00115-006-2098-7>
- Lang, P. J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, 16(6), 495–512. <https://doi.org/10.1111/j.1469-8986.1979.tb01511.x>
- Larsen, S. E., & Berenbaum, H. (2017). Did the DSM-5 Improve the Traumatic Stressor Criterion? Association of DSM-IV and DSM-5 Criterion A with Posttraumatic Stress Disorder Symptoms. *Psychopathology*, 50(6), 373–378. <https://doi.org/10.1159/000481950>
- Larsen, S. E., & Pacella, M. L. (2016). Comparing the effect of DSM-congruent traumas vs. Dsm-incongruent stressors on PTSD symptoms: A meta-analytic review. *Journal of Anxiety Disorders*, 38, 37–46. <https://doi.org/10.1016/j.janxdis.2016.01.001>
- Liebowitz, M. R. (1987). Social phobia. *Modern Problems of Pharmacopsychiatry*, 22, 141–173. <https://doi.org/10.1159/000414022>
- Margraf, J., Cwik, J. C., Pflug, V., & Schneider, S. (2017). Strukturierte klinische Interviews zur Erfassung psychischer Störungen über die Lebensspanne. *Zeitschrift Für Klinische Psychologie Und Psychotherapie*, 46(3), 176–186. <https://doi.org/10.1026/1616-3443/a000430>
- Margraf, J., Cwik, J.C., Suppiger, A., & Schneider, S. (2017). *DIPS Open Access: Diagnostisches Interview bei psychischen Störungen*. <https://doi.org/10.13154/rub.100.89>
- McMillan, K. A., & Asmundson, G. J. G. (2016). Ptsd, social anxiety disorder, and trauma: An examination of the influence of trauma type on comorbidity using a nationally representative sample. *Psychiatry Research*, 246, 561–567. <https://doi.org/10.1016/j.psychres.2016.10.036>
- McTeague, L. M., Lang, P. J., Laplante, M.-C., Cuthbert, B. N., Strauss, C. C., & Bradley, M. M. (2009). Fearful imagery in social phobia: Generalization, comorbidity, and physiological reactivity. *Biological Psychiatry*, 65(5), 374–382. <https://doi.org/10.1016/j.biopsych.2008.09.023>
- Moscovitch, D. A., Vidovic, V., Lenton-Brym, A. P., Dupasquier, J. R., Barber, K. C., Hudd, T., ... Romano, M. (2018). Autobiographical memory retrieval and appraisal in social anxiety disorder. *Behaviour Research and Therapy*, 107, 106–116. <https://doi.org/10.1016/j.brat.2018.06.008>
- Norton, A. R., & Abbott, M. J. (2016). The efficacy of imagery rescripting compared to cognitive restructuring for social anxiety disorder. *Journal of Anxiety Disorders*, 40, 18–28. <https://doi.org/10.1016/j.janxdis.2016.03.009>
- Norton, A. R., & Abbott, M. J. (2017aaa). Bridging the Gap between Aetiological and Maintaining Factors in Social Anxiety Disorder: The Impact of Socially Traumatic Experiences on Beliefs, Imagery and Symptomatology. *Clinical Psychology & Psychotherapy*, 24(3), 747–765. <https://doi.org/10.1002/c>
- Norton, A. R., & Abbott, M. J. (2017bbb). The Role of Environmental Factors in the Aetiology of Social Anxiety Disorder: A Review of the Theoretical and Empirical Literature. *Behaviour Change*, 34(2), 76–97. <https://doi.org/10.1017/bec.2017.7>
- O'Toole, M. S., Watson, L. A., Rosenberg, N. K., & Berntsen, D. (2016). Negative autobiographical memories in social anxiety disorder: A comparison with panic disorder and healthy controls. *Journal of Behavior Therapy and Experimental Psychiatry*, 50, 223–230. <https://doi.org/10.1016/j.jbtep.2015.09.008>
- Pfaltz, M. C., Michael, T., Meyer, A. H., & Wilhelm, F. H. (2013). Reexperiencing symptoms, dissociation, and avoidance behaviors in daily life of patients with PTSD and patients with panic disorder with agoraphobia. *Journal of Traumatic Stress*, 26(4), 443–450. <https://doi.org/10.1002/jts.21822>
- Rapee, R. M., & Spence, S. H. (2004). The etiology of social phobia: Empirical evidence and an initial model. *Clinical Psychology Review*, 24(7), 737–767. <https://doi.org/10.1016/j.cpr.2004.06.004>
- Reimer, S. G., & Moscovitch, D. A. (2015). The impact of imagery rescripting on memory appraisals and core beliefs in social anxiety disorder. *Behaviour Research and Therapy*, 75, 48–59. <https://doi.org/10.1016/j.brat.2015.10.007>
- Reynolds, M., & Brewin, C. R. (1998). Intrusive cognitions, coping strategies and emotional responses in depression, post-traumatic stress disorder and a non-clinical population. *Behaviour Research and Therapy*, 36(2), 135–147. [https://doi.org/10.1016/S0005-7967\(98\)00013-8](https://doi.org/10.1016/S0005-7967(98)00013-8)
- Sansen, L. M., Iffland, B., & Neuner, F. (2015). The trauma of peer victimization: Psychophysiological and emotional characteristics of memory imagery in subjects with social anxiety disorder. *Psychophysiology*, 52(1), 107–116. <https://doi.org/10.1111/psyp.12291>
- Schnyder, U., & Moergeli, H. (2005). German version of Clinician-Administered PTSD Scale. *Journal of Traumatic Stress*, 15(6), 487–492. <https://doi.org/10.1023/A:1020922023090>
- Sosic, Z., Gieler, U., & Stangier, U. (2008). Screening for social phobia in medical in- and outpatients with the German version of the Social Phobia Inventory (SPIN). *Journal of Anxiety Disorders*, 22(5), 849–859. <https://doi.org/10.1016/j.janxdis.2007.08.011>
- Speckens, A. E. M., Hackmann, A., Ehlers, A., & Cuthbert, B. (2007). Imagery special issue: Intrusive images and memories of earlier adverse events in patients with obsessive compulsive disorder. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 411–422. <https://doi.org/10.1016/j.jbtep.2007.09.004>

- Spence, S. H., & Rapee, R. M. (2016). The etiology of social anxiety disorder: An evidence-based model. *Behaviour Research and Therapy*, *86*, 50–67. <https://doi.org/10.1016/j.brat.2016.06.007>
- Spies, J.-P., Woud, M. L., Kessler, H., Rau, H., Willmund, G. D., Köhler, K., ... Cwik, J. C. (2020). Psychometric properties of the German version of the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5) in clinical routine settings: Study design and protocol of a multitrait-multimethod study. In *BMJ Open*, *10*. <https://doi.org/10.1136/bmjopen-2019-036078>
- van Houtem, C. M. H. H., van Wijk, A. J., & Jongh, A. de (2015). Presence, Content, and Characteristics of Memories of Individuals with Dental Phobia. *Applied Cognitive Psychology*, *29*(4), 515–523. <https://doi.org/10.1002/acp.3127>
- Wild, J., & Clark, D. M. (2011). Imagery Rescripting of Early Traumatic Memories in Social Phobia. *Cognitive and Behavioral Practice*, *18*(4), 433–443. <https://doi.org/10.1016/j.cbpra.2011.03.002>
- Wittchen, H. U., Stein, M. B., & Kessler, R. C. (1999). Social fears and social phobia in a community sample of adolescents and young adults: Prevalence, risk factors and comorbidity. *Psychological Medicine*, *29*(2), 309–323. <https://doi.org/10.1017/S0033291798008174>



# Social phobic beliefs mediate the relationship between post-event processing regarding the worst socially aversive experience and fear of negative evaluation

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## Abstract

The experience of socially aversive events is proposed to be a critical etiological factor in the development of social anxiety symptoms even though the experience itself is also common among healthy individuals. Rather than the event itself, accompanying factors such as maladaptive processing might be associated with higher levels of social anxiety symptoms. One-hundred-seventy-four individuals participated in this online-survey comprising questionnaires regarding social anxiety symptoms and retrospective reports concerning maladaptive processing of the worst socially aversive event. Structural equation modelling was used to analyze the hypothesized mediation of maladaptive processing and fear of negative evaluation by intrusive re-experiencing and social phobic beliefs. The positive association between retrospectively evaluated maladaptive processing after the worst socially aversive event and fear of negative evaluation was mediated by social phobic beliefs but not by intrusive re-experiencing. These results point towards the relevance of further investigating processing strategies after socially aversive events as a potential influencing factor for SAD development.

Trial registration.

The trial was registered at the German Clinical Trial Register (DRKS00021502) on June 3<sup>rd</sup>, 2020.

**Keywords** Post-event processing · Etiologically relevant socially aversive events · Structural equation modelling · Cognitive model of PTSD

## Introduction

Socially aversive experiences are proposed to be an important environmental risk factor for the development of Social Anxiety Disorder (SAD; Rapee & Spence, 2004; Spence & Rapee, 2016). These experiences are often linked to distorted self-images contributing to the maintenance of social anxiety symptoms by increasing

the assumed threat of social situations (Clark & Wells, 1995; Hackmann et al., 1998, 2000; Rapee & Heimberg, 1997). However, the experience of socially aversive events is not limited to patients with SAD, as many healthy individuals also report having experienced such events (e.g. Bjornsson et al., 2020; Carleton et al., 2011; Erwin et al., 2006). The relationship between these socially aversive events and the development of social anxiety symptoms resembles the aetiology of Posttraumatic Stress Disorder (PTSD). Beyond that, patients with SAD also suffer from posttraumatic stress symptoms such as avoidance, hyperarousal and intrusive re-experiencing, especially in the form of distorted self-images linked to early socially aversive events (Bjornsson et al., 2020; Carleton et al., 2011; Edwards et al., 2003; Erwin et al., 2006; Hackmann et al., 2000; Mellings & Alden, 2000; Rachman et al., 2000). Both patients with SAD and PTSD further experience negative beliefs related to the aversive event increasing the assumed threat of current situations (Clark

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& Wells, 1995; Ehlers & Clark, 2000; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Tutus & Goldbeck, 2016). These similarities indicate potential benefits from taking PTSD models into account to investigate the relationship between the experience of socially aversive events and social anxiety symptoms (Carleton et al., 2011; Norton & Abbott, 2017; Sansen et al., 2015).

According to the cognitive model of PTSD (Ehlers & Clark, 2000), maladaptive processing strategies after traumatic events play a significant role in the development of posttraumatic stress symptoms like intrusive re-experiencing and negative event-related beliefs (Brewin et al., 2010; Ehlers & Clark, 2000; Ehlers & Steil, 1995; Turliuc et al., 2015). Strategies like rumination, thought suppression or avoidance reduce distress related to the aversive event in the short-term by distracting attention from negative feelings (Michael et al., 2007). However, in the long-term, they impede adequate processing of the event by preventing problem-solving processes and the event's integration into long-term memory (Ehlers & Clark, 2000; Ehlers & Steil, 1995; Turliuc et al., 2015). Previous studies on the association between maladaptive processing strategies and PTSD symptoms after traumatic events have primarily been investigating by means of cross-sectional studies and retrospective evaluations of processing strategies (for an overview see Szabo et al., 2017), indicating significant associations between both constructs.

In their cognitive model of SAD, Clark and Wells (1995) propose that SAD patients also engage in maladaptive processing of current social situations. They repeatedly engage in negative reviews about the experience and especially their performance (Abbott & Rapee, 2004; Clark & Wells, 1995; McEvoy & Kingsep, 2006). This so-called '12' in SAD comprises cognitive and behavioral strategies such as rumination and avoidance resembling maladaptive processing strategies of traumatic events in PTSD (Clark & Wells, 1995; Ehlers & Clark, 2000; Rachman et al., 2000). Previous studies on the relationship between post-event processing and social anxiety have shown that post-event processing of recent socially aversive events is strongly associated with social anxiety in samples of students as well as patients (Dannahy & Stopa, 2007; McEvoy & Kingsep, 2006; Mellings & Alden, 2000; Rachman et al., 2000). Similar to maladaptive processing of traumatic events in PTSD, positive associations have also been found for post-event processing of recent socially aversive events with negative social phobic beliefs and intrusive re-experiencing in response to aversive social events (Abbott & Rapee, 2004; McEvoy & Kingsep, 2006; Rachman et al., 2000). Increasing negative self-evaluations of performance, post-event processing might finally prevent distorted self-images, as well as negative self-beliefs to update (Abbott & Rapee, 2004; Mellings & Alden, 2000; Norton & Abbott, 2017).

In sum, previous studies have demonstrated an association between etiologically relevant socially aversive events and key maintaining factors like intrusive self-images and negative self-beliefs in SAD. However, yet unclear are the processes by which these etiological and maintaining factors of SAD are linked. Previous findings from cross-sectional and longitudinal studies in PTSD show that (retrospectively evaluated) maladaptive processing strategies like rumination or avoidance are critical factors, both for the development and the maintenance of the disorder. Also in SAD, post-event processing of current aversive social situations contributes to the maintenance of anxiety symptoms. However, until now, little is known about the role of post-event processing in response to socially aversive events with potential etiological relevance. The aim of this online survey in a non-clinical student sample was to investigate retrospective reports about the intensity of post-event processing after the experience of the worst socially aversive event the participants have ever experienced. We selected the worst socially aversive event as an approximation of an etiologically relevant event because we studied a sample with varying degrees of fear of negative evaluation (FNE). More specifically, we were interested, whether individuals with higher levels of FNE retrospectively report having experienced more post-event processing after the worst socially aversive event. Fear of negative evaluation is a construct closely related to social anxiety and has shown to be suitable for analogous samples (Clark & Wells, 1995; Rapee & Heimberg, 1997; Stopa & Clark, 2001). It was also found to be associated with post-event processing in a non-clinical sample (Dannahy & Stopa, 2007). We were additionally interested in the relationship between post-event processing regarding the worst socially aversive event and intrusive re-experiencing (composed of intrusive thoughts and memories, 'here-and-now quality', nightmares, distress and bodily reactions while remembering) according to PTSD criteria, as well as general social phobic beliefs (composed of negative self-beliefs, expectations of social inadequacy and excessive social performance standards). Socially aversive events are associated with negative self-beliefs and intrusive re-experiencing, which in turn increase anxiety in social situations contributing to the maintenance of the disorder (e.g. Norton & Abbott, 2017). According to cognitive models of PTSD, maladaptive processing strategies of the event (resembling post-event processing in SAD) rather than the traumatic event itself play an essential role in the development of intrusive re-experiencing and negative beliefs (e.g. Ehlers & Clark, 2000). Therefore, we hypothesized that the relationship between retrospectively reported post-event processing after the worst socially aversive event and FNE is mediated by the frequency of intrusive re-experiencing regarding the same event, as well as social phobic beliefs. As retrospective estimations of post-event processing might be biased, we additionally investigated the association between

emotion regulation styles and the same variables in further analyses. Results of previous studies in PTSD have indicated similarities between trait-like emotion regulation styles and event-related processing strategies (Allbaugh et al., 2016; Cann et al., 2011).

## Material and Methods

### Participants

Four-hundred-forty-seven adults ( $\geq 18$  years) recruited from a local university's mailing list participated in this online survey. Two-hundred-seventy participants were excluded because of early termination of the survey, and three participants were excluded because they did not report having experienced a socially aversive event, leaving a final sample of 174 participants. Participants were on average 25.07 years old ( $SD = 6.42$  years, range = 18 – 56 years), and the majority of participants were female (73.0%). Sixty-nine per cent of all participants reported high school graduation as their highest educational level, 28.2% a university degree and 2.3% a secondary school leaving certificate. Prior to data collection, we determined a minimum sample size of  $N = 129$  to detect significant ( $\alpha = 0.05$ ) medium-sized effects ( $f^2 = 0.15$ ) for multiple regression analyses (4 predictors: FNE, post-event processing, social phobic beliefs, intrusive re-experiencing) with a power of 0.95 (G\*Power, Version 3.1.9.2, Faul et al., 2007). All participants gave informed consent, and the study protocol was approved by the local ethics committee.

### Procedure

Participants were asked to fill in several questionnaires via the online tool Sosci Survey (Leiner, 2019). First, participants completed a questionnaire listing socially aversive situations and were asked to recall their worst socially aversive event. This was followed by questionnaires concerning post-event processing and posttraumatic stress symptoms, as well as characteristics of the memory (not reported in this manuscript) concerning this worst socially aversive event, as well as questionnaires regarding FNE, negative social phobic beliefs, emotion regulation strategies and depressiveness. After completing all questionnaires, participants could participate in a raffle for two 50€ vouchers.

### Questionnaires

#### Fear of negative evaluation

The intensity of FNE was assessed with the German version of the self-report questionnaire 'Fear of Negative Evaluation

Scale' (FNES; Watson & Friend, 1969; German version: Vormbrock & Neuser, 1983). The FNES is depicting a central component of social anxiety, namely the fear to make a negative impression on other people, using 20 items rated on a 4-point scale ranging from 1 (almost never) to 4 (almost every time). Vormbrock and Neuser (1983) reported a good internal consistency for the German version, and reliability analysis in our sample revealed a Cronbach's  $\alpha$  of 0.905.

#### Social phobic beliefs

Dysfunctional social phobic beliefs were assessed using the German version of the 'Social Attitudes Questionnaire' (SAQ; Clark, 1995; Stangier et al., 1996). Fifty items were rated on a 7-point scale ranging from 0 (not at all) to 6 (completely) examining negative self-beliefs, expectations of social inadequacy and excessive social performance standards (e.g. German translation of "I am not acceptable.", "My fear is obvious for other people.", "I have to do all things right to get accepted."). Internal consistency is reported to be acceptable to high (Mitte et al., 2007). Reliability analysis for our sample also showed good reliability (Cronbach's  $\alpha = 0.962$ ).

#### Depressiveness

Depressiveness was assessed to describe the sample further and was measured with the depression scale of the German version of the 'Depression-Anxiety-Stress-Scale-21' (DASS-21; Lovibond & Lovibond, 1995; Nilges & Essau, 2015). Seven items were rated on a 4-point scale ranging from 0 (not at all) to 3 (very much/most of the time). The psychometric properties of the German version are reported to be good (Nilges & Essau, 2015). Reliability analysis for our sample also revealed good internal consistency (Cronbach's  $\alpha = 0.909$ ).

#### Emotion regulation strategies

The German questionnaire 'Heidelberg Form of Emotion Regulation Strategies' (HFERST; Izadpanah et al., 2019) was used to examine the regular usage of eight emotion regulation strategies (rumination, reappraisal, acceptance, problem solving, suppression of emotional expression, suppression of emotional experience, avoidance, social support). In this manuscript we focused on the dysfunctional strategies (rumination, avoidance, experience suppression, expressive suppression), as these strategies are described as aspects of post-event processing (see Clark & Wells, 1995). The internal consistency of the individual subscales was reported to be good (Cronbach's  $\alpha > 0.8$ , Izadpanah et al., 2019) and reliability analysis in our sample revealed acceptable to good reliability for rumination (Cronbach's  $\alpha = 0.882$ ),

avoidance (Cronbach's  $\alpha=0.769$ ), expressive suppression (Cronbach's  $\alpha=0.716$ ) and experience suppression (Cronbach's  $\alpha=0.815$ ). Three to four items are rated on a 5-point scale ranging from 1 (never) to 5 (always) for each subscale.

### Socially aversive event

Participants completed a questionnaire inquiring whether they had ever experienced any of the listed socially aversive situations of various nature, such as showing poor performance in public, being ridiculed by authorities or being bullied by other children (adapted from Erwin et al., 2006). There was also an open response option to make sure that all potential situations were covered. Participants were instructed to choose the worst socially aversive situation they had ever experienced. Questionnaires concerning intrusive re-experiencing (see sect. [Intrusive re-experiencing](#)) and post-event processing (see sect. [Post-event processing](#)) refer to this worst socially aversive event. Participants were excluded if they chose an event that happened in the last four weeks because PTSD symptoms are diagnosed at the earliest four weeks after the traumatic event (Falkai et al., 2018).

### Intrusive re-experiencing

An adapted version of the German version of the 'Posttraumatic Diagnostic Scale' (PTDS; Foa et al., 1997; Griesel et al., 2006) was used to investigate the frequency of the experience of posttraumatic stress symptoms related to the worst socially aversive event (see sect. [Socially aversive event](#)) in the last four weeks (e.g. intrusive re-experiencing, avoidance, hyperarousal). Besides, participants were asked if they had indicated problems (at least one of the previous section's posttraumatic stress symptoms) related to the aversive event in the last four weeks. If they had experienced problems, it was also assessed whether these had affected participants in various areas of their lives (e.g. work, relationship with friends, eroticism). The PTDS also collects data concerning the event's time (6 categories: less than one month ago, one to three months ago, three to six months ago, six months to three years ago, three to five years ago, more

than five years ago). This manuscript only focused on the intrusive re-experiencing scale composed of 5 items regarding intrusive thoughts and memories, 'here-and-now quality', nightmares, distress and bodily reactions while remembering. The items were rated on a 4-point scale ranging from 0 (never or only one time in the last month) to 3 (five or more times a week/nearly always), and a sum score of all five items was used. Psychometric properties of the German version of the PTDS have shown to be good (Griesel et al., 2006). Reliability analysis of the intrusive re-experiencing scale in our sample revealed a Cronbach's  $\alpha$  of 0.869.

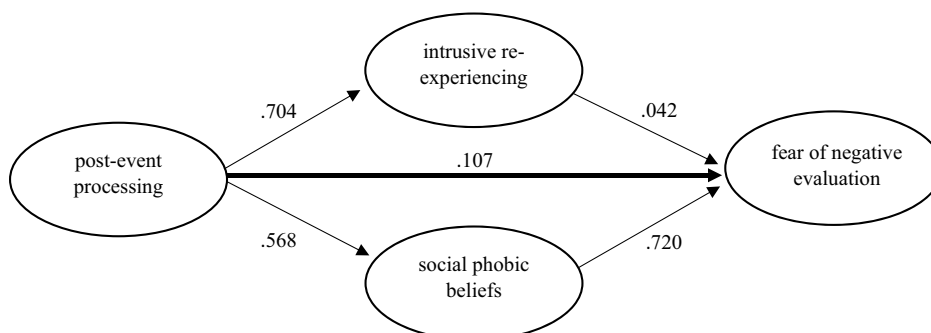
### Post-event processing

Post-event processing regarding the worst socially aversive event was assessed using the German version of the 'Post-event Processing Questionnaire' (PEPQ; Rachman et al., 2000; German revised version: Fehm et al., 2008). The PEPQ assesses post-event processing by subsuming different cognitive and emotional processing strategies after socially aversive events, e.g. thought suppression, avoidance or rumination, and negative consequences of the memory, e.g., interference with concentration and negative emotional responses. It consists of 17 items rated on a visual analogue scale from 0 (none/never/not at all) to 100 (very strong). Participants were instructed to rate the items regarding their worst socially aversive event (see sect. [Socially aversive event](#)). Reliability analysis in our sample showed good internal consistency (Cronbach's  $\alpha=0.895$ ).

### Statistical analyses

Structural equation modelling (SEM) was performed to analyze the relationship between post-event processing and social anxiety. We hypothesized a direct relationship and a mediation by intrusive re-experiencing and social phobic beliefs, respectively (see Fig. 1). Post-hoc analyses were computed with emotion regulation styles (rumination, avoidance, expressive suppression and experience suppression; instead of post-event processing) and their relationship with

**Fig. 1** Standardized coefficients for the relationship between post-event processing (PEPQ), intrusive re-experiencing (PTDS), social phobic beliefs (SAQ) and fear of negative evaluation (FNES)



FNE, social phobic beliefs and intrusive re-experiencing (see Supplementary tables 1 – 5). SEM makes use of multivariate techniques to estimate the hypothesized relationship between independent and dependent variables based on the observed covariance matrix of measured variables (Beaujean, 2014) and was performed using R (Version 4.0.2; R Core Team, 2017) with the R package lavaan (Version 0.6 – 7; Rosseel, 2012).

Manifest variables in the SEM consisted of all items of the FNES (FNE), all items of the intrusive re-experiencing scale of the PTSD (intrusive re-experiencing), all items of the PEPQ (post-event processing) and all items of the SAQ (social phobic beliefs). Prior to analysis, missing data were excluded list-wise. Normality (Shapiro Wilk Test,  $p < 0.05$ ), skewness and kurtosis (Mardia's test,  $p < 0.05$ ) were assessed, revealing a violation of multivariate normal distribution. Thus, we used standard maximum likelihood estimation of model parameters with robust standard errors and a Satorra-Bentler scaling of test statistics. For the evaluation of overall model fit, we relied on Hooper et al., (2008), who consider a comparative fit index (CFI)  $> 0.95$ , a root mean square error (RMSEA)  $< 0.07$ , and a standardized root mean square residual (SRMR)  $< 0.08$  as acceptable fit.

## Results

### Characteristics of the socially aversive events

The intensity of FNE and depressiveness varied largely across the sample (see Table 1), and all participants reported that they had experienced at least one socially aversive event.

**Table 1** Descriptive statistics of fear of negative evaluation (FNES), social phobic beliefs (SAQ), post-event processing (PEPQ), intrusive re-experiencing (PTDS), depressiveness (DASS) and emotion regulation strategies (HFERST)

Variable	<i>M</i>	<i>SD</i>	Range
Fear of negative evaluation	52.632	11.869	23–77
Social phobic beliefs	120.402	53.643	18–271
Post-event processing	855.563	365.480	68–1700
Intrusive re-experiencing	3.718	3.641	0–15
Depressiveness	7.270	5.878	0–21
Emotion regulation strategies			
Rumination	14.977	4.251	4–20
Reappraisal	11.670	3.676	4–20
Acceptance	9.477	2.973	3–15
Problem solving	15.351	3.593	4–20
Expressive suppression	13.115	3.564	4–20
Experience suppression	10.126	3.805	4–20
Avoidance	9.828	2.817	3–15
Social support	6.345	2.659	2–10

To further describe the socially aversive events, we report the recalled content category and timeframe of the events, which may be subject to memory bias. Categories of the worst socially aversive events reported varied between participants: 20.1% indicated that they had been rejected or excluded, 19.5% had been ridiculed by their peers, 13.2% had been criticized for their appearance, 10.9% had given a poor performance in public, 8.6% had been bullied by parents or authorities, and 8.0% chose the open response option. The remaining 19.7% of the participants reported having experienced one of the remaining categories as the worst socially aversive event ( $< 7%$  for each category). The time at which the event occurred also differed between subjects: The majority of participants reported that they remembered that the event had occurred more than five years ago (67.2%), followed by six months to 3 years ago (14.9%) and 3 to 5 years ago (13.2%). The remaining 4.6% reported that the event had occurred in the last six months. None of the participants reported that the event had happened in the previous four weeks. More than two-thirds of all participants (69.5%) reported in the PTSD (Foa et al., 1997; Griesel et al., 2006) that they had experienced posttraumatic stress symptoms related to the event in the last four weeks (e.g. intrusions, avoidance, concentration difficulties). These problems have reportedly affected participants in the following areas of their daily life: Relationships with friends (57.9%), entertainment/recreation (42.1%), education (41.3%), relationship to family members (28.9%), work (27.3%), housework (23.1%) and eroticism (23.1%). More than half of the participants (61.2%) reported that their overall life satisfaction had been affected by consequences of the event during the last four weeks.

### Mediation analysis

Correlation analyses revealed significant correlations between all four variables (see Table 2). The SEM investigated social phobic beliefs (SAQ) and intrusive re-experiencing (PTDS) as mediators between post-event processing (PEPQ) and FNE (FNES), respectively (see Fig. 1). The model displayed an acceptable fit (robust CFI = 0.688, robust RMSEA = 0.067, SRMR = 0.078). All standardized

**Table 2** Pearson correlations between fear of negative evaluation (FNES), social phobic beliefs (SAQ), post-event processing (PEPQ) and intrusive re-experiencing (PTDS)

Variable	Fear of negative evaluation	Social phobic beliefs	Post-event processing
Social phobic beliefs	.750		
Post-event processing	.463	.524	
Intrusive re-experiencing	.384	.419	.590

Note. All  $p < .001$

**Table 3** Structural equation model (SEM) for the relationship between fear of negative evaluation (FNES), intrusive re-experiencing (PTSD), social phobic beliefs (SAQ), and post-event processing (PEPQ)

Path	$\beta$	$p$	$SE$
Fear of negative evaluation ←			
Intrusive re-experiencing	.042	.587	.094
Social phobic beliefs	.720	<.001	.142
Post-event processing	.107	.307	.177
Social phobic beliefs ←			
Post-event processing	.568	<.001	.117
Intrusive re-experiencing ←			
Post-event processing	.704	<.001	.112

Note.  $\beta$  = standardized regression coefficients

**Table 4** Direct and indirect pathways from post-event processing (PEPQ) to fear of negative evaluation (FNES)

Pathways	$\beta$	$p$	$SE$
Direct pathway			
Fear of negative evaluation ← post-event processing	.107	.307	.177
Indirect pathways			
Fear of negative evaluation ← social phobic beliefs ← post-event processing	.409	<.001	.131
Fear of negative evaluation ← intrusive re-experiencing ← post-event processing	.030	.585	.092
Total effect	.546	<.001	.159

Note.  $\beta$  = standardized regression coefficients

regression coefficients of latent variables on manifest variables were at least 0.160 (median = 0.640).

We examined several paths from post-event processing to FNE (see Fig. 1 and Tables 3 and 4). The direct path showed only a small effect ( $\beta = 0.107$ ). Most prominent was a path showing an effect mediated by social phobic beliefs ( $\beta = 0.409$ ). Post-event processing also showed a strong association with intrusive re-experiencing ( $\beta = 0.704$ ), but a relation of intrusive re-experiencing and FNE barely existed, which resulted in a mediation effect of only  $\beta = 0.042$ . Thus, we can conclude that the substantial effect of post-event processing on FNE resulted from mediation by social phobic beliefs only.

Further correlational analyses of the relationship between dysfunctional emotion regulation styles (rumination, avoidance, expressive suppression, experience suppression), post-event processing, social phobic beliefs, intrusive re-experiencing and FNE revealed significant correlations between all variables except for expressive suppression and intrusive re-experiencing, as well as experience suppression and intrusive re-experiencing (see Supplementary table 1). Hence, separate mediation models were calculated for rumination

and avoidance (see Supplementary tables 2 – 5; Bonferroni correction for multiple testing:  $\alpha = 0.025$ ). The relationship of both, rumination and avoidance, respectively, and FNE was mediated by social phobic beliefs but not by intrusive re-experiencing.

## Discussion

This study is a first approach to investigate maladaptive processing strategies after early socially aversive experiences (similar to PTSD). Since there are no long-term studies on this topic yet, the aim of this online survey in a student sample was to investigate retrospective reports of post-event processing after the worst socially aversive event and its association with social anxiety symptoms, similar to previous cross-sectional studies in PTSD (see Szabo et al., 2017). We expected the association of post-event processing after the worst socially aversive event and FNE to be mediated by intrusive re-experiencing of the same event as well as social phobic beliefs. As hypothesized, post-event processing after the worst socially aversive event was positively related to self-reported FNE, as well as intrusive re-experiencing and social phobic beliefs. Furthermore, the relationship between post-event processing and FNE was mediated by social phobic beliefs, while no mediation effect was found for intrusive re-experiencing. As retrospective reports regarding post-event processing can be biased, we have included current dysfunctional emotion regulation styles in the analyses to approximate a current measure of post-event processing and analyses indeed revealed similar results. However, being no substitute for prospective studies, results have to be interpreted with caution. Nevertheless, this might be a first indication of the potential role of dysfunctional processing strategies after aversive experiences, not only in PTSD but also regarding social anxiety.

Our results are in line with previous findings that the mere experience of socially aversive events is not specific for developing social anxiety symptoms, as previously demonstrated in SAD (Bjornsson et al., 2020; Erwin et al., 2006). In this heterogeneous sample in terms of FNE, nearly all (except three) participants were able to report a socially threatening event from their past. Beyond that, many participants reported that these events continued to result in various problems such as intrusive re-experiencing, avoidance or concentration difficulties that affected different areas in their lives in the last four weeks. These findings further support the relevance of investigating factors potentially contributing to the development of social anxiety after socially aversive events.

Moreover, our results show that retrospective reports of post-event processing are associated with today's self-reported FNE, being a first indication towards an association

between both constructs. These results are also in line with previous studies on post-event processing after traumatic events in PTSD, as well as post-event processing after recent socially aversive events in SAD (Brewin et al., 2010; Ehlers & Clark, 2000; Ehlers & Steil, 1995; Szabo et al., 2017; Turliuc et al., 2015). In this study, post-event processing of the worst socially aversive event was further associated with social phobic beliefs mediating the relationship between post-event processing and FNE. As in PTSD, post-event processing may lead to a biased recall of the memory by interfering with adaptive changes to the meaning of the event resulting in persistent negative self-beliefs (Brewin et al., 1996; Ehlers & Clark, 2000). However, due to our cross-sectional design, we cannot conclude the relevance of post-event processing for SAD development. We do not know whether participants with a higher level of FNE experienced increased post-event processing after the event. It is equally possible that looking back, participants with higher levels of FNE think about the event in a more negative way. In addition, the initial level of social anxiety during the time when the worst socially aversive event happened remains unknown. However, post-hoc correlational and mediation analyses revealed a significant correlation between dysfunctional emotion regulation styles and post-event processing, as well as a significant mediation effect of social phobic beliefs on the relationship between these emotion regulation styles and FNE (see Supplementary tables 1 to 5). Similarities in 14 may indicate that individuals with higher levels of trait rumination and avoidance might also have experienced more post-event processing regarding the socially aversive event. Previous studies on PTSD indicate a temporal stability of the association between trait-like emotion regulation styles and event-related processing (e.g. Allbaugh et al., 2016; Cann et al., 2011). In addition, the positive correlation between emotion regulation styles and intrusive re-experiencing after the aversive social event further points towards an association between emotion regulation strategies and PTSD symptoms in SAD patients, similar to PTSD (Frewen et al., 2012; Pugach et al., 2020; Sippel et al., 2016). At the same time, this may also indicate that the habitual use of maladaptive emotion regulation strategies might be a risk factor for post-event processing of socially aversive events and, finally, the development of social anxiety. These uncertainties demonstrate the importance of further investigating processing strategies after socially aversive events as influencing factors for the development of SAD. To rule out potential memory biases and confirm temporal relationships, longitudinal studies in children and adolescents are necessary.

Intrusive re-experiencing was found to be no significant mediator of post-event processing and FNE even though previous studies in PTSD suggest that maladaptive processing such as rumination leads to intrusive recollections

of the aversive event (e.g. Ehlers & Steil, 1995; Michael et al., 2007). Posttraumatic stress symptoms after socially aversive events in SAD may differ in their form between SAD and PTSD, with a focus on intrusive distorted self-images in SAD (Carleton et al., 2011; Erwin et al., 2006; Hackmann et al., 2000), which were not explicitly assessed by the PTDS (Griesel et al., 2006). Furthermore, the PTDS assesses the frequency of intrusive re-experiencing regarding the socially aversive event in the last four weeks. The data of this study were collected during a statewide domestic quarantine due to the Covid-19 pandemic. Thus, participants probably were not confronted with many social situations at that time. However, intrusive re-experiencing regarding aversive events is typically triggered by similar stimuli (in this case, social situations) and thus might not have been as present during this time as in other months. Questionnaires concerning FNE and social phobic beliefs might not have been influenced as strongly, as they examine traits and not experiences exclusively in the last four weeks.

These are only preliminary results that must be interpreted with caution. First of all, mediation analyses in our cross-sectional design may be biased due to the lack of temporal ordering between post-event processing, intrusive re-experiencing, social phobic beliefs and FNE (Cole & Maxwell, 2003; Maxwell & Cole, 2007). The retrospective reports of the time frame, as well as further aspects (e.g. category, processing) of the experiences could also be biased. Longitudinal studies with clear temporal ordering are necessary to examine the relationship between the constructs. Moreover, the model tested in this manuscript explains only 25% of the variance of FNE. In addition to that, we derived our hypotheses based on PTSD models even though we only investigated intrusive re-experiencing and no other PTSD symptoms. We decided to examine only intrusive re-experiencing because there is already some evidence on intrusive re-experiencing in SAD and its association with post-event processing (Hackmann et al., 2000; Norton & Abbott, 2017; Rachman et al., 2000). Besides, by examining a non-clinical sample, we cannot make a statement on the clinical relevance of post-event processing after the worst socially aversive event in patients with SAD. Additionally, we did not measure social anxiety but FNE (even though the constructs are closely related; Clark & Wells, 1995; Rapee & Heimberg, 1997; Stopa & Clark, 2001).

## Conclusion

These preliminary findings are a first indication that post-event processing after the experience of socially aversive events may not only play a role in the maintenance of social anxiety but might also be an essential factor

regarding etiologically relevant socially aversive events. Prospective studies are highly important to validate these results. Overlapping symptoms and similarities in the aetiology of PTSD and SAD point towards benefits from integrating both models for a better understanding of the development of SAD.

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## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest to disclose.

**Compliance with ethical standards** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the local Ethics Committee of the Faculty of Psychology and Sport Science at the Justus Liebig University Giessen.

**Consent to participate** Informed consent was obtained from all individual participants included in the study.

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## References

- Abbott, M. J., & Rapee, R. M. (2004). Post-event rumination and negative self-appraisal in social phobia before and after treatment. *Journal of Abnormal Psychology, 113*(1), 136–144. <https://doi.org/10.1037/0021-843X.113.1.136>
- Allbaugh, L. J., Wright, M., & O'D., & Folger, S. F. (2016). The role of repetitive thought in determining posttraumatic growth and distress following interpersonal trauma. *Anxiety, Stress, and Coping, 29*(1), 21–37. <https://doi.org/10.1080/10615806.2015.1015422>
- Beaujean, A. A. (2014). Latent Variable Modeling Using R. *Routledge*. <https://doi.org/10.4324/9781315869780>
- Bjornsson, A. S., Hardarson, J. P., Valdimarsdottir, A. G., Gudmundsdottir, K., Tryggvadottir, A., Thorarinsdottir, K., Wessman, I., Sigurjonsdottir, Ó., Davidsdottir, S., & Thorisdottir, A. S. (2020). Social trauma and its association with posttraumatic stress disorder and social anxiety disorder. *Journal of Anxiety Disorders, 72*
- Brewin, C. R., Dalgleish, T., & Joseph, S. (1996). A dual representation theory of posttraumatic stress disorder. *Psychological Review, 103*(4), 670–686. <https://doi.org/10.1037//0033-295X.103.4.670>
- Brewin, C. R., Gregory, J. D., Lipton, M., & Burgess, N. (2010). Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. *Psychological Review, 117*(1), 210–232. <https://doi.org/10.1037/a0018113>
- Cann, A., Calhoun, L. G., Tedeschi, R. G., Triplett, K. N., Vishnevsky, T., & Lindstrom, C. M. (2011). Assessing posttraumatic cognitive processes: The event related rumination inventory. *Anxiety, Stress, and Coping, 24*(2), 137–156. <https://doi.org/10.1080/10615806.2010.529901>
- Carleton, R. N., Peluso, D. L., Collimore, K. C., & Asmundson, G. J. G. (2011). Social anxiety and posttraumatic stress symptoms: The impact of distressing social events. *Journal of Anxiety Disorders, 25*(1), 49–57. <https://doi.org/10.1016/j.janxdis.2010.08.002>
- Clark, D. M. (1995). *Social attitudes questionnaire (SAQ)*. Oxford University, Oxford, UK.
- Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg (Ed.), *Social phobia: diagnosis, assessment, and treatment*. Guilford Press.
- Cole, D. A., & Maxwell, S. E. (2003). Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology, 112*(4), 558–577. <https://doi.org/10.1037/0021-843X.112.4.558>
- Dannahy, L., & Stopa, L. (2007). Post-event processing in social anxiety. *Behaviour Research and Therapy, 45*(6), 1207–1219. <https://doi.org/10.1016/j.brat.2006.08.017>
- Edwards, S. L., Rapee, R. M., & Franklin, J. (2003). Postevent rumination and recall bias for a social performance event in high and low socially anxious individuals. *Cognitive Therapy and Research, 27*(6), 603–617.
- Ehlers, A., & Steil, R. (1995). Maintenance of intrusive memories in posttraumatic stress disorder: A cognitive approach. *Behavioural and Cognitive Psychotherapy, 23*, 217–249.
- Ehlers, A., & Clark, D. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy, 38*, 319–345.
- Erwin, B. A., Heimberg, R. G., Marx, B. P., & Franklin, M. E. (2006). Traumatic and socially stressful life events among persons with social anxiety disorder. *Journal of Anxiety Disorders, 20*(7), 896–914. <https://doi.org/10.1016/j.janxdis.2005.05.006>

- Falkai, P., Wittchen, H.-U., Döpfner, M., Gaebel, W., Maier, W., Rief, W., Saß, H., & Zaudig, M. (Eds.). (2018). *Diagnostisches und statistisches Manual psychischer Störungen DSM-5®* (2. korrigierte Auflage, deutsche Ausgabe). Hogrefe
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2007). G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175–191. <https://doi.org/10.3758/BF03193146>
- Fehm, L., Hoyer, J., Schneider, G., Lindemann, C., & Klusmann, U. (2008). Assessing post-event processing after social situations: A measure based on the cognitive model for social phobia. *Anxiety, Stress, and Coping*, 21(2), 129–142. <https://doi.org/10.1080/10615800701424672>
- Foa, E. B., Cashman, L., Jaycox, L., & Perry, K. (1997). The validation of a self-report measure of posttraumatic stress disorder: The posttraumatic diagnostic scale. *Psychological Assessment*, 9(4), 445–451. <https://doi.org/10.1037/1040-3590.9.4.445>
- Frewen, P. A., Dozois, D. J. A., Neufeld, R. W. J., & Lanius, R. A. (2012). Disturbances of emotional awareness and expression in posttraumatic stress disorder: Meta-mood, emotion regulation, mindfulness, and interference of emotional expressiveness. *Psychological Trauma: Theory, Research, Practice, and Policy*, 4(2), 152–161. <https://doi.org/10.1037/a0023114>
- Griesel, D., Wessa, M., & Flor, H. (2006). Psychometric qualities of the german version of the posttraumatic diagnostic scale (ptsd). *Psychological Assessment*, 18(3), 262–268. <https://doi.org/10.1037/1040-3590.18.3.262>
- Hackmann, A., Clark, D. M., & McManus, F. (2000). Recurrent images and early memories in social phobia. *Behaviour Research and Therapy*, 38, 601–610.
- Hackmann, A., Surawy, C., & Clark, D. M. (1998). Seeing yourself through others' eyes: A study of spontaneously occurring images in social phobia. *Behavioural and Cognitive Psychotherapy*, 26(1), 3–12. <https://doi.org/10.1017/S1352465898000022>
- Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural equation modelling: Guidelines for determining model fit. Advance online publication. <https://doi.org/10.21427/D7CF7R>
- Izadpanah, S., Barnow, S., Neubauer, A. B., & Holl, J. (2019). Development and validation of the heidelberg form for emotion regulation strategies (hferst): Factor structure, reliability, and validity. *Assessment*, 26(5), 880–906. <https://doi.org/10.1177/1073191117720283>
- Leiner, D. J. (2019). *Sosci survey (version 3.1.06) [computer software]*. <https://www.socsisurvey.de>. Accessed 31 Mar 2020
- Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the depression anxiety stress scales (dass) with the beck depression and anxiety inventories. *Behaviour Research and Therapy*, 33(3), 335–343.
- Makkar, S. R., & Grisham, J. R. (2011). Social anxiety and the effects of negative self-imagery on emotion, cognition, and post-event processing. *Behaviour Research and Therapy*, 49(10), 654–664. <https://doi.org/10.1016/j.brat.2011.07.004>
- Maxwell, S. E., & Cole, D. A. (2007). Bias in cross-sectional analyses of longitudinal mediation. *Psychological Methods*, 12(1), 23–44. <https://doi.org/10.1037/1082-989X.12.1.23>
- McEvoy, P. M., & Kingsep, P. (2006). The post-event processing questionnaire in a clinical sample with social phobia. *Behaviour Research and Therapy*, 44(11), 1689–1697. <https://doi.org/10.1016/j.brat.2005.12.005>
- Mellings, T. M. B., & Alden, L. E. (2000). Cognitive processes in social anxiety: The effects of self-focus, rumination and anticipatory processing. *Behaviour Research and Therapy*, 38, 243–257.
- Michael, T., Halligan, S. L., Clark, D. M., & Ehlers, A. (2007). Rumination in posttraumatic stress disorder. *Depression and Anxiety*, 24(5), 307–317. <https://doi.org/10.1002/da.20228>
- Mitte, K., Heidenreich, T., & Stangier, U. (2007). *Diagnostik bei sozialen Phobien. Kompendien psychologische Diagnostik: (Vol. 9)*. Hogrefe.
- Nilges, P., & Essau, C. (2015). Die Depressions-Angst-Stress-Skalen: Der DASS—ein Screeningverfahren nicht nur für Schmerzpatienten [Depression, anxiety and stress scales: DASS—A screening procedure not only for pain patients]. *Schmerz (berlin, Germany)*, 29(6), 649–657. <https://doi.org/10.1007/s00482-015-0019-z>
- Norton, A. R., & Abbott, M. J. (2016). The efficacy of imagery rescripting compared to cognitive restructuring for social anxiety disorder. *Journal of Anxiety Disorders*, 40, 18–28. <https://doi.org/10.1016/j.janxdis.2016.03.009>
- Norton, A. R., & Abbott, M. J. (2017). Bridging the gap between aetiological and maintaining factors in social anxiety disorder: The impact of socially traumatic experiences on beliefs, imagery and symptomatology. *Clinical Psychology & Psychotherapy*, 24(3), 747–765. <https://doi.org/10.1002/cpp.2044>
- Pugach, C. P., Campbell, A. A., & Wisco, B. E. (2020). Emotion regulation in posttraumatic stress disorder (ptsd): Rumination accounts for the association between emotion regulation difficulties and ptsd severity. *Journal of Clinical Psychology*, 76(3), 508–525. <https://doi.org/10.1002/jclp.22879>
- Rachman, S., Grüter-Andrew, J., & Shafran, R. (2000). Post-event processing in social anxiety. *Behaviour Research and Therapy*, 38, 611–617.
- Rapee, R. M., & Heimberg, R. G. (1997). A cognitive-behavioral model of anxiety in social phobia. *Behaviour Research and Therapy*, 35(8), 741–756.
- Rapee, R. M., & Spence, S. H. (2004). The etiology of social phobia: Empirical evidence and an initial model. *Clinical Psychology Review*, 24(7), 737–767. <https://doi.org/10.1016/j.cpr.2004.06.004>
- R Core Team (2017) R: A Language and Environment for Statistical Computing. <https://www.R-project.org/>
- Reimer, S. G., & Moscovitch, D. A. (2015). The impact of imagery rescripting on memory appraisals and core beliefs in social anxiety disorder. *Behaviour Research and Therapy*, 75, 48–59. <https://doi.org/10.1016/j.brat.2015.10.007>
- Rosseel, Y. (2012). Lavaan : An r package for structural equation modeling. *Journal of Statistical Software*, 48(2). <https://doi.org/10.18637/jss.v048.i02>
- Sansen, L. M., Iffland, B., & Neuner, F. (2015). The trauma of peer victimization: Psychophysiological and emotional characteristics of memory imagery in subjects with social anxiety disorder. *Psychophysiology*, 52(1), 107–116. <https://doi.org/10.1111/psyp.12291>
- Sippel, L. M., Roy, A. M., Southwick, S. M., & Fichtenholtz, H. M. (2016). An examination of the roles of trauma exposure and posttraumatic stress disorder on emotion regulation strategies of operation iraqi freedom, operation enduring freedom, and operation new dawn veterans. *Cognitive Behaviour Therapy*, 45(5), 339–350. <https://doi.org/10.1080/16506073.2016.1183037>
- Spence, S. H., & Rapee, R. M. (2016). The etiology of social anxiety disorder: An evidence-based model. *Behaviour Research and Therapy*, 86, 50–67. <https://doi.org/10.1016/j.brat.2016.06.007>
- Stangier, U., Heidenreich, T., Ehlers, A., & Clark, D. M. (1996). *Fragebogen zu sozialphobischen Einstellungen (SPE)*. Johann Wolfgang Goethe Universität Frankfurt am Main.
- Stopa, L., & Clark, D. M. (2001). Social phobia: Comments on the viability and validity of an analogue research strategy and british norms of the fear of negative evaluation questionnaire.

- Behavioural and Cognitive Psychotherapy*, 29(4), 423–430. <https://doi.org/10.1017/S1352465801004039>
- Szabo, Y. Z., Warnecke, A. J., Newton, T. L., & Valentine, J. C. (2017). Rumination and posttraumatic stress symptoms in trauma-exposed adults: A systematic review and meta-analysis. *Anxiety, Stress, and Coping*, 30(4), 396–414. <https://doi.org/10.1080/10615806.2017.1313835>
- Turliuc, M. N., Măirean, C., & Turliuc, M. D. (2015). Rumination and suppression as mediators of the relationship between dysfunctional beliefs and traumatic stress. *International Journal of Stress Management*, 22(3), 306–322. <https://doi.org/10.1037/a0039272>
- Tutus, D., & Goldbeck, L. (2016). Posttraumatic symptoms and cognitions in parents of children and adolescents with ptsd. *European Child & Adolescent Psychiatry*, 25(9), 997–1005. <https://doi.org/10.1007/s00787-016-0821-x>
- Vormbrock, F., & Neuser, J. (1983). Konstruktion zweier spezifischer Fragebögen zur Erfassung von Angst in sozialen Situationen (SANB und SVSS). *Diagnostica*, 29(2), 165–182.
- Watson, D., & Friend, R. (1969). Measurement of social-evaluative anxiety. *Journal of Consulting and Clinical Psychology*, 33(4), 448–457. <https://doi.org/10.1037/h0027806>

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# Effects of Imagery Rescripting on Emotional Responses During Imagination of a Socially Aversive Experience

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## Abstract

Imagery rescripting (ImRs) of socially aversive memories is a promising intervention in the treatment of Social Anxiety Disorder. Little is known about the effects of ImRs on physiological responses to the rescripted socially aversive memory, which was the focus of this study in a healthy sample. Thirty individuals performed an imagination task measuring psychophysiological responses and subjective feelings (post-hoc) related to the rescripted memory, as well as to two control memories. In a within-subject design, participants completed the imagination task before and after a control intervention, and subsequently after one session ImRs of the socially aversive memory. At one-week follow-up, lasting effects on social anxiety and subjective feelings were assessed online ( $N = 26$ ). ImRs of the socially aversive memory resulted in a significant reduction in negative feelings and activity of the corrugator supercilii, as well as a significant increase in valence and positive feelings related to the socially aversive memory compared to both control memories. However, only effects for positive feelings and corrugator supercilii were significantly stronger for ImRs compared to the control intervention. Lasting effects appeared for fear of negative evaluation and subjective emotional responses to the rescripted memory. These findings give preliminary evidence for the impact of ImRs on emotional aspects of the rescripted memory, indicating that ImRs might work through changing the representation of the aversive event in memory.

**Keywords** social anxiety; unconditioned stimulus revaluation; psychophysiology; posttraumatic memory characteristics

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Imagery rescripting (ImRs) is a transdiagnostic psychotherapeutic intervention taking into account the importance of aversive events as a core etiological feature in many psychiatric disorders (e.g., Grunert et al., 2013; Nilsson et al., 2012; Norton & Abbott, 2016; Smucker & Neiderdee, 1995). Attaining promising effects in the treatment of Posttraumatic Stress Disorder (PTSD, e.g., Grunert et al., 2003; Smucker & Neiderdee, 1995), ImRs was also found to reduce symptoms in Social Anxiety Disorder (SAD, e.g., Lee & Kwon, 2013; Nilsson et al., 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Wild et al., 2007; 2008). However, underlying mechanisms of ImRs still remain largely unknown. Unconditioned stimulus

(UCS) revaluation theory suggests that ImRs leads to changes in the (emotional) meaning of the memory (representation of the UCS), impacting the association of the conditioned stimulus (CS) with the UCS and thus modulating the intensity of the conditioned response (Arntz, 2011, 2012; Davey, 1989). Accordingly, previous studies in SAD, PTSD as well as in healthy samples found that ImRs impacts emotional responses to the rescripted memory, such as distress, valence, fear, sadness or guilt (e.g., Arntz et al., 2007; Kunze et al., 2019; Siegesleitner et al., 2019; Strohm et al., 2019; Lee & Kwon, 2013; Nilsson et al., 2012; Romano et al., 2020; Wild et al., 2007). Related to these findings, ImRs was also found to have an effect

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on other aspects of the memory, such as vividness and cognitions (Hagenaars & Arntz, 2012).

Despite of the growing evidence regarding ImRs effects on self-reported emotional responses, until now, only few studies have investigated the impact of ImRs on psychophysiological correlates. Previous studies revealed reductions in heart rate (HR) during ImRs in participants with increased health anxiety (Tolgou et al., 2018), as well as increased heart rate variability in response to social stress after ImRs in SAD patients (Hyett et al., 2018). While these studies provide preliminary evidence that ImRs in general affects psychophysiological parameters during and also after the intervention, until now little is known about psychophysiological responses to the rescripted memory. Strohm and colleagues (2021) were the first to investigate effects of ImRs compared to a control intervention (positive imagery) on psychophysiological responses during reactivation of the rescripted memory in a nonclinical sample. They found a reduction in HR (as an indicator for arousal) and activity of the corrugator supercilii (as an indicator for valence) for both interventions, however no differences between the interventions. There are no studies up to date investigating ImRs effects on psychophysiological responses to a socially aversive memory. Previous studies on psychophysiological responses to socially aversive memories in general (without ImRs) report attenuated physiological arousal (skin conductance level, HR) in SAD patients, as well as negative valence (activity of the corrugator supercilii) in SAD patients and healthy controls during reactivation of the memories (e.g., Cuthbert et al., 2003; McTeague et al., 2009; Sansen et al., 2015). Psychophysiological correlates of positive valence (activity of the zygomaticus major, e.g., Cacioppo et al., 1986) have not yet been investigated, even though previous studies also found ImRs effects on self-reported positive emotionality (Çili et al., 2016; Kunze et al., 2019).

The aim of this study was to further investigate the effects of ImRs on the emotional response to a socially aversive memory with a special focus on psychophysiological measures in a healthy sample. We investigated the effect of ImRs on a socially aversive memory, as ImRs plays an important role in the treatment of SAD and the experience of such events at some point in life is also common among healthy individuals (e.g. Bjornsson et al., 2020; Erwin et al., 2006; Moscovitch et al., 2018). To investigate ImRs effects specific to the rescripted socially aversive memory, two control memories (generally aversive, neutral), which were not rescripted were used for comparison. In addition to that, prior to ImRs an active control intervention (answering questions regarding certain details of the event) was conducted. Lasting

effects of the single ImRs session on fear of negative evaluation, social anxiety and subjective feelings were examined online at one-week follow-up. We expected ImRs to alter self-reported feelings (decrease: negative feelings, arousal; increase: positive feelings, valence) and psychophysiological responses (decrease: HR, skin conductance responses (SCRs), corrugator supercilii; increase: zygomaticus major) regarding the socially aversive memory compared to two control memories and an active control intervention. Moreover, we expected a decrease in fear of negative evaluation and social anxiety, as well as changes in subjective feelings regarding the socially aversive memory one week after ImRs. In addition to that, we investigated emotional responses to the three memory conditions during the imagination task at baseline, as well as ImRs effects on posttraumatic memory characteristics and memory-related cognitions.

## Method

### Participants

Thirty-three students recruited from the local university participated in this study. Exclusion criteria were current or past self-reported mental or physical illnesses, current medication affecting the central nervous system, and recent (within the last three months) or regular drug abuse. Participants received course credits as compensation for their participation. Three participants were excluded because of early termination of the experimental session ( $n = 1$ ), or technical problems during data acquisition ( $n = 2$ ), leaving a final sample of 30 participants (for demographics, see Table 1), 26 of whom also completed the follow-up online assessments one week after the experimental session. Sample sizes in previous studies investigating effects of ImRs in SAD patients were also in this range or smaller (e.g., Lee & Kwon, 2013; Reimer & Moscovitch, 2015; Wild et al., 2007, 2008). Regarding power analysis, effect sizes for ImRs on social anxiety, as well as self-report measures concerning imagery/memory distress and vividness were reported to be large in previous studies on patients with SAD (Lee & Kwon, 2013; Nilsson et al., 2012; Wild et al., 2008; Norton & Abbott, 2016). There are no studies up to date investigating the effects of ImRs of a socially aversive memory in healthy participants, and especially on psychophysiological responses. Tolgou et al. (2018) reported medium effect sizes for effects of ImRs on HR in a sample of students with high levels of health anxiety. Prior to study conductance we determined the sample size for medium effect sizes (28 participants,  $d = 0.5$ ) to detect significant within-factor interaction effects at power of .8 (G\*Power, Version 3.1.9.2, Faul et al., 2007). Written informed consent was obtained from all participants and the study

protocol was approved by the local Ethics Committee. The trial was registered retrospectively at the German Clinical Trial Register (DRKS00021173).

**Table 1.** Sociodemographic Variables and Questionnaires

variable		
sex, female (%)	86.7	
age, <i>M(SD)</i> , range	22.80 (3.48)	19 – 32
social anxiety, <i>M(SD)</i> , range		
FNES	48.27 (10.16)	30 – 72
SPIN	15.42 (12.88)	0 – 49
depression, <i>M(SD)</i> , range		
BDI-II	7.73 (5.27)	0 – 23
anxiety, <i>M(SD)</i> , range		
state (STAI-S)	36.20 (7.16)	22 – 53
trait (STAI-T)	38.03 (7.35)	27 – 54
emotion regulation, <i>M(SD)</i> , range		
expressive suppression (ERQ)	3.06 (1.16)	1.25 – 5.50
cognitive reappraisal (ERQ)	4.56 (0.94)	2.67 – 6.00

*Note.* Means (*M*) and standard deviations (*SD*) and range or percentage (%) of sociodemographic variables and questionnaires. FNES: Fear of Negative Evaluation Scale; SPIN: Social Phobia Inventory; BDI-II: Beck's Depression Inventory II; STAI-S/-T: State-Trait-Anxiety Inventory – State/Trait; ERQ: Emotion Regulation Questionnaire.

### Experimental Procedure

Each participant was invited for a single session (for overview see Figure 1). First, the autobiographical interview was conducted. Participants further filled in questionnaires concerning social anxiety, depressive symptoms, emotion regulation strategies, posttraumatic stress symptoms, state and trait anxiety, as well as memory appraisals. Afterwards, a psychophysiological baseline measurement, where participants were instructed to relax and close their eyes or fixate on a point in the room, as well as a face processing task were performed (data will be reported elsewhere). After that, the imagination task as well as memory appraisal ratings were conducted. Subsequently, the control intervention was performed, followed by the imagination task, as well as the memory appraisal ratings. Finally, the experimental intervention (ImRs of the socially aversive memory) was conducted. Afterwards the imagination task was

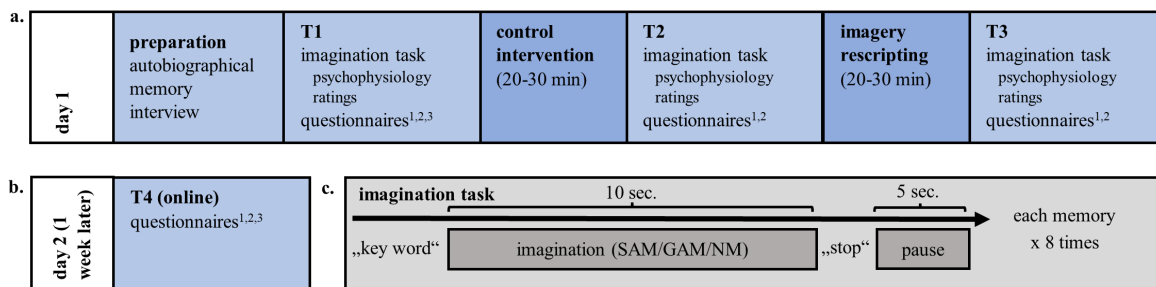
performed again and participants filled in the memory appraisal ratings. One week later, participants were asked to complete questionnaires concerning fear of negative evaluation, social anxiety, as well as the memory appraisal ratings via the online tool Socsisurvey (Leiner, <https://www.socsisurvey.de>).

### Autobiographical Memory Interview

The purpose of this interview was to collect data about three different autobiographical situations: 1) neutral memory, e.g., grocery shopping, 2) generally aversive memory, e.g., death of grandparent, 3) socially aversive memory, e.g., poor performance in public. Participants were asked to describe each situation and answer questions concerning the emotional state and cognitions during each situation, as well as the presence of other people, and their and the participants' behavior. In addition, participants selected an individual keyword for each of the three situations (for a detailed description see Supplement A).

### Imagination Task (Subjective and Psychophysiological Emotional Response)

The procedure of the imagination task was adapted from previous studies on imagery in SAD (McTeague et al., 2009; Sansen et al.; 2015). Instead of sentences/scripts, participants were presented with one keyword for each situation in order to facilitate modifications to the imagination of the original memory in the course of the study. The keywords selected in the autobiographical memory interview were spoken and recorded by the experimenter and presented to the participants via headphones in a randomized order for eight times each. After the presentation of each keyword, participants were instructed to imagine the situation indicated by the keyword for a duration of 10 sec., as vividly as possible. A 5 sec. break was implemented after each 10 sec. of imagination, indicated by an auditory cue ("stop"). This procedure was repeated for 24 times (for overview see Figure 1c). The total duration ranged from approximately six to seven minutes, depending on the duration of the individual keywords' audio segment. Prior to the task, participants were instructed to close their eyes or fixate on a point in the room and adjust the volume of the headphones. A training trial (each keyword was presented once) was conducted before the experiment to ensure that participants knew how to perform the task. During the task psychophysiological data were recorded. Directly after the task participants rated their positive and negative feelings with regard to each memory condition during the task using 9-point unipolar rating scales ranging from 0 ("not at all") to 8 ("extremely") and valence and

**Figure 1.** Schematic Description of Experimental Protocol (a, b) and Imagination Task (c)

*Note.* Experimental protocol: **a.** At day 1 (laboratory session), an autobiographical memory interview, control intervention and Imagery Rescripting of the socially aversive memory as well as assessment of the imagination task (psychophysiology, ratings) and questionnaires (<sup>1</sup>memory appraisal, <sup>2</sup>cognitions and posttraumatic memory characteristics, <sup>3</sup>social anxiety (in general)) were conducted. **b.** One week after day 1 at day 2 (online measurement) questionnaires (<sup>1</sup>memory appraisal, <sup>2</sup>cognitions and posttraumatic memory characteristics, <sup>3</sup>social anxiety (in general)) were assessed via an online tool. **c.** Imagination task: one trial of the imagination task, beginning with the auditory presentation of an individual keyword, imagination of the corresponding memory condition (10 sec.), ending with an auditory stop signal, and a break (5 sec.) before the next keyword was presented. After the imagination task, participants rated their emotional responses during the task to the three memory conditions. During the imagination phase, psychophysiological data were measured. The imagination task consisted of 8 trials for each condition (socially aversive memory [SAM], generally aversive memory [GAM], neutral memory [NM]) in a pseudorandomized order (24 trials altogether).

arousal using the Self-Assessment Manikins on a bipolar scale from 0 (“unpleasant”/ “calm”) to 8 (“pleasant”/ “excited”; Bradley & Lang, 1994).

### Self-Report Data

#### Social Anxiety and Fear of Negative Evaluation.

**Social Anxiety.** Intensity of social anxiety was assessed with the German version of the self-report questionnaire Social Phobia Inventory (SPIN; Connor et al., 2000; Susic et al., 2008). The SPIN consists of 17 items rated on a 5-point-scale from „not at all“ to „extremely“ and has demonstrated good reliability (Cronbach’s  $\alpha = .87 - .94$  [patients with SAD] and Cronbach’s  $\alpha = .82 - .90$  [healthy controls]; Connor et al., 2000; Susic et al., 2008).

**Fear of Negative Evaluation.** The Fear of Negative Evaluation Scale (FNES; Vormbrock & Neuser, 1983; Watson & Friend, 1969) is depicting on one part of social anxiety namely the fear to make a negative impression on other people, using 20 items. Vormbrock and Neuser (1983) report a good internal consistency (Cronbach’s  $\alpha = .92$ ) for the German version.

**Memory Appraisal Ratings.** Since the follow-up timepoint was an online assessment, no data was gathered regarding the imagination task. To obtain information about changes in emotional responses, memory appraisal ratings resembling the ratings of the imagination task were collected during the experimental session (T2) and at the follow-up timepoint (T4). Memory appraisal ratings and ratings of the imagination task were (highly) correlated at T2 ( $r = .394 - .923$ ). Valence and arousal ratings with

regard to the autobiographical memories were assessed using the Self-Assessment Manikins on a bipolar scale from 0 (“unpleasant”/ “calm”) to 8 (“pleasant”/ “excited”; Bradley & Lang, 1994). Negative and positive feelings were rated on 9-point scales ranging from 0 (“not at all”) to 8 (“extremely”). Participants were instructed to think about the memories and indicate their current emotional state while remembering (“Please indicate how your emotional state is now when you remember the [...] situation.”).

**Further Measures.** Several more questionnaires regarding depressive symptoms, emotion regulation strategies, state and trait anxiety, as well as memory-related cognitions and post-traumatic memory characteristics were conducted (for a more detailed description see Supplement B).

#### Psychophysiological Data Assessment, Reduction, and Analysis

Psychophysiological data were recorded (1,000 Hz) with the actiCHamp Plus amplifier and the Brain Vision Recorder software.

**Electromyography.** The muscle activity of the left corrugator supercilii and zygomaticus major were assessed using 4 mm Ag/AgCl electrodes placed according to the recommendations of Fridlund and Cacioppo (1986). The recording was subdivided into segments for each trial ranging from -1,000 msec. to 10,000 msec. relative to the presentation of the keyword. Data were preprocessed and analyzed using Brain Vision Analyzer 2 (Brain Products, Gilching, Germany). Raw data were screened and artifacts were corrected manually. To analyze the data, they were

**Table 2.** Baseline differences (T1) in emotional responses between the three memory conditions

	SAM vs GAM vs NM			
	<i>F</i>	<i>df</i>	<i>p</i>	<i>partial</i> $\eta^2$
subjective feelings				
negative feelings	44.43	2, 58	<.001*	.605
positive feelings	8.32	2, 58	.001*	.223
valence	33.15	2, 58	<.001*	.533
arousal	16.71	2, 58	<.001*	.366
psychophysiology				
corrugator supercillii	10.26	2, 50	<.001*	.291
zygomaticus major	0.31	2, 44	.736	.014
ECG (IBI)	1.38	2, 54	.260	.049
SCRs	0.02	2, 42	.984	.001

*Note.* SAM = socially aversive memory, GAM = generally aversive memory, NM = neutral memory. *F*-statistics, significance level (*p*), effect sizes (*Cohen's d*). ECG = electrocardiogram; IBI = interbeat-interval; SCRs = skin conductance responses. Bonferroni-Holm correction for subjective feelings.

filtered (high-pass: 30 Hz), rectified, smoothed (high cutoff 8 Hz, fourth order Butterworth filter) and baseline corrected (-1,000 to 0 msec.). An average activation was calculated for each trial and each muscle.

**Skin Conductance Responses.** SCRs were measured using Ag/AgCl electrodes (5 mm) placed on the non-dominant hand and filled with isotonic electrolyte medium. Data were preprocessed and analyzed using MATLAB R2018B (The MathWorks, Natick, MA, USA) with the toolbox Ledalab 3.4.4 (available under [www.ledalab.de](http://www.ledalab.de)). Raw data were downsampled to 100 Hz and smoothed (32 sample full width at half maximum Gaussian kernel). Participants with less than one response (responses <0.01  $\mu$ S were considered to be zero) were categorized as nonresponders and were excluded ( $n = 1$ ). All data were screened manually for artifacts. Through-to-peak (TTP) analysis in Ledalab 3.4.4 (Benedek & Kaernbach, 2010) was used to extract the response with the maximum amplitude starting during the imagination phase (analysis time window: 0.8 – 10 sec. after start of the imagination phase).

**Heart Rate.** For electrocardiogram (ECG) measurement, three disposable foam electrodes (TIGA-MED Gold, TIGA-MED Deutschland GmbH, Ronneburg, Germany; diameters: adhesive foam = 43 mm, pre-filled solid gel = 16 mm, Ag/AgCl electrode = 7.5 mm) were applied on the left chest (one over the sternum, one over the heart) and the left flank. The ECG was filtered (low cut-off 1Hz and high cut-off 30 Hz, fourth-order two-way Butterworth filter), and the EKG Markers solution in Brain Vision Analyzer 2 (Brain Products, Gilching, Germany) was used to detect R spikes automatically. Artifacts were corrected manually. The ECG was converted to interbeat intervals (IBI) using MATLAB scripts (Mueller et al., 2013; MATLAB Version R2019a; The MathWorks, Natick, MA). The IBI time series were then subdivided

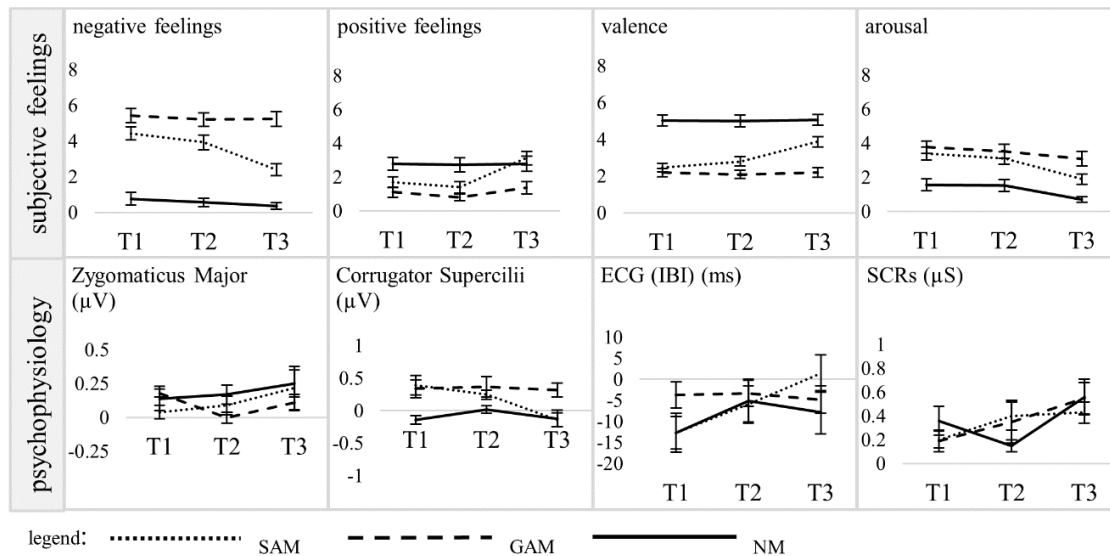
into segments for each trial ranging from -1,000 to 10,000 msec. relative to the presentation of the keyword for each memory condition. After that, the IBI time series were baseline-corrected relative to -1,000 to 0 msec. and an average was determined for each memory condition.

### Experimental Intervention

The experimental interventions (control intervention, ImRs) were only conducted for the socially aversive memory, not for the neutral memory or the generally aversive memory.

**Control Intervention (Duration 20 – 30 Min).** During the control intervention participants were instructed to write down and discuss what they remembered in detail about the socially aversive situation. In order to adjust the procedure to the ImRs procedure it was divided into three different questions: about the situation in general, the location of the event and other people involved. After each question, the experimenter left the room for three minutes and the participants were asked to write down what they remembered. Subsequently, the participants were instructed to tell the experimenter what they wrote down. After summarizing, the experimenter asked more questions concerning details of the situation (e.g., sensory impressions). Psychophysiological data were recorded during the control intervention (data will not be reported in this manuscript).

**Imagery Rescripting of the Socially Aversive Memory (Duration 20 – 30 Min).** ImRs was performed by the experimenter following a protocol adapted from Wild and Clark (2011) which has already been used in several studies (Nilsson et al., 2012; Norton & Abbott, 2016; Wild et al., 2007, Wild et al., 2008; for detailed description see Supplement C). The protocol was divided into three phases: During the first phase participants were asked to go back in their socially aversive situation and imagine re-experiencing

**Figure 2.** Changes in responses to the three memory conditions during the experimental session

*Note.* SAM = socially aversive memory; GAM = generally aversive memory; NM = neutral memory. ECG = electrocardiogram; IBI = interbeat interval; SCRs = skin conductance responses. T1 = baseline; T2 = after the control intervention; T3 = after Imagery Rescripting.

the situation as their former self. In the second phase, participants described the same scene, now from an observer perspective, as their current adult self and carried out changes to the original memory. In the third phase, the participants relived the situation again from the perspective of their younger self but with all the changes introduced by the adult self. Psychophysiological data were recorded throughout the procedure (data will not be reported in this manuscript).

### Statistical Analyses

The Statistical Package for the Social Sciences software 24.0 (SPSS software 24.0; IBM Corporation, Armonk, NY, USA) for Windows was used to conduct all statistical analyses. The level of significance was determined at  $\alpha = .05$  (Bonferroni-correction for subjective feelings). Prior to analysis, participants differing more than two standard deviations from the mean in psychophysiological measures were excluded list-wise. Repeated-measure ANOVAs were used to analyze baseline differences at T1 with memory condition (socially aversive vs generally aversive vs neutral) as within-subject factor. Post-hoc pairwise comparisons between the memory conditions at T1 were analyzed using paired *t*-tests. To examine effects of the active control intervention and ImRs on subjective and physiological responses to the socially aversive memory we used repeated-measure ANOVAs with memory condition (socially aversive vs generally

aversive vs neutral) and timepoints (T1 vs T2 vs T3) as within-subject factors. Effects of ImRs at one-week follow-up were also analyzed using repeated-measure ANOVAs (only subjective data available). Memory condition  $\times$  timepoints interaction effects are the critical effects for the hypotheses tested (main effects will not be reported in this manuscript). For significant interaction effects further post-hoc analyses were conducted using repeated-measure ANOVAs and paired *t*-tests. To specifically analyze ImRs effects compared to the active control intervention, paired *t*-tests were calculated (T2 - T1 vs T3 - T2 [T2 - T1 vs T4 vs T2 for follow-up]). Paired *t*-tests were used to analyze changes in fear of negative evaluation and social anxiety (T1 vs T4). In addition, an exploratory correlational analysis between symptom severity (social anxiety, fear of negative evaluation) and ImRs effects on memory-related variables for the socially aversive memory (T2 vs T3) was conducted.

## Results

### Baseline Differences in Emotional Responses Between the Three Memory Cognitions

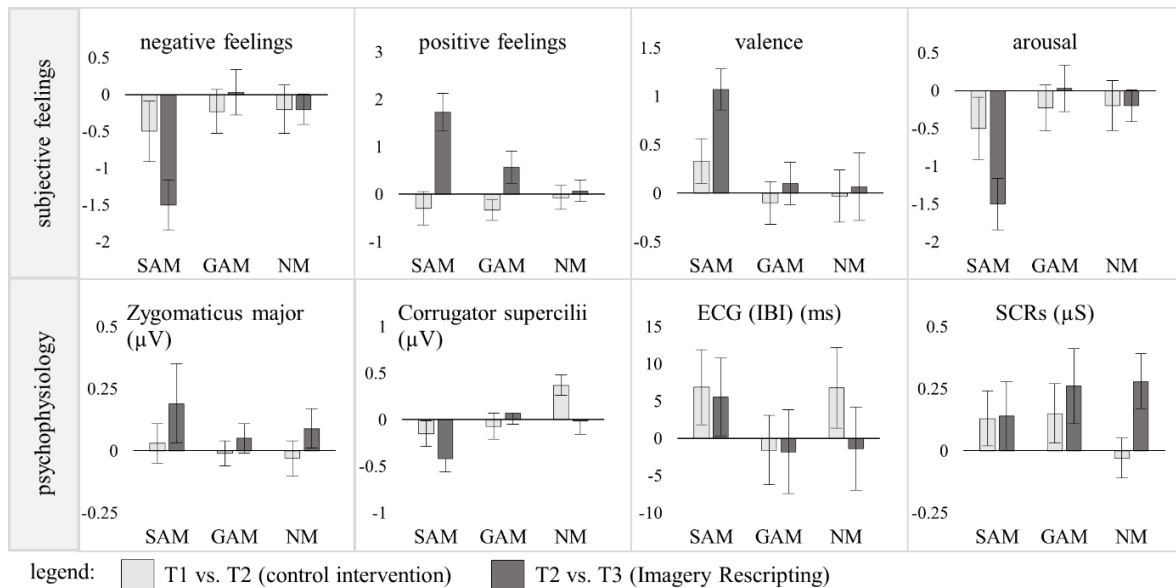
**Subjective Feelings.** Significant differences between the three memory conditions at T1 were found for negative feelings, positive feelings, valence and arousal (see Table 2, for descriptive statistics see Supplementary Table 1). Post-hoc analyses revealed that negative feelings and arousal were rated

**Table 3.** Post hoc tests of effects of the active control intervention and Imagery Rescripting on emotional responses to the socially aversive memory compared to both control memory conditions

	memory comparison	intervention effects (T1 vs T2 vs T3)			control intervention (T1 vs T2)			imagery rescripting (T2 vs T3)					
		<i>F</i>	<i>df</i>	<i>p</i>	<i>partial η<sup>2</sup></i>	<i>F</i>	<i>df</i>	<i>p</i>	<i>partial η<sup>2</sup></i>	<i>F</i>	<i>df</i>	<i>p</i>	<i>partial η<sup>2</sup></i>
subjective feelings													
negative feelings	SAM vs GAM	12.45	2, 58	<.001*	.300	0.42	1, 29	.523	.014	19.53	1, 29	<.001*	.402
	SAM vs NM	4.69	2, 58	.013*	.139	0.21	1, 29	.653	.007	8.47	1, 29	.007*	.226
positive feelings	SAM vs GAM	4.40	2, 58	.017	.132	0.01	1, 29	.928	.000	5.15	1, 29	.031	.151
	SAM vs NM	7.66	2, 58	.001*	.209	0.30	1, 29	.587	.010	16.71	1, 29	<.001*	.365
valence	SAM vs GAM	9.07	2, 58	<.001*	.238	2.06	1, 29	.162	.066	11.79	1, 29	.002*	.289
	SAM vs NM	7.68	2, 58	.001*	.209	0.80	1, 29	.380	.027	8.06	1, 29	.008*	.217
psychophysiology													
corrugator supercillii	SAM vs GAM	2.75	2, 50	.073	.099	0.62	1, 26	.438	.023	5.03	1, 25	.034*	.167
	SAM vs NM	5.17	2, 44	.016*	.190	3.97	1, 23	.058	.147	3.48	1, 22	.075	.137

*Note:* Post-hoc tests of analysis of differences in emotional responses to the socially aversive compared to the generally aversive memory condition (SAM vs GAM) and the socially aversive compared to the neutral memory condition (SAM vs NM) between the three timepoints of the experimental session (T1 = baseline; T2 = after the control intervention; T3 = after Imagery Rescripting), as well as effects of the control intervention (T1 vs T2) and Imagery Rescripting (T2 vs T3). *F*-statistics of interaction effects, degrees of freedom (*df*), significance level (*p*) and effect sizes (*partial η<sup>2</sup>*). Bonferroni-correction for multiple testing for subjective feelings.

**Figure 3.** Mean differences in subjective feelings and psychophysiology between the interventions (T1 vs T2; T2 vs T3) for each memory condition



*Note.* Mean difference scores of T2 minus T1 (control intervention) and T3 minus T2 (Imagery Rescripting) for each of the three memory conditions. SAM = socially aversive memory; GAM = generally aversive memory; NM = neutral memory; ECG = electrocardiogram, IBI = interbeat intervals; SCRs = skin conductance responses. Error bars represent standard errors.

significantly higher and positive feelings and valence significantly lower for both aversive memories compared to the neutral memory, which is in line with the hypotheses (see Supplementary Table 2, Supplementary Figure 1). No significant differences were found between the socially aversive compared to the generally aversive memory.

**Psychophysiology.** Activity of the corrugator supercilii differed significantly between the memory conditions (see Table 2, Supplementary Table 1). Compared to the neutral memory, activity of the corrugator supercilii was significantly higher for both aversive memories, which is consistent with the hypotheses (see Supplementary Table 2). No differences were found for the other psychophysiological parameters.

### Short-Term Intervention Effects on the Socially Aversive Memory

#### Subjective Feelings.

**Interventions Effects (T1 vs T2 vs T3).** Repeated-measure ANOVAs (3 timepoints  $\times$  3 memory conditions) were conducted to analyze effects of ImRs on the socially aversive memory compared to the control intervention and both control memories (which were not rescripted). Analyses revealed significant timepoint  $\times$  memory condition interaction effects for negative feelings, positive feelings and valence, while no significant differences were found for arousal (see

Supplementary Table 3, for descriptive statistics see Supplementary Table 1). To further investigate these effects, additional repeated-measure ANOVAs were conducted for comparison of the socially aversive memory with each control memory separately (3 timepoints  $\times$  2 memory conditions), also revealing significant effects for negative feelings, positive feelings (only marginally significant for comparison of the socially aversive compared to the generally aversive memory) and valence (see Table 3, Figure 2, Figure 3). Post-hoc analyses investigating effects of both interventions separately are reported in the following paragraphs.

**Effects of Control Intervention (T1 vs T2).** To specifically investigate effects of the control intervention (T1 vs T2), repeated-measure ANOVAs (2 timepoints  $\times$  2 memory conditions) were conducted. Analyses revealed no significant interaction effects for subjective feelings between the socially aversive memory and both control memories separately, which is in line with the hypotheses (see Table 3).

**Effects of ImRs (T2 vs T3).** Effects of ImRs (T2 vs T3) were also analyzed using repeated-measure ANOVAs for comparison of the socially aversive memory with the general aversive and neutral memory, respectively (2 timepoints  $\times$  2 memory conditions). Compared to both control memories separately, negative feelings were significantly reduced for the socially aversive memory from before to after ImRs,

while positive feelings (for comparison of the socially aversive vs generally aversive memory only marginally significant) and valence were significantly increased (see Table 3). Post-hoc analyses of effects on the socially aversive memory revealed hypotheses-confirming effects: a significant reduction in negative feelings ( $t(29) = 4.49, p < .001, \text{Cohen's } d = 0.820$ ) and significant increases in positive feelings ( $t(29) = -4.29, p < .001, \text{Cohen's } d = -0.783$ ) and valence ( $t(29) = -4.98, p < .001, \text{Cohen's } d = -0.909$ ) from before to after ImRs. No significant changes were found for the generally aversive memory (negative feelings:  $t(29) = -0.11, p = .914, \text{Cohen's } d = -0.020$ ; positive feelings:  $t(29) = -1.66, p = .108, \text{Cohen's } d = -0.303$ ; valence:  $t(29) = -0.47, p = .639, \text{Cohen's } d = 0.086$ ) and the neutral memory (negative feelings:  $t(29) = 0.95, p = .351, \text{Cohen's } d = 0.173$ ; positive feelings:  $t(29) = -0.28, p = .778, \text{Cohen's } d = -0.051$ ; valence:  $t(29) = -0.19, p = .851, \text{Cohen's } d = -0.035$ ).

**Comparison Between Interventions (T2-T1 vs T3-T2).** To examine differences in effects of the control intervention compared with the ImRs session, difference scores of the socially aversive memory minus the generally aversive memory and the socially aversive memory minus the neutral memory were compared between T2 minus T1 (control intervention) vs T3 minus T2 (ImRs) for negative feelings, positive feelings and valence. Analyses revealed that ImRs compared to the control intervention resulted in a marginally significant stronger decrease in negative feelings for the socially aversive memory compared to the generally aversive memory ( $t(29) = 2.02, p = .053, \text{Cohen's } d = 0.369$ ), but not to the neutral memory ( $t(29) = 1.05, p = .304, \text{Cohen's } d = 0.192$ ). In comparison to the neutral (but not the generally aversive) memory, positive feelings were significantly stronger increased for the socially aversive memory from before to after ImRs compared to the control intervention (social vs neutral memory:  $t(29) = -2.99, p = .006, \text{Cohen's } d = 0.546$ ; social vs generally aversive memory:  $t(29) = -1.51, p = .141, \text{Cohen's } d = -0.276$ ). No significant differences between the interventions were found for valence (social vs generally aversive memory:  $t(29) = -1.29, p = .208, \text{Cohen's } d = 0.236$ ; social vs neutral memory:  $t(29) = -0.91, p = .372, \text{Cohen's } d = -0.166$ ). Post-hoc *t*-tests of the socially aversive memory revealed no significant differences in changes of negative feelings between both interventions ( $t(29) = 1.51, p = .143, \text{Cohen's } d = 0.276$ ) and also no significant changes between the interventions for the generally aversive memory ( $t(29) = -0.57, p = .576, \text{Cohen's } d = -0.104$ ). Regarding positive feelings, post-hoc *t*-tests revealed that ImRs compared to the control intervention resulted in a significantly stronger increase ( $t(29) = -3.23, p = .003, \text{Cohen's } d = -0.590$ ) for the socially aversive memory,

while no significant differences between the interventions were found for the neutral memory ( $t(29) = 0.35, p = .730, \text{Cohen's } d = 0.064$ ).

#### Psychophysiology.

**Intervention Effects (T1 vs T2 vs T3).** Repeated-measure ANOVAs (3 timepoints  $\times$  3 memory conditions) were conducted to analyze effects of ImRs on psychophysiological responses to the socially aversive memory in comparison to the control intervention and both control memories. As hypothesized, significant timepoint  $\times$  memory interaction effects were found for activity of the corrugator supercilii (see Supplementary Table 3, for descriptive statistics see Supplementary Table 1), which remained significant for comparison of the socially aversive memory with each control memory separately over the three timepoints (for comparison of the socially aversive vs generally aversive memory only marginally significant, see Table 3, Figure 2, Figure 3). No significant effects were found for ECG, SCRs and activity of the zygomaticus major, contradicting hypotheses.

**Effects of the Control Intervention (T1 vs T2).** To analyze effects of the control intervention (T1 vs T2) separately, repeated-measure ANOVAs (2 timepoints  $\times$  2 memory conditions) were conducted. Changes in activity of the corrugator supercilii from before to directly after the control intervention did not differ significantly between the socially aversive compared to the generally aversive memory, but marginally significant compared to the neutral memory (see Table 3). Post-hoc *t*-tests of effects specifically on the socially aversive memory however revealed no significant changes in activity of the corrugator supercilii from before to directly after the control intervention ( $t(23) = 1.47, p = .155, \text{Cohen's } d = 0.307$ ), but a marginally significant increase in activation for the neutral memory ( $t(23) = -1.96, p = .062, \text{Cohen's } d = 0.400$ ).

**Effects of ImRs (T2 vs T3).** Effects of ImRs (T2 vs T3) on activity of the corrugator supercilii were also analyzed using repeated-measure ANOVAs (2 timepoints  $\times$  2 memory conditions). Activity of the corrugator supercilii was significantly stronger reduced for the socially aversive memory compared to each control memory (for comparison with the neutral memory only marginally significant) from before to directly after ImRs (see Table 3). Post-hoc *t*-tests of the socially aversive memory revealed a significant reduction in activity of the corrugator supercilii ( $t(26) = 2.88, p = .008, \text{Cohen's } d = 0.554$ ), while no significant changes were found for the generally aversive memory ( $t(25) = -0.20, p = .844, \text{Cohen's } d = 0.039$ ) and neutral memory ( $t(22) = 0.09, p = .927, \text{Cohen's } d = 0.019$ ), which is in line with the hypotheses.

**Table 4.** Analysis of follow-up effects (T2 vs T4) on subjective feelings

	SAM vs GAM vs NM			SAM vs GAM			SAM vs NM		
	<i>F</i>	<i>p</i>	<i>partial</i> $\eta^2$	<i>F</i>	<i>p</i>	<i>partial</i> $\eta^2$	<i>F</i>	<i>p</i>	<i>partial</i> $\eta^2$
negative feelings	8.67	.001*	.257	9.60	.005*	.277	12.62	.002*	.335
positive feelings	7.79	.001*	.238	0.98	.332	.038	15.49	.001*	.383
valence	9.85	<.001*	.283	3.98	.057	.137	55.11	<.001*	.688
arousal	4.32	.019	.147	-	-	-	-	-	-

*Note.* SAM = socially aversive memory, GAM = generally aversive memory, NM = neutral memory. *F*-statistics, significance level (*p*) and effect size (*partial*  $\eta^2$ ). Degrees of freedom (*df*) for SAM vs GAM vs NM = 2, 50; *df* for SAM vs GAM = 1, 25; *df* for SAM vs NM = 1, 25. \*  $p < .05$ . Bonferroni correction for multiple testing.

**Comparison Between Interventions (T2-T1 vs T3-T2).** Differences in effects of the control intervention and the ImRs session were analyzed by conducting difference scores of the socially aversive memory minus the generally aversive memory and the socially aversive memory minus the neutral memory, which were compared between T2 minus T1 (control intervention) vs T3 minus T2 (ImRs). No significant differences between the interventions were found for activity of the corrugator supercilii for the socially aversive memory compared to the neutral memory ( $t(22) = -0.20, p = .841, Cohen's d = -0.042$ ), however marginally significant differences compared to the generally aversive memory ( $t(22) = 2.07, p = .050, Cohen's d = 0.432$ ), partially confirming the hypotheses. Post-hoc *t*-tests revealed no significant differences in changes in activity of the corrugator supercilii between the interventions for the socially aversive memory ( $t(22) = 0.86, p = .400, Cohen's d = 0.179$ ) and the generally aversive memory ( $t(22) = -1.25, p = .223, Cohen's d = 0.261$ ).

#### Further Analyses.

**Cognitions.** In addition to emotional responses (which were the main focus of this study), effects of ImRs on several cognitions were analyzed. Consistent effects were only found for empowerment, which was significantly increased during ImRs for the socially aversive memory ( $t(29) = -4.75, p < .001, Cohen's d = -0.867$ ), while no effects were found for the generally aversive memory ( $t(29) = -1.58, p = .125, Cohen's d = -0.288$ ). Moreover, empowerment for the neutral memory was significantly reduced ( $t(29) = 2.28, p = .030, Cohen's d = 0.416$ ). Effects of ImRs on empowerment of the socially aversive memory were significantly stronger compared to both control memories and the control intervention (see Supplementary Tables 4–6).

**Posttraumatic Memory Characteristics.** Besides, we also investigated ImRs effects on memory disorganization and re-experiencing. Memory

disorganization of the socially aversive memory was reduced significantly from before to after ImRs ( $t(29) = 2.86, p = .008, Cohen's d = 0.522$ ), while disorganization of the generally aversive memory ( $t(29) = -1.87, p = .072, Cohen's d = -0.341$ ) and neutral memory ( $t(29) = -3.12, p = .004, Cohen's d = -0.570$ ) were (marginally) significantly increased. ImRs effects on disorganization of the socially aversive memory were significantly stronger compared to both control memories and the control intervention (see Supplementary Tables 4–6). ImRs effects on memory re-experiencing, however, did not differ significantly for the socially aversive memory compared to both control memories and the control intervention.

#### One-Week Follow-up Intervention Effects on the Socially Aversive Memory

As data at the one-week follow-up were assessed online, no data of the imagination task are available for this timepoint. Data regarding subjective feelings presented in the following are derived from a questionnaire on memory appraisal ratings resembling the ratings of subjective feelings of the imagination task.

**Subjective Feelings.** To analyze effects of ImRs one week after the intervention (T2 vs T4), repeated-measure ANOVAs (2 timepoints  $\times$  3 memory conditions) were conducted for negative feelings, positive feelings, valence and arousal. Interaction effects revealed significant differences in changes from before ImRs (T2) to one-week follow-up (T4) for negative feelings, positive feelings and valence for the socially aversive compared to both control memories (see Table 4). To further specify these effects additional repeated-measure ANOVAs (2 timepoints  $\times$  2 memory conditions) were conducted for the socially aversive memory compared to each control memory separately. Analyses revealed that the socially aversive memory compared to both control memories separately differed significantly in negative feelings, positive

feelings (only socially aversive vs neutral) and valence (only socially aversive vs neutral) from before ImRs compared to one-week follow-up (see Table 4). Post-hoc *t*-tests of the socially aversive memory revealed hypotheses-confirming effects: a significant reduction in negative feelings ( $t(25) = 6.18, p < .001, \text{Cohen's } d = 1.212$ ) and a significant increase in valence ( $t(25) = -4.37, p < .001, \text{Cohen's } d = -0.857$ ) from before ImRs to one-week follow-up (no effects for positive feelings:  $t(25) = -1.57, p = .130, \text{Cohen's } d = -0.308$ ). No effects were found for negative feelings for the neutral ( $t(25) = 1.25, p = .224, \text{Cohen's } d = 0.245$ ) and the generally aversive memory ( $t(25) = 2.47, p = .021, \text{Cohen's } d = 0.484$ ), while positive feelings ( $t(25) = 2.63, p = .014, \text{Cohen's } d = 0.516$ ) and valence ( $t(25) = 1.07, p = .295, \text{Cohen's } d = 0.210$ ) were significantly decreased for the neutral memory.

**Comparison Between Interventions (T2-T1 vs T4-T2).** To analyze differences between short-term effects of the control intervention and one-week follow-up effects of ImRs, difference scores for negative feelings and valence (control intervention: T2 - T1; one-week follow-up: T4 - T2) were calculated for each memory condition. No differences between short-term effects of the control intervention and one-week follow-up effects were found for negative feelings (socially aversive vs generally aversive:  $t(25) = 1.48, p = .152, \text{Cohen's } d = 0.290$ ; socially aversive vs neutral:  $t(25) = 1.06, p = .300, \text{Cohen's } d = 0.208$ ), but for valence, which was (marginally) significantly stronger increased for the socially aversive compared to the generally aversive ( $t(25) = -1.80, p = .085, \text{Cohen's } d = 0.353$ ) and to the neutral memory ( $t(25) = -3.04, p = .005, \text{Cohen's } d = 0.596$ ). Post-hoc analyses of the socially aversive memory revealed that valence ( $t(25) = -2.55, p = .017, \text{Cohen's } d = 0.500$ ) was significantly stronger increased from before ImRs to one-week follow-up for the socially aversive memory, while no effects were found for the generally aversive memory ( $t(25) = -0.72, p = .478, \text{Cohen's } d = 0.141$ ) and the neutral memory ( $t(25) = 1.41, p = .172, \text{Cohen's } d = 0.277$ ).

#### Further Analyses.

**Cognitions.** Similar to short-term effects, consistent effects for cognitions at one-week follow-up (T2 vs T4) were only found for empowerment, which was significantly increased from before ImRs to one-week follow-up for the socially aversive memory ( $t(25) = -4.27, p < .001, \text{Cohen's } d = 0.837$ ), while no effects were found for the generally aversive memory ( $t(25) = -1.55, p = .133, \text{Cohen's } d = 0.304$ ) and the neutral memory ( $t(25) = 1.62, p = .118, \text{Cohen's } d = 0.318$ ). Effects from before ImRs to one-week follow-up on empowerment regarding the socially aversive memory were significantly stronger compared to both control memories (see Supplementary Table 7) and compared

to short-term effects (T1 vs T2) of the control intervention ( $t(25) = -3.02, p = .006, \text{Cohen's } d = 0.592$ ).

**Posttraumatic Memory Characteristics.** Memory disorganization was reduced significantly from before ImRs to one-week follow-up (T2 vs T4) for the socially aversive memory ( $t(25) = 2.90, p = .008, \text{Cohen's } d = 0.569$ ), while memory disorganization of the generally aversive memory ( $t(25) = -2.21, p = .037, \text{Cohen's } d = 0.433$ ) and the neutral memory ( $t(25) = -3.31, p = .003, \text{Cohen's } d = 0.649$ ) was significantly increased. Disorganization of the socially aversive memory was significantly stronger reduced for the socially aversive memory from before ImRs to one-week follow-up compared to both control memories (see Supplementary Table 7) and marginally significant compared to short-term effects of the control intervention (T1 vs T2;  $t(25) = 1.93, p = .065, \text{Cohen's } d = 0.379$ ). ImRs effects on memory re-experiencing did not differ significantly for the socially aversive memory compared to both control memories from before ImRs to one-week follow-up.

#### Fear of Negative Evaluation and Social Anxiety.

**Effects of the Experimental Session on Fear of Negative Evaluation and Social Anxiety.** To investigate effects of the experimental session on fear of negative evaluation and social anxiety, paired-*t*-tests (T1 vs T4) were conducted. As hypothesized, we found a significant reduction in fear of negative evaluation ( $t(25) = 2.40, p = .024; \text{Cohen's } d = 0.471$ ) from before to one week after the experimental session ( $M(SD)$  T1: 48.27 (10.16) vs T4: 45.08 (10.62)). No effects, however, were found for social anxiety ( $t(26) = 1.24, p = .226; \text{Cohen's } d = 0.239; M(SD)$  T1: 15.42 (12.88) vs T4: 13.54 (12.69)).

**Effects of Fear of Negative Evaluation and Social Anxiety on Memory-Related Outcomes.** To analyze associations between symptom severity (fear of negative evaluation, social anxiety) and ImRs effects on memory-related outcomes (subjective feelings, psychophysiology, posttraumatic memory characteristics, cognitions), exploratory correlational analyses were conducted between fear of negative evaluation and social anxiety (T1) and changes in memory-related outcomes from before to after ImRs (T3 - T2) for the socially aversive memory. Analyses revealed significant positive correlations between social anxiety and an increase in valence ( $r = .482, p = .007$ ) and marginally significant in empowerment ( $r = .360, p = .071$ ), as well as a decrease in SCRs ( $r = -.361, p = .099$ ), indicating greater effects of ImRs for participants with increased levels of social anxiety (all other variables:  $p > .05$  after Bonferroni-Holm correction). No significant correlations were found for fear of negative evaluation.

## Discussion

The aim of this study was to examine if ImRs of a socially aversive memory has any effect on emotional responses (subjective, psychophysiological) during imagination of the rescripted memory. An adapted version of an imagination task (McTeague et al., 2009; Sansen et al., 2015) proved to be valid in eliciting emotional responses during voluntary recall of aversive memories compared to a neutral memory. Results indeed showed effects of ImRs on emotional responses specifically to the rescripted socially aversive memory: an increase in positive feelings and valence, as well as a reduction in negative feelings, and activity of the corrugator supercilii related to the socially aversive memory. However, ImRs did not have an additional effect on negative feelings and valence but on positive feelings and activity of the corrugator supercilii (only compared to the generally aversive memory) when compared to the preceding active control intervention. Concerning memory-related cognitions and posttraumatic memory characteristics, we found a significant increase in empowerment, as well as a reduction in disorganization after ImRs compared to the control intervention, specifically regarding the socially aversive memory. At one-week follow-up, negative feelings were still reduced, and valence still increased significantly and participants indicated increased empowerment and decreased disorganization specifically regarding the socially aversive memory. Correlational analyses revealed (marginally) significant associations between social anxiety and ImRs effects in some variables, indicating more benefits for participants with increased levels of social anxiety. In addition, levels of fear of negative evaluation (but not social anxiety) were reduced significantly one week after ImRs.

This study was the first using an imagination task to examine effects of ImRs on psychophysiological correlates of a rescripted socially aversive memory. At baseline, we found the expected differences in subjective emotional responses to the memories also coinciding with stronger activity of the corrugator supercilii during imagination of the socially aversive memory in comparison to the neutral memory. This is in accordance with findings of heightened activation of the corrugator supercilii during imagination of a socially aversive situation in both, healthy controls and SAD patients (McTeague et al., 2009). No differences in activity of the zygomaticus major, HR and SCRs during imagination of the socially aversive memory compared to the neutral memory were found in the current study. Previous findings in healthy participants (examined as a control group for SAD) showed no heightened HR and SCL to standardized socially

aversive scripts, but to personal fear scripts (not socially aversive) (Cuthbert et al., 2003; McTeague et al., 2009). In this study we used an autobiographical socially aversive memory, which might have not induced as strong negative emotions in healthy participants as a personal fear memory or as in patients with SAD.

In addition to these findings at baseline, our results showed that ImRs led to changes in the emotional responses (more positive, less negative) to the socially aversive memory. Results of self-report measures coincide with psychophysiological measures, showing that ImRs led to a decrease in activation of the corrugator supercilii during imagination of the socially aversive memory compared to the generally aversive memory. These findings are in line with studies in SAD patients, reporting reduced distress related to the socially aversive memory due to ImRs (e.g., Lee & Kwon, 2013; Reimer & Moscovitch, 2015; Romano et al., 2020; Wild et al., 2007). However, effects of ImRs on negative feelings and valence did not go beyond effects of the preceding active control intervention reducing the interpretability of these findings. As participants also took a closer look at the socially aversive memory in the control intervention and were guided by an experimenter, this may also have had small effects on the measures. Simultaneously, a single session ImRs especially in healthy individuals might not produce large effects (for this, an intensification of the intervention [e.g., multiple sessions] might be more effective). At one-week follow-up (compared to pre-ImRs) negative feelings regarding the socially aversive memory were still reduced and valence still increased significantly, also compared to both control memories, indicating intervention specific effects on the measures. However, one-week follow-up effects of negative feelings did again not go beyond short-term effects of the control intervention. In addition, results of follow-up analyses cannot be compared one to one to the results of the experimental session because different data collection methods were used (imagination task vs memory appraisal ratings). To sum up, even in a healthy sample, ImRs led to changes in the emotional response to a socially aversive memory. However, in some cases, these effects did not go beyond the effects of a preceding active control intervention which might be grounded in reduced distress in response to the socially aversive memory, as well as (naturally) lower SAD symptoms (e.g., physiological activation) in healthy individuals compared to SAD patients (DSM-5; American Psychiatric Association, 2013). Increased ImRs effects for participants with higher levels of social anxiety ([marginally] significant correlations for some variables) point towards potentially increased benefits

for individuals with increased social anxiety or even SAD.

ImRs also led to a decrease (also at one-week follow-up) in memory disorganization, as well as an increase in empowerment specific for the socially aversive memory. During the process of ImRs participants relive their memory for several times which might enhance factual memory, as well as its contextualization and thus reduce memory disorganization (e.g., Hagens & Arntz, 2012). Effects concerning empowerment are in line with previous results indicating that ImRs in nightmare disorder works through increased feelings of mastery (Kunze et al., 2019). The intervention highlights participants' development from feeling exposed to the situation as their younger self to actively intervene as an adult. No consistent effects were found for other memory-related cognitions despite empowerment and memory re-experiencing, which might also be grounded in our healthy sample.

This study has several limitations. First, we used a within-subject design which does not allow to distinguish between effects of ImRs and the control intervention especially regarding the effects on fear of negative evaluation and social anxiety measures one week after the experiment. The control intervention can, however, similar to previous studies (e.g., Norton & Abbott, 2016; Wild et al., 2007, 2008), also be regarded as an additional preparation for the subsequent ImRs session. Second, we cannot rule out potential sequence effects, as we always applied ImRs after the control intervention. We did not use a cross-over design to rule out expectable carry-over effects of ImRs on the control intervention. However, stronger increase in positive feelings and stronger decrease in activity of the corrugator supercilii after ImRs compared to the control intervention indicate additional effects going beyond habituation. To explore the specificity of the intervention on the rescripted memory, we added the generally aversive memory and the neutral memory as control conditions. Future studies should employ a between-subjects design with one group receiving one session ImRs and the other group a control intervention. Third, we cannot make a statement on mechanisms of change in ImRs as our study design does not meet the requirements for analysis of a causal mediation model (Kazdin, 2007). Finally, ImRs in healthy participants might work differently than in SAD patients and thus we cannot be certain whether the presented results can be generalized to a patient population. Analyses of the effects of social anxiety point towards potential differences in efficacy of the intervention (for some responses to the memory), with greater benefit for participants with increased social anxiety. Hence, replications in patient samples would be desirable.

## Conclusions

This is the first study to use an imagination task to examine effects of ImRs on subjective and physiological emotional responses to a socially aversive memory. Results indicate that ImRs affects the emotional processing of the memory and thus further support UCS revaluation theory (Arntz, 2011, 2012; Davey, 1989), indicating that ImRs has a direct effect on the emotional meaning of the memory. However, more information, especially about physiological processes during ImRs in patients with SAD, are needed to better understand its underlying mechanisms.

## Additional Information

### Supplementary Materials

Supplementary materials for this article can be viewed here: <https://osf.io/eb6zp>

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### Conflict of Interest

The authors have no conflicts of interest to disclose.

### Ethical Approval

The study protocol (2018-0036) was approved on 11/15/2018 by the local ethics committee of the Department 06 Psychology and Sport Sciences of the Justus Liebig University Giessen.

### Data Availability

Data not available.

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## References

- Abler, B., & Kessler, H. (2009). Emotion Regulation Questionnaire—Eine deutschsprachige Fassung des ERQ von Gross und John [Emotion Regulation Questionnaire—A German version of

- the ERQ by Gross and John]. *Diagnostica*, 55(3), 144–152. <https://doi.org/10.1026/0012-1924.55.3.144>
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5<sup>th</sup> ed.). Arlington, VA: Author.
- Arntz, A. (2011). Imagery rescripting for personality disorders. *Cognitive and Behavioral Practice*, 18, 466–481, doi: 10.1016/j.cbpra.2011.04.006
- Arntz, A. (2012). Imagery Rescripting as a Therapeutic Technique: Review of Clinical Trials, Basic Studies, and Research Agenda. *Journal of Experimental Psychopathology*, 3(2), 189–208, doi:10.5127/jep.024211
- Arntz, A., & Tiesemann, M., & Kindt, M. (2007). Treatment of PTSD: a comparison of imaginal exposure with and without imagery rescripting. *Journal of Behavior Therapy and Experimental Psychiatry*, 38, 345–370.
- Arntz, A., & Weertman, A. (1999). Treatment of childhood memories: theory and practice. *Behaviour Research and Therapy*, 37, 715–740.
- Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory-II*. Psychological Corporation. <https://doi.org/10.1037/t00742-000>
- Benedek, M., & Kaernbach, C. (2010). A continuous measure of phasic electrodermal activity. *Journal of Neuroscience Methods*, 190(1), 80–91. <https://doi.org/10.1016/j.jneumeth.2010.04.028>
- Bjornsson, A. S., Hardarson, J. P., Valdimarsdottir, A. G., Gudmundsdottir, K., Tryggvadottir, A., Thorarinsdottir, K., Wessman, I., Sigurjonsdottir, Ó., Davidsdottir, S., & Thorisdottir, A. S. (2020). Social trauma and its association with posttraumatic stress disorder and social anxiety disorder. *Journal of Anxiety Disorders*, 72, 102228. <https://doi.org/10.1016/j.janxdis.2020.102228>
- Bradley, M.M., Lang, P.L. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, 25(1), 49–59.
- Cacioppo, J.T., Petty, R.E., Losch, M.E., & Kim, H.S. (1986). Electromyographic activity over facial muscle regions can differentiate the valence and intensity of affective reactions. *Journal of Personality and Social Psychology*, 50(2), 260–268. <https://doi.org/10.1037/0022-3514.50.2.260>
- Carleton, R. N., Peluso, D. L., Collimore, K. C., & Asmundson, G. J. G. (2011). Social anxiety and posttraumatic stress symptoms: The impact of distressing social events. *Journal of Anxiety Disorders*, 25(1), 49–57. <https://doi.org/10.1016/j.janxdis.2010.08.002>
- Çili, S., Pettit, S., & Stopa, L. (2016). Impact of imagery rescripting on adverse self-defining memories and post-recall working selves in a non-clinical sample: A pilot study. *Cognitive Behaviour Therapy*, 46, 75–89.
- Connor, K. M., Davidson, J. R. T., Churchill, L. E., Sherwood, A., Weisler, R. H., & Foa, E. (2000). Psychometric properties of the Social Phobia Inventory (SPIN). *British Journal of Psychiatry*, 176(4), 379–386. <https://doi.org/10.1192/bjp.176.4.379>
- Cuthbert, B. N., Lang, P. J., Strauss, C. C., Drobos, D., Patrick, Christopher, J., & Bradley, M. M. (2003). The psychophysiology of anxiety disorder: Fear memory imagery. *Psychophysiology*, 40, 407–422.
- Davey, G. C. L. (1989). UCS revaluation and conditioning models of acquired fears. *Behaviour Research and Therapy*, 27(5), 521–528.
- Erwin, B. A., Heimberg, R. G., Marx, B. P., & Franklin, M. E. (2006). Traumatic and socially stressful life events among persons with social anxiety disorder. *Journal of Anxiety Disorders*, 20(7), 896–914. <https://doi.org/10.1016/j.janxdis.2005.05.006>
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175–191. doi:10.3758/BF03193146
- Foa, E., Cashmann, L., Jaycox, L., & Perry, K. (1997). The validation of a self-report measure of posttraumatic stress disorder: The Posttraumatic Diagnostic Scale. *Psychological Assessment*, 9(4), 445–451.
- Fridlund, A. & Cacioppo, J. T. (1986). Guidelines for Human Electromyographic Research. *The Society for Psychophysiological Research*, 23(5).
- Grunert, Brad, K., Smucker, Mervin, R., Weis, Jo, M., & Rusch, Mark, D. (2003). When prolonged exposure fails: adding imagery-based cognitive restructuring components in the treatment of industrial accident victims suffering from PTSD. *Cognitive and Behavioral Practice*, 10, 333–346.
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85(2), 348–362. <https://doi.org/10.1037/0022-3514.85.2.348>
- Hackmann, A., Clark, D. M., & McManus, F. (2000). Recurrent images and early memories in social phobia. *Behaviour Research and Therapy*, 38, 601–610.
- Hagenaars, M. A., van Minnen, A., Hoogduin, C. A. L., & Verbraak, M. (2009). A

- transdiagnostic comparison of trauma and panic memories in PTSD, panic disorder, and healthy controls. *Journal of Behavior Therapy and Experimental Psychiatry*, 40(3), 412–422. <https://doi.org/10.1016/j.jbtep.2009.04.001>
- Hagenaars, M.A., & Arntz, A. (2012). Reduced intrusion development after post-trauma imagery rescripting: an experimental study. *Journal of Behavior Therapy and Experimental Psychiatry*, 43(2), 808–814.
- Hautzinger, M., Keller, F., & Kühner, C. (2006). *Das Beck Depressionsinventar II. Deutsche Bearbeitung und Handbuch zum BDI II*. Harcourt Test Services.
- Hyett, M.O., Bank, S.R., Lipp, O.V., Erceg-Hurn, D., Alvares, G.A., Maclaine, E. et al. (2018). Attenuated psychophysiological reactivity following single-session group imagery rescripting versus verbal restructuring in social anxiety disorder: results from a randomized controlled trial. *Psychotherapy and Psychosomatics*, 87(6), 340–349.
- Kazdin, A. E. (2007). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical Psychology*, 3, 1–27. <https://doi.org/10.1146/annurev.clinpsy.3.022806.091432>
- Kunze, A. E., Arntz, A., & Kindt, M. (2019). Investigating the effects of imagery rescripting on emotional memory: A series of analogue studies. *Journal of Experimental Psychopathology*, 10(2), 204380871985073. <https://doi.org/10.1177/2043808719850733>
- Kunze, A. E., & Lancee, J., Morina, N., Kindt, M., & Arntz, A. (2019). Mediators of change in imagery rescripting and imaginal exposure for nightmares: evidence from a randomized wait-list controlled trial. *Behavior Therapy*, 50(5), 978–993.
- Lang, P. J., Greenwald, Mark, K., Bradley, M. M., & Hamm, Alfons, O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology*, 30, 261–273.
- Lang, P. J., Kozak, M. J., Miller, G. A., Levin, D. N., McLean Jr., A. (1980). Emotional Imagery: Conceptual Structure and Pattern of Somato-Visceral Response. *Psychophysiology*, 17(2), 179–192. <https://doi.org/10.1111/j.1469-8986.1980.tb00133.x>
- Lang, P. J., Levin, D.N., Miller, G. A., & Kozak, M. J. (1983). Fear behavior, fear imagery, and the psychophysiology of emotion: The problem of affective response integration. *Journal of Abnormal Psychology*, 92(3), 276–306.
- Laux L, Glanzmann P, Schaffner P, Spielberger CD (1981) *State-Trait-Angstinventar (STAI)*. Beltz, Weinheim
- Lee, S. W., & Kwon, J.-H. (2013). The efficacy of imagery rescripting (IR) for social phobia: A randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry*, 44(4), 351–360. <https://doi.org/10.1016/j.jbtep.2013.03.001>
- Leiner, D. J. *SoSci Survey (Version 3.1.06) [Computer software]*. Available at <https://www.socsisurvey.de>.
- McTeague, L. M., Lang, P. J., Laplante, M.-C., Cuthbert, B. N., Strauss, C. C., & Bradley, M. M. (2009). Fearful imagery in social phobia: Generalization, comorbidity, and physiological reactivity. *Biological Psychiatry*, 65(5), 374–382. <https://doi.org/10.1016/j.biopsych.2008.09.023>
- Moscovitch, D. A., Gavric, D. L., Merrifield, C., Bielak, T., & Moscovitch, M. (2011). Retrieval properties of negative vs. Positive mental images and autobiographical memories in social anxiety: Outcomes with a new measure. *Behaviour Research and Therapy*, 49(8), 505–517. <https://doi.org/10.1016/j.brat.2011.05.009>
- Moscovitch, D. A., Vidovic, V., Lenton-Brym, A. P., Dupasquier, J. R., Barber, K. C., Hudd, T., Zabara, N., & Romano, M. (2018). Autobiographical memory retrieval and appraisal in social anxiety disorder. *Behaviour Research and Therapy*, 107, 106–116. <https://doi.org/10.1016/j.brat.2018.06.008>
- Mueller, E. M., Stemmler, G., Hennig, J., & Wacker, J. (2013). 5-HTTLPR and anxiety modulate brain-heart covariation. *Psychophysiology*, 50(5), 441–453. <https://doi.org/10.1111/psyp.12016>
- Nilsson, J.-E., Lundh, L.-G., & Viborg, G. (2012). Imagery rescripting of early memories in social anxiety disorder: An experimental study. *Behaviour Research and Therapy*, 50(6), 387–392. <https://doi.org/10.1016/j.brat.2012.03.004>
- Norton, A. R., & Abbott, M. J. (2016). The efficacy of imagery rescripting compared to cognitive restructuring for social anxiety disorder. *Journal of Anxiety Disorders*, 40, 18–28. <https://doi.org/10.1016/j.janxdis.2016.03.009>
- Reimer, S. (2014). *Single-session imagery rescripting for social anxiety disorder: efficacy and mechanisms* (dissertation). retrieved from: <https://uwspace.uwaterloo.ca/handle/10012/8583>
- Reimer, S. G., & Moscovitch, D. A. (2015). The impact of imagery rescripting on memory appraisals and core beliefs in social anxiety disorder. *Behaviour Research and Therapy*, 75, 48–59. <https://doi.org/10.1016/j.brat.2015.10.007>
- Romano, M., Moscovitch, D.A., Huppert, J.D., Reimer, S.G., & Moscovitch, M. (2020). The effects of imagery rescripting on memory outcomes in social anxiety disorder. *Journal of*

- Anxiety Disorders*, 69.  
<https://doi.org/10.1016/j.janxdis.2019.102169>.
- Sansen, L.M., Iffland, B., & Neuner, F. (2015). The trauma of peer victimization: Psychophysiological and emotional characteristics of memory imagery in subjects with social anxiety disorder. *Psychophysiology*, 52, 107-116.
- Siegesleitner, M., Strohm, M., Wittekind, C. E., Ehring, T., & Kunze, A. E. (2019). Effects of imagery rescripting on consolidated memories of an aversive film. *Journal of Behavior Therapy and Experimental Psychiatry*, 62, 22–29.  
<https://doi.org/10.1016/j.jbtep.2018.08.007>
- Smucker, M.R., & Neiderdee, J. (1995). Treating incest-related PTSD and pathogenic schemas through imaginal exposure and rescripting. *Cognitive and behavioral practice*, 2, 63-93.
- Sosic, Z., Gieler, U., & Stangier, U. (2008). Screening for social phobia in medical in- and outpatients with the German version of the Social Phobia Inventory (SPIN). *Journal of Anxiety Disorders*, 22(5), 849–859.  
<https://doi.org/10.1016/j.janxdis.2007.08.011>
- Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.
- Strohm, M., Siegesleitner, M., Kunze, A. E., Ehring, T., & Wittekind, C. E. (2019). Imagery Rescripting of Aversive Autobiographical Memories: Effects on Memory Distress, Emotions, and Feelings of Mastery. *Cognitive Therapy and Research*, 43(6), 1005–1017.  
<https://doi.org/10.1007/s10608-019-10021-2>
- Strohm, M., Siegesleitner, M., Kunze, A. E., Werner, G. G., Ehring, T., & Wittekind, E. (2021). Psychological and Physiological Effects of Imagery Rescripting for Aversive Autobiographical Memories. *Cognitive Therapy and Research*, 45, 1093 - 1104.  
<https://doi.org/10.1007/s10608-021-10233-5>
- Tolgou, T., Rohrman, S., Stockhausen, C., Krampen, D., Warnecke, I., & Reiss, N. (2018). Physiological and psychological effects of imagery techniques on health anxiety. *Psychophysiology*, 55(2).  
<https://doi.org/10.1111/psyp.12984>
- Vormbrock, F. & Neuser, J. (1983). Konstruktion zweier spezifischer Fragebögen zur Erfassung von Angst in sozialen Situationen (SANB und SVSS). *Diagnostica*, 29(2), 165–182.
- Watson, D. & Friend, R. (1969). Measurement of social-evaluative anxiety. *Journal of Consulting and Clinical Psychology*, 33, 448–457.
- Wild, J., & Clark, D. M. (2011). Imagery Rescripting of Early Traumatic Memories in Social Phobia. *Cognitive and Behavioral Practice*, 18(4), 433–443. <https://doi.org/10.1016/j.cbpra.2011.03.002>
- Wild, J., Hackmann, A., & Clark, D. M. (2007). When the present visits the past: Updating traumatic memories in social phobia. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 386–401.  
<https://doi.org/10.1016/j.jbtep.2007.07.003>
- Wild, J., Hackmann, A., & Clark, D. M. (2008). Rescripting early memories linked to negative images in social phobia: A pilot study. *Behavior Therapy*, 39(1), 47–56.  
<https://doi.org/10.1016/j.beth.2007.04.003>