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A	Auditory modality
Acta Neurol Scand	Acta Neurologica Scandinavica
Am J Geriatr Psychiatry	American Journal of Geriatric Psychiatry
Am J Psychiatry	American Journal of Psychiatry
Am J Psychol	American Journal of Psychology
Am Psychol	American Psychologist
Ann Math Stat	Annals of Mathematical Statistics
Annu Rev Clin Psychol	Annual Review of Clinical Psychology
ANOVA	Analysis of variance
Arch Gen Psychiatry	Archives of General Psychiatry
ARO	Arousal
a. u.	arbitrary units
AUT	Authenticity
AV	Audiovisual modality
Behav Cogn Psychother	Behavioural and Cognitive Psychotherapy
Behav Res Ther	Behaviour Research and Therapy
Behav Ther	Behavior Therapy
BDI	Beck Depression Inventory
Biol Psychiatry	Biological Psychiatry
Biol Psychol	Biological Psychology
Brain Res	Brain Research
CA	California
CBT	cognitive-behavioral therapy
Child Adolesc Psychiatr Clin N Am	Child and Adolescent Psychiatric Clinics of North America
Clin Psychol Rev	Clinical Psychlogy Review
cm	centimeters
Cogn Behav Ther	Cognitive Behaviour Therapy
Cogn Emot	Cognition and Emotion
Cogn Ther Res	Cognitive Therapy and Research
Curr Biol	Current Biology

DC	District of Columbia
Depress Anxiety	Depression and Anxiety
df	degrees of freedom
diff	difference
$diff_{corr}$	difference corrected for the variance associated with LSAS-scores
DOM	Dominance
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders IV
eds.	editors
e.g.	exempli gratia
Expert Rev Neurother	Expert Review of Neurotherapeutics
f	female
Fig.	Figure
GAD	General anxiety disorder
Glot Int	Glot International
H_u	Unbiased hit rate
Hum Brain Mapp	Human Brain Mapping
HUMOR	Humor: International Journal of Humor Research
ICD-10	International Classification of Diseases 10
i.e.	id est
Inc.	Incorporation
Isr J Psychiatry Rel Sci	Israel Journal of Psychiatry and Related Sciences
J Abnorm Psychol	Journal of Abnormal Psychology
J Anxiety Disord	Journal for Anxiety Disorders
J Behav Ther Exp Psychiatry	Journal of Behavior Therapy and Experimental Psychiatry
J Clin Psychiatry	Journal of Clinical Psychiatry
J Cognit Psychother	Journal of Cognitive Psychotherapy
J Consult Clin Psychol	Journal of Consulting and Clinical Psychology
J Neurosci Methods	Journal of Neuroscience Methods
J Nonverbal Behav	Journal of Nonverbal Behavior
JOY	Joyful laughter

J Psychiatry Res	Journal of Psychiatric Research
J Psychopathol Behav Assess	Journal of Psychopathology and Behavioral Assessment
J Res Pers	Journal of Research in Personality
LSAS	Liebowitz Social Anxiety Scale
LSAS-SR score	Liebowitz Social Anxiety Scale self-rating score
ltype	laughter type
M	mean
M_{corr}	mean corrected for the variance associated with LSAS-scores
m	male
Max	maximum
Min	minimum
mod	modality
ms	milliseconds
MWT-B	Mehrfach-Wortschatz-Intelligenz-Test version B
N	number
NSB	negative self-beliefs
NY	New York
OTHER	condition of a third person perspective: laughter is directed at another person
p.	page
PAD	Pleasure-Arousal-Dominance
PhoPhiKat-45	Questionnaire for measurement of gelotophobia, gelotophilia and katagelasticism
Physiol Behav	Physiology & Behavior
PLoS One	Public Library of Science One
pp	posterior probabiliy
Proc Natl Acad Sci U S A	Proceedings of the National Academy of Sciences of the United States of America
Prog Brain Res	Progress in Brain Research
Psychol Bull	Psychological Bulletin

Psychol Med	Psychological Medicine
Psychol Monogr	Psychological Monographs
Psychol Rev	Psychological Review
Psychol Sci	Psychological Science
Psychol Test Assess Model	Psychological Test and Assessment Modeling
Psychon Bull Rev	Psychonomic Bulletin and Review
r	Pearson coefficient
Rev Gen Psychol	Review of General Psychology
rhr	raw hit rate
r_S	Spearman coefficient
s	seconds
SA	Social anxiety
SAD	Social anxiety disorder
SAM	Self-Assessment Manikin
SCID	Structured Clinical Interview for DSM-IV
SD	Standard deviation
SELF	condition of first person perspective: laughter is self-directed
SEM	Standard error of the mean
Sig.	Significance
SPIN	Social Phobia Inventory
STAI	State-Trait-Anxiety-Inventory
TAU	Taunting laughter
TIC	Tickling laughter
Trends Cogn Sci	Trends in Cognitive Sciences
TYP	Laughter type
USA	United States of America
V	Visual modality
VAL	Valence

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1. Introduction

1.1 Social anxiety and social anxiety disorder

Social anxiety (SA) is the fear of embarrassment and humiliation in social situations caused by the expectation of negative evaluation from others. Hence, socially anxious individuals tend to feel tense and worried during social encounters and therefore show symptoms that have a great variety including physiological reactions like blushing, sweating or heart palpitations as well as behavioral manifestations like the avoidance of the anxiety-provoking situation. The core issues of this phenomenon are social fears which are very common among the general population exhibiting a lifetime prevalence of 15.9% in developed countries. These social fears can refer to a variety of social situations like speaking up in a meeting (12.5%) or in public (13.0%), but also to using a public bathroom (3.1%) or to writing, eating or drinking in public (4.4%; Stein et al., 2010).

In some people, however, social anxiety rises to a level that keeps them from interacting with others and leads them to withdraw from social exchange. This intense and impairing form of social anxiety is called social anxiety disorder (SAD; also known as social phobia) which represents one of the most common mental disorders (Stein and Stein, 2008). Diagnostic criteria are defined in the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV; table 1; American Psychiatric Association, 1994) as well as in the International Classification of Diseases 10 (ICD-10; table 2; World Health Organization, 2016). The lifetime prevalence indicated in different studies varies with values of 5.0% (Grant et al., 2005), 6.1% (Stein et al., 2010) and 12.1% (Ruscio et al., 2008) depending on which criteria have been used to diagnose SAD in the respective study. SAD is a phenomenon that affects individuals of any age by typically having an early onset in childhood or adolescence (Chavira and Stein, 2005) and persisting into adulthood and even late life (Cairney et al., 2007). By causing a severe loss of quality of life (Mendlowicz and Stein, 2000) as well as high economical costs (Lipsitz and Schneier, 2000) SAD is a burden for both the individual and the society.

Table 1. DSM-IV diagnostic criteria for social anxiety disorder (SAD)

A A marked and persistent fear of one or more social or performance situations in which the person is exposed to unfamiliar people or possible scrutiny by others. The individual fears that he or she will act in a way (or show anxiety symptoms) that will be humiliating or embarrassing.

B Exposure to the feared social situation almost invariably provokes anxiety, which may take the form of a situationally bound or situationally predisposed panic attack.

C The person recognizes that the fear is excessive or unreasonable.

D The feared social or performance situations are avoided or else are endured with intense anxiety or distress.

E The avoidance, anxious anticipation, or distress in the feared social or performance situation(s) interferes significantly with the person's normal routine, occupational (academic) functioning, or social activities or relationships, or there is marked distress about having the phobia.

F In individuals under age 18 years, the duration is at least 6 months.

G The fear or avoidance is not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition and is not better accounted for by another mental disorder (e.g. Panic Disorder With or Without Agoraphobia, Separation Anxiety Disorder, Body Dysmorphic Disorder, a Pervasive Developmental Disorder, or Schizoid Personality Disorder).

H If a general medical condition or another mental disorder is present, the fear in Criterion A is unrelated to it, e.g., the fear is not of stuttering, trembling in Parkinson's disease, or exhibiting abnormal eating behavior in Anorexia Nervosa or Bulimia Nervosa).

Specify the disorder as generalized if the fears include most social situations (also consider the additional diagnosis of Avoidant Personality Disorder).

Table 2. ICD-10 diagnostic criteria for social anxiety disorder (SAD)

F40.1 Social phobias:

Fear of scrutiny by other people leading to avoidance of social situations. More pervasive social phobias are usually associated with low self-esteem and fear of criticism. They may present as a complaint of blushing, hand tremor, nausea, or urgency of micturition, the patient sometimes being convinced that one of these secondary manifestations of their anxiety is the primary problem. Symptoms may progress to panic attacks.

1.2 Theoretical models of social anxiety disorder

Individuals with SAD tend to avoid the anxiety-provoking stimulus (i.e., the feared social situation). However, while it might be possible for a person with an arachnophobia to avoid encounters with spiders without a relevant impairment of life quality, socially anxious individuals cannot shirk every social situation so easily and thus often have to face feared stimuli. This makes a huge difference to specific phobias like arachnophobia, height phobia or claustrophobia since in these, the strict avoidance of the phobic object is thought to be a core mechanism for the persistence of the anxiety (Clark, 2001). So why does SAD persist over years or even decades although socially anxious persons are exposed to feared cues in their everyday life?

In order to explain this question, different theoretical models have been proposed since SAD began to be distinguished from other phobias in the 1960s (Marks and Gelder, 1966). Early theoretical work regarding this issue has been made by Beck, Emery and Greenberg (1985), Butler (1985), Hartman (1983), Heimberg and Barlow (1988), Leary (1983), Salkovskis (1991) and Trower and Gilbert (1989). Taking their considerations into account, in the 1990s, two theoretical models came up which have been shaping the social anxiety research for the past two decades up to now: the "Cognitive Model of Social Phobia" by David M. Clark and Adrian Wells (1995) and the "Cognitive-Behavioral Model of Anxiety in Social Phobia" by Ronald M. Rapee and Richard G. Heimberg (1997).

1.2.1 Clark and Wells: A Cognitive Model of Social Phobia

According to the model proposed by Clark and Wells (1995), the occurrence of a social situation activates assumptions in individuals with SAD that they have developed of themselves in the past due to negative experiences in former social encounters. These assumptions consist of the belief that in social situations, they behave in an inept and unacceptable way, and that such behavior leads to detrimental consequences like social rejection and loss of status and worth. The consequence of this is that individuals with SAD perceive danger in social situations, which leads to the automatic activation of an "anxiety program" (p. 70) comprising cognitive, somatic, affective and behavioral responses. These responses help to maintain or even exacerbate anxiety by becoming further sources of perceived danger and thus starting a vicious circle. An important

element of this is that individuals with SAD tend to become preoccupied with their somatic reactions and negative thoughts about their social evaluation so that their ability to process social cues is interfered. According to Clark and Wells, "the importance of this processing bias is that it prevents social phobics from getting maximum benefit from their everyday experience with social situations or from the exposure exercises in behavior therapy treatment programs" (p. 72).

1.2.2 Rapee and Heimberg: A Cognitive-Behavioral Model of Anxiety in Social Phobia

Similarly to Clark and Wells' assumptions which they argue are activated in persons with SAD in social encounters, Rapee and Heimberg (1997) suggest that socially anxious individuals form a mental representation of the self and their external behavior and appearance as presumably seen by the audience when entering a social situation. This representation is based on inputs from long-term memory including prior experiences in similar situations as well as the general image the person has of him-/herself and modified by perceived both internal (e.g. proprioception, somatic symptoms) and external cues (e.g. audience feedback). Because socially anxious individuals exhibit information processing biases and an attentional resource allocation this representation is not likely to be objective but rather negatively distorted. Simultaneously, the socially anxious individual forms an opinion about what performance standard or norm he/she expects is utilized by the audience in the given situation and then compares his/her mental representation of the self with this standard. This leads to a discrepancy between the two compared elements, which is why the socially anxious individual expects a negative evaluation and thus also social consequences like rejection from the audience. This leads to physiological, cognitive and behavioral anxiety symptoms which in turn influence the mental representation the socially anxious person has of him-/herself and therefore, a vicious circle is formed.

Beside all differences, the two presented models both attribute an important causal role of information processing biases to the maintenance process of SA since they suggest that biases in the interpretation of (i.e., interpretation bias) as well as the attention towards (i.e., attention bias) social cues confirm the negative impression the socially anxious person has of him-/herself as a social object and thus maintain the symptoms of anxiety.

1.3 Information processing biases in social anxiety

According to both theoretical models, socially anxious individuals are supposed to exhibit specific information processing biases. Information processing biases in general are cognitive biases which emerge in all human beings in situations of uncertainty or when information processing time and ability are limited. Under such circumstances humans employ heuristic principles in order to make complex tasks simpler. As a consequence biases arise (Tversky and Kahneman, 1974).

In socially anxious individuals, however, further information processing biases appear when entering a social situation. Two of these biases are of particular importance and will be described in the following:

1.3.1 Interpretation bias

Socially anxious persons tend to interpret neutral or ambiguous stimuli as threatening, which in SA research is called negative interpretation bias. Several studies found evidence for the existence of this bias using different types of stimulus material (for a review, see Morrison and Heimberg, 2013):

Using video sequences in which an actor or an actress commented on the spectator's actions or belongings in a positive, negative or ambiguous way Amir et al. (2005) showed that socially anxious persons assessed the valence of ambiguous cues as more negative than did non-anxious controls. This negative interpretation bias in spoken cues is not limited to verbal expressions but was also observed for prosody in a study in which meaningless utterances spoken in a neutral, angry, sad, fearful, disgusted or happy tone of voice were used as stimulus material (Quadflieg et al., 2007).

Other studies investigated the interpretation bias in SA by using facial expression as stimuli (for a review, see Machado-de-Sousa et al., 2010): Winton et al. (1995) found that socially anxious subjects are more likely to assess others' emotional facial expressions as negative than non-anxious controls. Trying to approach the dynamic nature of facial expressions more accurately Joormann and Gotlib (2006) utilized a morphed-faced task but found no evidence for a negative interpretation bias in individuals with SA. In another morphed-face study, however, socially anxious individuals were more likely to misinterpret disgust as contempt than non-anxious ones,

which demonstrates a negative interpretation bias regarding the intention of the speaker towards the listener (Heuer et al., 2010).

Another feature of the interpretation bias in SA is that socially anxious individuals tend to interpret positive social events in a negative way, e.g. as threatening (Alden et al., 2008). This negative interpretation of positive events appears in socially anxious persons more often than in individuals with other anxiety disorders and correlates with the severity of personal fears (Laposa et al., 2010). Further, individuals with SAD also tend to interpret unambiguous but mildly negative social events in a more negative or even catastrophic fashion than patients with other anxiety disorders or non-anxious controls (Stopa and Clark, 2000).

It could also be shown that socially anxious individuals exhibit a negative interpretation bias not only in response to external but to internal cues as well: While persons with SAD generally tend to have more negative self-evaluative thoughts (Stopa and Clark, 1993), they are also more likely to interpret their own social performance as more negatively than non-clinical controls (Wallace and Alden, 1997) and to think that anxiety symptoms that they have in social situations are interpreted by others as a sign for intense anxiety or a psychiatric condition rather than a normal physical state (Roth et al., 2001).

Finally, other studies suggest that the negative interpretation bias in social anxiety may be accompanied by a lack of a benign interpretation bias that can be found in non-anxious individuals (Hirsch and Mathews, 1997; Constans et al., 1999; Hirsch and Mathews, 2000).

Taken together, there is much evidence that socially anxious individuals tend to make more threat interpretations and fewer benign interpretations especially in response to ambiguous stimuli than non-anxious persons do. To affirm that this interpretation bias plays a causal role in the maintenance of SA as hypothesized by theoretical models, recent research has used cognitive bias modification (Beard, 2011) to train socially anxious individuals to interpret ambiguous stimuli in a more benign way. As a result, adults high in SA (Beard and Amir, 2008) as well as adults with generalized SAD (Amir and Taylor, 2012) were more likely to interpret ambiguous cues in a benign way after performing an interpretation modification training, which also lead to a reduction of symptoms of SA. These findings underline that research on the field of information

processing biases in SA is not only of academic interest, but has also practical benefit for the treatment of patients with SAD. Likewise, research on the effects of cognitive-behavioral therapy (CBT) which in the field of SAD tries to help patients to generate alternative interpretations for ambiguous cues and thus correct the negative interpretation bias found that on a forced-choice measure the negative interpretation bias was greater in untreated individuals with generalized SAD in comparison to treated ones and non-anxious controls while, however, with an open-ended measure this outcome could not be replicated (Franklin et al., 2005).

1.3.2 Attention bias

As a second difference to non-anxious persons, socially anxious individuals are hyper-vigilant towards threatening stimuli. This form of information processing bias is called attention bias in SA research. Research up to now has demonstrated this bias using different paradigms (for a review, see Bar-Haim et al., 2007; Schultz and Heimberg, 2008):

Early research in the 1990s began investigating the attention bias by using a modification of the Stroop task (Stroop, 1938; Mathews and MacLeod, 1985) in which participants were asked to name the color of the letters in which the presented words are printed (blue, green, yellow, or red). The presented words comprise social threat words, physical threat words and non-threat words. Presumably because of a difficulty to ignore social threat individuals with SAD were even slower to color-name social threat words than non-threat words in comparison to non-anxious controls (Mattia et al., 1993). This effect could be shown to be specific for social anxiety by comparing individuals with SA with patients with other anxiety disorders like panic disorder (Hope et al., 1990; Maidenberg et al., 1996) and generalized anxiety disorder (Becker et al., 2001) while a present comorbidity with depression seems to make the attention bias disappear (Grant and Beck, 2006).

Another paradigm that was early used to investigate the attention bias in social anxiety was the probe detection task initially described by MacLeod et al. (1986) in the 1980s in order to explore attention biases in emotional disorders. The dot probe task is a computer-generated paradigm in which a neutral dot is presented directly after the presentation of a word pair consisting of a neutral and a threat word which can appear

on the upper or lower area (or right and left area) of the computer monitor with equal probability. Likewise, the subsequent dot appears randomly on one of the two areas and the response time is measured which a participant needs to decide in which area the dot appears. Presumably because their attention is allocated and fixed to social threat, patients with SAD are faster to detect probes following social threat words (Asmundson and Stein, 1994). This finding could be replicated by Musa et al. (2003) whose results are additionally in line with those of Grant and Beck (2006) who found that while simultaneously suffering on depression patients with SAD do not exhibit the attention bias.

In order to use a more ecologically valid stimulus material, Mogg and Bradley (2002) modified the dot-probe task by employing pictures of facial impressions instead of words arguing that these may be closer to naturalistic social situations. Likewise, they found that anxious individuals tend to allocate their attention towards threatening stimuli.

Photographs of faces were also used in a face-in-the-crowd task in which pictures of human faces taken from the same person but varying in the expression of different emotions like anger, disgust and happiness were shown in matrices. The participants' task consisted in deciding whether all the faces in the matrix were similar to each other or if one of the faces did not fit to the others. It was found that individuals with SAD were faster to detect an angry face than a happy face in a neutral crowd, which can be explained by an attention allocating towards threatening stimuli. Furthermore, patients with SAD were slower to detect neutral faces in angry crowds as well as in happy crowds than non-anxious controls. The authors of this study suggest that these findings could be in line with the attention bias towards threatening cues since happy faces which smile could be perceived as threatening by socially anxious persons due to their fear of being laughed at (Gilboa-Schechtman et al., 1999).

Using the eye-tracking technique in which a camera records the movements of the participants' eyes while watching stimulus material, there are likewise indications for an attention bias in SA: Socially anxious individuals were found to be faster to fixate on emotional faces than on neutral ones in comparison to low anxious persons, but to then direct their gaze also faster away from the emotional faces, which indicates that the

attention bias towards threat may be accompanied by a subsequent avoidance of the threatening stimulus (Garner et al., 2006).

In order to explore the existence of the attention bias in SA in an environment as close to natural social situations as possible, Veljaca and Rapee (1998) used a live audience consisting of confederates who gave feedback via prescribed positive behaviors like nodding and smiling or negative ones like yawning and looking at their watch while subjects giving a speech. Subjects were instructed to record these feedbacks. As a result, those high in SA were more accurate than low anxious controls at detecting actual negative feedback of the audience. Additionally, there was an indication for a negative interpretation bias since high socially anxious individuals were more liberal in interpreting a behavior as negative, which is similar to the findings of Winton et al. (1995) described above.

Recent research has tried to verify the presumed causal role of the attention bias for the maintenance of SA. To this end, patients with SAD were trained to allocate their attention away from threatening social stimuli using a computer-based attention modification procedure based on a probe detection task. As a result, patients with SAD disengaged more easily from threatening stimuli after the attention modification training, which can be seen as a reduction of the attention bias. This also led to a reduction of SA symptoms with half of the participants even no longer meeting DSM-IV criteria for SAD (Amir et al., 2009). These results underline the causal role of attention bias in SA, which is also reflected by findings of the research on psychotherapy suggesting that CBT which is the psychological gold standard therapy for anxiety disorders (Hofmann and Smits, 2008) reduces the attention bias in SA (Tobon et al., 2011).

However, there are also a number of studies which did not clearly demonstrate an attention bias in SA (Horenstein and Segui, 1997; Amir et al., 2003). Moreover, several studies (most of them using the probe detection paradigm and pictures of faces expressing positive, neutral or negative emotions as stimuli) indicated, in contrast to the hypervigilance-hypothesis, that socially anxious persons exhibit an attentional avoidance of social threat stimuli (Mansell et al., 1999; Chen et al., 2002). Because of the scientific debate having arisen about these contradictory findings and their implications on the plausibility of the different theoretical models of SA (Schultz and

Heimberg, 2008), subsequent studies were designed to verify or falsify hypotheses based on previous investigations. To this end, Sposari and Rapee (2007) utilized the same experimental setup (including the same stimuli and method) as Mansell et al. (1999) with one little modification regarding the threat induction: While Mansell et al. told their participants that they were expected to hold a speech and locate the audience's evaluative behavior after the dot probe session, Sposari and Rapee instructed their subjects that they would have to give a speech afterwards, but without a hint for a locating of the behavior of audience members. Interestingly, the results of Sposari and Rapee, contrary to Mansell et al., are indicative for the existence of an attention bias towards threat in SA. These contradictions show that the very nature of the attention bias in SA is still not fully understood and that further research on this field is necessary. This is also reflected by findings of two recent studies suggesting that the attention bias in SA may also be accompanied by a bias away from positive social stimuli: In the first study, it was shown that an attention bias away from positive social cues mediated the effect of SA on the response to a social stressor (Taylor et al., 2010). The second study demonstrated that an attention training towards positive cues leads to a diminished anxiety reactivity to a stressor (Taylor et al., 2011).

1.3.3 Stimuli used to investigate information processing biases in social anxiety

There is a large body of studies which tried to investigate information processing biases in SA. Most of them found evidence for the hypotheses that socially anxious persons tend to interpret neutral or ambiguous stimuli as threatening (i.e., interpretation bias) and that they are hyper-vigilant towards threatening stimuli (i.e., attention bias). In the course of this, the history of research on the field of information processing biases in SA is also a history of trying to find appropriate valid stimuli which approach natural social situations as close as possible in order to provoke realistic responses of subjects investigated. Put in other words, the validity and conclusiveness of a study is directly depending on the validity of the stimulus material utilized. Taken together, previous research has been confined on a limited number of social stimuli such as verbal (both written as words (Mattia et al., 1993; Asmundson and Stein, 1994) as well as spoken as comments (Amir et al., 2005)), prosodic (Quadflieg et al., 2007), facial (Machado-de-Sousa et al., 2010; Staugaard, 2010) and behavioral (Veljaca and Rapee, 1998)

expressions. However, there are further social communication signals which occur frequently in everyday life, but have not yet received attention in SA research. Since research employing the described body of stimulus material has to some extent produced controversial results (see above) and thus, the very nature of information processing biases in SA has not yet been fully understood, the use of further social communication signals as stimuli would be a valuable supplement.

1.4 Relevance of laughter for social anxiety

1.4.1 Laughter as a communication signal

One of the social communication signals that have not been utilized in SA research is laughter. And yet laughter can be assumed to have great potential as a tool for the investigation of information processing biases in SA because of its ambiguity and frequent occurrence in everyday life as described in Ritter et al. (2015, p. 178f):

"Laughter is an ancient communication signal which as tickling laughter is already present in nonhuman primates (Davila Ross et al., 2009). In humans it evolved into different laughter types (e.g. joyful or taunting laughter) which serve different social functions such as group bonding (Provine, 2013), but also social segregation (Eibl-Eibesfeldt, 1970). Tickling laughter, on the other hand, is an evolutionary older type of laughter. It is confined to bodily interactions serving the reinforcement of play behavior (Panksepp and Burgdorf, 2003) and contains less complex social information.

It could be shown that these different laughter types are distinguishable based on the vocal signal alone (Szameitat et al., 2009). Nevertheless, the laughter signal is not unambiguous. It can remain difficult to distinguish between the different types especially when there is little or no contextual information. This very ambiguity makes laughter as stimulus material for SA research very attractive as it is siutable to evoke typical behavioral correlates of SA through the transmission of ambiguous social information to socially anxious individuals whose central fears pertain to humiliation, criticism and rejection."

Furthermore, laughter is a communication signal that comprises two sensory modalities: an auditory and a visual one. Therefore, unlike most of the stimulus material utilized in previous SA research, laughter stimuli can be presented in different sensory modalities and thus, the ambiguity of the originally audiovisual laughter signal can be further

increased by removal of sensory redundancy through unimodal (i.e., auditory) presentation. As described above, a negative interpretation bias in SA means that socially anxious persons tend to interpret specifically ambiguous stimuli as threatening. Therefore, it can be assumed that this bias is more prominent for unimodally presented laughter stimuli as compared to multimodal presentations.

1.4.2 Laughter as an emotion-expressing as well as emotion-provoking stimulus

Laughter is able to serve different social functions in everyday behavior because it is able to convey emotional states from the laughing person to the laughter-perceiving individuals. Put in other words, it is a means to express emotions of the laughing person, but simultaneously also elicits emotions in the laughter-perceiving individuals. Therefore, the understanding of the potency of laughter as a communication signal is closely related to the understanding of the nature of emotions.

To try this, however, is a difficult task to undertake since psychological research up to now has produced a plethora of different definitions of emotion due to various different theories about what emotions are, how they emerge and what exact functions they serve (Darwin, 1872; James, 1884; Cannon, 1927; Schachter and Singer, 1962; Lazarus, 1991). Nevertheless, useful frameworks could be created to classify emotions and emotional stimuli: While emotions can be categorized to discrete categories such as happiness, sadness, anger, fear, disgust or surprise (Ekman, 1992; Ekman et al., 1969), there also exist dimensional models of emotion which try to conceptualize emotions by defining where these are located in two or more so called dimensions (Wundt, 1896; Osgood et al., 1957; Fontaine et al., 2007). According to the Pleasure-Arousal-Dominance (PAD) emotional state model by Mehrabian and Russell (1977), emotional states can be described by three independent and bipolar dimensions which are pleasure-displeasure, degree of arousal and dominance-submissiveness: The pleasure-displeasure dimension indicates how pleasant an emotion is, e.g. joy is high on pleasure while sadness, anger and fear are high on displeasure. The dimension of arousal refers to a combination of activity and alertness and indicates how awake and energized one is during an emotional state, e.g. anger and rage have a high arousal state while boredom has a low one. Finally, the dominance-submissiveness dimension refers to how unrestricted or free one feels to act in a variety of ways, e.g. anger and rage are rather

dominant emotions while fear is a rather submissive one since while having fear all attention is focused to the fear-provoking stimulus greatly limiting the range of acting possibilities (Mehrabian, 1980). Using these three basic dimensions of emotions any emotional state can be adequately described: It could be shown that using State Pleasure, State Arousal and State Dominance scales (Mehrabian and Russell, 1974), different emotions can be matched to a specific configuration of the three dimensions (which have a range from - 1 to + 1 with a neutral value of 0; table 3; Russell and Mehrabian, 1977).

For the field of laughter perception in SA, this means that emotions that are expressed by laughter can also be described using dimensional models of emotions. Since the aim of the present study is to investigate information processing biases in socially anxious individuals the utilized stimulus material must be able to express the emotional state of the laughing person (including his/her arousal, dominance and receiver-directed valence) so that based on the assumed emotional state of the sender, the laughter-perceiving individuals can try to assess the social inclusiveness/exclusiveness of the presented laughter. To investigate what emotional state a stimulus expresses, measurements of emotional dimensions can be performed for each stimulus and then compared to measurements of emotional states in previous studies. It can be assumed that different laughter types express different emotions with joyful laughter expressing a pleasant emotional state while taunting laughter can be presumed to express a rather dominant emotional state.

Table 3. Definition of terms denoting emotions in term of pleasure, arousal and dominance

		Pleasure		Arousal		Dominance	
Term	N	Mean	SD	Mean	SD	Mean	SD
Joyful	29	0.76	0.22	0.48	0.26	0.35	0.31
Happy	29	0.81	0.21	0.51	0.26	0.46	0.38
Anxious	28	0.01	0.45	0.59	0.31	–0.15	0.32
Fearful	29	–0.64	0.20	0.60	0.32	–0.43	0.30
Surprised	29	0.40	0.30	0.67	0.27	–0.13	0.38

Examples of the dimensional configuration of emotional terms rated by undergraduate students in a study by Russell and Mehrabian (1977). Mean is the mean rating transformed to a – 1 to +1 scale**.**

1.4.3 Multimodal integration of emotional stimuli

As already outlined in the two previous chapters, laughter as a stimulus for SA research demonstrates various characteristics such as the capability to express emotional states and intentions of the laughing person, the capability to evoke emotional states in the laughter-perceiving individuals, as well as the advantage in comparison to other kinds of stimuli that it is multimodal and can be presented both unimodally as well as bimodally in order to vary its ambiguity. To better understand to what degree the ambiguity of laughter stimuli can be varied through uni- versus bimodal presentation, the question arises whether there is a facilitation effect during audio-visual integration of laughter as it could be shown for other emotion expressing cues (see below). The term multimodal integration refers to the process by which information from different sensory modalities (auditory, visual, haptic, olfactory, gustatory ones) are combined by the brain to influence perception of stimuli occurring in more than one sensory modality like most of the cues occurring in everyday communication do. The advantage of a multimodal integration is, on the one hand, that when information of different modalities are redundant the reliability of sensory estimates can be increased. On the other hand, when information of different modalities are non-redundant, complementary cues from different modalities can be put together to gain an information that could not be extracted from one modality alone (Ernst and Bulthoff, 2004). Since laughter is a communication signal that comprises two sensory modalities (i.e., vision and audition), an audio-visual integration of laughter in the human brain appears to be probable. Up to

now, however, research has not yet demonstrated an integration effect for laughter as it could be done for other emotional expressions (Campanella and Belin, 2007; Ethofer et al., 2006b): It could be found that behavioral reactions to emotional information carrying stimuli is facilitated by congruence between facial expression and affective prosody (Massaro and Egan, 1996; Dolan et al., 2001; de Gelder and Vroomen, 2000; Kreifelts et al., 2007). Research also showed that information obtained in one sensory modality can affect information processing in another (Ethofer et al., 2006a; de Gelder and Vroomen, 2000; Massaro and Egan, 1996). This crossmodal bias was shown to occur irrespective of attention why it stands to reason that multimodal integration of emotional information is an automatic process (de Gelder and Vroomen, 2000; Ethofer et al., 2006a; Collignon et al., 2008). Additionally, Collignon et al. (2008) found that when information from the different sensory modalities are incongruent, individuals tend to be led by the visual modality while categorizing emotional expression. This visual domination, however, did not seem to occur in a rigid manner since when the information of the visual modality was less reliable individuals assessed the stimulus material based on the auditory modality.

In order to be able to estimate whether the ambiguity of laughter stimuli is variable by presenting them in different modalities, it seems reasonable to investigate the audio-visual integration of laughter prior to utilize laughter stimuli in SA research.

1.4.4 Gelotophobia: The fear of being laughed at

While physiologically laughter in its different types serves as an everyday social communication signal whose benefits are appreciated by a majority of people, some individuals feel very uneasy when encountering a situation in which people laugh. The reason for their uneasiness is the fear of being ridiculed and laughed at. In order to describe this phenomenon, the novel concept of gelotophobia has been proposed by recent research (Titze, 2009) and will be described in the following:

Gelotophobia (derived from Ancient Greek γέλως (laughter) and φοβία (fear)) is defined as “the pathological fear of being the object of laughter” (p. 27), and, according to the model of Titze, it develops on the base of “repeated traumatic experiences of being ridiculed (…) during childhood and adolescence” (p. 32). Its development in childhood is further fostered by overprotecting parents who have rigid normative

demands and do not smile as a positive social signal, but utilize laughter rather as a means to ridicule their children when these do not meet requirements. Because of that children do not get used to laughter as a positive element of shared identity, but identify laughter as something dangerous. As a result, children have difficulties in finding and fitting into extra-familial social groups since in these, laughter is used as a communication signal to define and sharpen the group's identity. On the contrary, these children feel uneasy in social situations in which laughter emerges and thus behave in a tense and unrelaxed way so that their appearance becomes "wooden" through muscular tension and stiffness, which Titze (1996) calls the Pinocchio Complex. What follows is that gelotophobic persons appear involuntarily funny to others so that these laugh and thus, a vicious circle is built.

Since this concept has a lot in common with models of SA, the question arises whether gelotophobia and SA are different aspects of the same entity and one a part of the other respectively or if these two phenomena are two different entities. Despite all similarities between the two concepts, previous literature regarding this question is prone to assume the latter possibility: Titze (2009) considers gelotophobia to be a specific variant of shame-bound anxiety which is why the concept of gelotophobia focuses on the self as the central object of evaluation (according to this, the gelotophobic person considers his/her self as being intolerably ridiculous), whereas the focus of SA lies on specific inexcusable failures in social performances but not directly on the self. Edwards et al. (2010) examined undergraduate students to investigate relations between gelotophobia, social anxiety and memories of being the target of teasing during childhood and adolescence. They found that gelotophobia was highly correlated to measures of SA, but that the association between gelotophobia and a history of being teased remained significant after controlling for SA. Because of these findings they conclude that gelotophobia is related, but distinct from SA, although their study is limited by the fact that they used only a sub-clinical sample.

In contrast to previous research in SA, laughter stimuli were already utilized in the field of gelotophobia research: Ruch et al. (2009) recorded laughter of various emotional qualities on tapes and presented these to gelotophobic and non-gelotophobic individuals. As a result, positively motivated laughter was interpreted as more unpleasant by gelotophobic than by non-gelotophobic participants. Moreover, the

gelotophobic subjects tended more to estimate the laughing person to be in a state of negative affect as compared to non-gelotophobic ones. This finding could be seen as a counterpart to the negative interpretation bias as identified for SA (see above). Nevertheless, as there is no comparable study with socially anxious individuals, it still remains unclear whether persons with SA would response to laughter stimuli in a similar way as gelotophobic individuals, as Sarid et al. (2011, p. 14) state: "However, it seems as if the literature on social phobia does not concur with predicting these outcomes. Social phobics, or patients with other social anxiety disorders, should not necessarily feel unease when hearing others laugh or relate this laughter to them."

For that, it seems obvious that further research is needed to answer the question how socially anxious individuals perceive laughter, whether they exhibit the same information processing biases for laughter as they do for other social stimuli, and what implications the perception of laughter in socially anxious individuals has for the relationship between SA and gelotophobia.

1.5 Emotion regulation in social anxiety

As described in chapter 1.2, theoretical models of SAD posit that a main reason for the maintenance of SAD consists of the belief in individuals with SAD that they behave in an inadequate way in social situations and that such behavior leads to disastrous negative social consequences (Clark and Wells, 1995; Rapee and Heimberg, 1997). As extensively described, these beliefs are facilitated by information processing biases. However, there seem to be further mechanisms playing a role in contributing to this process since, despite all cognitive biases, there are further opportunities to alter negative assumptions and beliefs one develops about one's own behavior and subsequent reactions by others. These opportunities comprise emotion regulation strategies such as approaching or avoiding certain emotion-provoking places, persons or objects (i.e., situation selection), modifying emotion-provoking situations (i.e., situation modification), distraction or concentrating oneself in emotion-provoking situations (i.e., attentional deployment), reinterpreting the meaning of the emotion-provoking stimulus (i.e., cognitive change), and influencing the physiological, experiential or behavioral responding to the emotion-provoking stimulus (i.e., response modulation; Gross, 1998). Thus, difficulties in emotion regulation which can be defined as "the process by which

individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (p. 275) may be another core feature of SA, as presumed by cognitive models (Hermann et al., 2004; Hofmann, 2004).

Previous research suggests that anxiety disorders are associated with deficits in emotion regulation (Amstadter, 2008). Likewise, it could be shown that socially anxious individuals have difficulties with emotion regulation: In one study, individuals with SAD reported to pay less attention to their emotions and have more trouble describing emotions than persons with GAD and non-anxious controls (Turk et al., 2005). Similarly, in another study, a SAD diagnosis was best predicted by poor emotional understanding (Mennin et al., 2009). Furthermore, socially anxious individuals seem to use more emotional suppression than non-anxious ones and have greater ambivalence about expressing emotions and more difficulties in emotional responding. They also appear to fear emotional experiences more than non-anxious controls and have more negative beliefs about emotional expressions. The beliefs of socially anxious individuals that they have to control their emotional expressions in order to not appear weak to others have been shown to mediate the association between SA and emotional suppression (Spokas et al., 2009). These findings are of peculiar importance since they indicate a lower emotional competence in patients with SAD: Emotional competence which can be defined as the functional skill to "emerge from an emotion-eliciting encounter with a sense of having accomplished what we set out to do" (Saarni, 1999, p. 3) has the premise to be able to identify one's own emotions in order to be able to manage these. Thus, the problems patients with SAD have in implementing emotion regulation strategies may already start in their deficits in awareness of their emotional states (Werner et al., 2011).

However, one specific emotion regulation strategy seems to be of further importance for the explanation of SA: Since a core problem of socially anxious individuals consists especially of their cognitive beliefs about their social performance and the subsequent consequences, they especially seem to have problems in implementing cognitive reappraisal strategies which can be used to modulate negative self-impressions and perceived danger in social situations (e.g. by imaging that the anxiety-provoking cue is not directed at oneself). It could be shown that non-socially anxious individuals use cognitive reappraisal strategies to decrease negative emotional experience (Lazarus and

Alfert, 1964). In contrast, there are previous findings suggesting that socially anxious individuals have difficulties in implementing such strategies: In a study in which patients with SAD and non-anxious controls were trained to implement cognitive reappraisal strategies in response to negative self-beliefs (NSB), the SAD group had greater negative emotions when responding both with and without applying cognitive reappraisal. On the behavioral level, the SAD group was equally able to use cognitive reappraisal to decrease negative emotions as compared to the healthy controls. Within the SAD group, however, a lesser downregulation of negative emotions was associated with the severity of SA symptoms as measured by the Liebowitz Social Anxiety Scale (LSAS). This effect was not found within the control group. Additionally, on the neural level, it was found that individuals with SAD show later and fewer brain responses related to cognitive reappraisal as compared to non-anxious controls indicating that patients with SAD have specific deviances regarding neural timing, connectivity and brain-behavioral associations (Goldin et al., 2009b). Likewise, another study showed as well that individuals with SAD have greater negative emotions than healthy controls in response to both social and physical threat stimuli, but that there is no significant difference between these two groups regarding the ability to decrease negative emotions using cognitive reappraisal. On the neural level, however, it could be shown again that patients with SAD exhibit a reduced cognitive regulation-related neural activation specifically for social threat cues (Goldin et al., 2009a). Two recent studies suggest that the problem of patients with SAD may not primarily be the inability to implement cognitive reappraisal strategies but rather the lower self-efficacy they have when using these strategies: Werner et al. (2011) found that individuals with SAD use cognitive reappraisal with the same frequency as non-anxious controls, but have lower self-efficacy in doing so, which could be indicative of a distorted perception of the emotion regulation efficacy in SAD patients. Moreover, it could be shown that cognitive reappraisal self-efficacy mediates the effects of individual CBT for SAD (Goldin et al., 2012).

Taken together, socially anxious individuals seem to have difficulties with emotion regulation and especially with cognitive reappraisal. As described, however, the exact mechanisms of these difficulties are not yet fully understood. Therefore, further research is necessary. Since the aim of the current study is to investigate laughter

perception in individuals with SA in order to get further insights in the processes of how SA influences the perception in social situations, it seems worthy to implement a paradigm in the current study which also allows conclusions of whether socially anxious individuals are able to use cognitive reappraisal strategies while perceiving laughter.

1.6 Goals and hypotheses of the present study

The goal of the present study was to investigate social information processing biases in SA and the effects of cognitive reappraisal on biased perception. To this end, novel, ecologically valid multimodal laughter stimuli were used because of the presumed advantages of this stimulus type explained above. Since this stimulus type was novel and not yet used in other studies, the study had to be divided into two parts:

1.6.1 Pre-studies

First, adequate stimulus sequences had to be produced and then validated using a sample of low-anxious individuals (i.e., pre-studies). To this end, the produced laughter sequences were presented to non-anxious individuals which were asked to assess whether the presented laughter could be categorized as joyful laughter, tickling laughter or taunting laughter (i.e., laughter type), and to evaluate the emotional state of the sender of the presented laughter (and not his/her own emotional state): The participants rated how pleasant the sender was towards the receiver (i.e., valence), how aroused he was (i.e., arousal), and how dominant he was (i.e., dominance). Moreover, the laughter stimuli were assessed relating to how authentic they appear (i.e., authenticity). Based on the literature referenced above, the following hypotheses were proposed which served as a plausibility check that the produced stimulus material is valid:

1. The three laughter types joyful laughter, tickling laughter and taunting laughter will be recognizable based on the auditory, visual and audiovisual signal. There will be an audiovisual integration effect displayed by a higher recognition performance in the audiovisual than in the unimodal modalities.
2. Joyful laughter will be assessed as expressing a more pleasant intention towards the receiver than taunting laughter.

3. Tickling laughter will be assessed as expressing a higher arousal than joyful laughter and taunting laughter.
4. Taunting laughter will be assessed as expressing greater dominance than joyful laughter.
5. The majority of laughter stimuli will be assessed as being authentic.

1.6.2 Main study

Second, these validated stimuli were presented to individuals with varying degrees of SA which were asked to judge the communicative intentions (social inclusion, exclusion) expressed in different laughter types (joyful, taunting, tickling laughter) while imaging themselves in one of two situations (i.e., main study): (1) being the intended target of the laughter, or (2) watching an actor rehearse laughter for a play (i.e., a condition which equals a cognitive reappraisal strategy).

Based on the literature referenced above, the study was designed to test the following hypotheses:

1. Laughter will be rated as more socially rejecting with increasing severity of SA (i.e., negative interpretation bias).
2. This negative interpretation bias will decrease under cognitive reappraisal conditions.
3. The negative interpretation bias will be stronger for unimodal auditory laughter stimuli due to the higher level of ambiguity.
4. There will be a linear relationship between SA and faster response times to taunting laughter than to joyful laughter (i.e., attention bias towards threatening cues).

2. Method

The present study consists of two parts with different goals. The first part itself is divided into four sections which will be called pre-studies in the following. They were designed to evaluate the produced laughter stimuli in order to utilize these for the second part of the study called main study in the following. This main study then serves the actual investigation about laughter perception in social anxiety.

2.1 Pre-studies

The major aim of the pre-studies was to select and validate adequate laughter stimuli for the main study. However, prior to evaluation of which stimuli were adept for investigating laughter perception in social anxiety, first a stimulus corpus had to be produced out of which adequate stimuli could be chosen for the main study. To this end, professional actors were invited to produce a video footage out of which short video sequences were cut. In order to select appropriate sequences for the main study, four groups of fourteen healthy students each were invited who were asked to assess whether the presented laughter could be categorized as joyful laughter, tickling laughter or taunting laughter (i.e., laughter type), how pleasant the sender was towards the receiver (i.e., valence), how aroused he was (i.e., arousal), how dominant he was (i.e., dominance), and how authentic the presented laughter appeared (i.e., authenticity). Based on the analysis of this rating, sixty sequences were selected to serve as stimuli in the main study.

2.1.1 Participants

In the pre-studies, in total fifty-six participants (28 women, 28 men; M_{age} = 24.3 years, SD = 2.9) voluntarily took part. They were recruited through an email to all students of the University of Tübingen as well as through announcements on bulletin boards in public buildings in Tübingen inviting subjects who have no problems in social situations for a study about the perception of laughter. All participants were German native speakers and reported normal hearing and normal or corrected-to-normal vision. They all had no history of neurological or psychiatric illness, or substance abuse. They were screened for SAD using the Mini-SPIN, a 3-item short version of the 17-item Social Phobia Inventory (SPIN; Connor et al., 2001) as well as the Liebowitz Social

Anxiety Scale (LSAS, German self-report version; Stangier and Heidenreich, 2003). Only subjects with a Mini-SPIN score below 6 and an LSAS score below 40 were included in the study. Prior to their inclusion in the study, written informed consent was given by all subjects. The participants received a monetary compensation for their participation.

The fifty-six participants were divided into four groups of fourteen subjects each with respect to a balanced gender ratio within the groups and a comparable age distribution between the groups. Each of these groups was assigned for one of the pre-studies so that the single pre-studies had the following population parameters:

- Pre-study valence (VAL): 7 women, 7 men; M_{age} = 24.6 years, SD = 3.3,
- Pre-study arousal (ARO): 7 women, 7 men, M_{age} = 23.4 years, SD = 2.3,
- Pre-study laughter type (TYP): 7 women, 7 men, M_{age} = 24.6 years, SD = 2.4, and
- Pre-study dominance/authenticity (DOM/AUT): 7 women, 7 men, M_{age} = 24.3 years, SD = 3.5.

2.1.2 Stimuli

The stimuli were part of a larger corpus of video footage produced by eight professional actors (4 women, 4 men) using a script-based auto-induction technique. Based on the video footage, 187 separate video sequences were derived showing the actors' faces wearing black head caps in front of a black background in order to minimize the influence of different haircuts. The sequences were post-processed using Adobe Premiere Pro CS3 software (Adobe Systems Inc., San Jose, CA, USA) to ensure equal quality of the recordings. Post-production steps included an editing of videos with respect to the alignment of the vertical facial symmetry axis and the size of the portrayed faces as well as normalization of sound intensity to a mean of 70 dB (using PRAAT, version 5.1.07; Boersma, 2001).

2.1.3 Experimental design and task

The stimuli were shown on a computer using the software "Presentation" (Neurobehavorial Systems Inc., Albany, CA, USA), a 17-inch flat screen (LG Flatron L1953PM) and a Sennheiser HD 515 headphone (Sennheiser electronic GmbH & Co.

KG, Wedemark-Wanneborstel, Germany). Every stimulus was presented in three different modalities: auditory (A), visual (V) and audiovisual (AV). The order in which stimuli were presented was randomized.

Depending on the assignment to one of the four pre-studies, participants were instructed to assess one of the following aspects of each of the 561 stimuli (187 auditory, 187 visual, 187 audiovisual) by answering one of the following questions:

- VAL: whether the presented stimulus expresses a rather pleasant/positive or unpleasant/negative emotional state, or put in other words, whether the sender of the presented stimulus is rather pleasant or unpleasant towards the receiver (i.e., valence);
- ARO: whether the presented stimulus expresses a rather strong or weak emotional activation (i.e., arousal);
- TYP: whether the presented stimulus expresses a joyful, tickling or taunting laughter (i.e., laughter type).
- DOM/AUT: This pre-study comprised two tasks: first to asses, whether the presented stimulus expresses rather a dominant or submissive attitude of the laughing person (i.e., dominance); second, whether the presented laughter is rather authentic or unauthentic (i.e., authenticity).

For the rating of valence, arousal, dominance and authenticity, a 9-point Self-Assessment Manikin scale (SAM; Bradley and Lang, 1994) was used to evaluate the different dimensions:

- Valence: 1 = highly unpleasant/negative; 5 = neutral; 9 = highly pleasant/positive;
- Arousal: 1 = no activation; 5 = neutral; 9 = very strong activation;
- Dominance: 1 = highly submissive; 5 = neutral; 9 = highly dominant;
- Authenticity: 1 = highly unauthentic; 5 = neutral; 9 = highly authentic.

The type of laughter was assessed using a 3-point scale: 1 = taunting laughter (In German the term “Auslachen” was used which means excluding (hostile) laughter); 2 = tickling laughter (German translation: “Kitzellachen”); 3 = joyful laughter (In German

the term ”Anlachen” was used which means including (welcoming/inviting/friendly) laughter).

For half of the participants the scales were flipped horizontally by alternating the poles of the scales while keeping the neutral response option in the middle position. The aim of this was to avoid effects attributable to the arrangement of the response categories. Participants were asked to rate as fast as possible via the number keys (1-9 and 1-3 respectively) on the keyboard.

2.2 Main study

After evaluating the produced laughter stimuli in the pre-studies and selecting appropriate ones based on the pre-studies' results, the main study was carried out to investigate social information processing biases in SA and the effects of cognitive reappraisal on biased perception. To this end, sixty participants of varying degrees of SA were invited to assess the social inclusiveness/exclusiveness of the presented laughter stimuli. The description of the participant recruitment, stimuli, experimental set-up and performance is partly adopted from Ritter et al. (2015) where this part of the study and its results have been published before. Respective passages are put in quotation marks and italics.

2.2.1 Participants

Sixty individuals (30 women, 30 men; M_{age} = 24.2 years, SD = 3.2) took part in the main study. The recruitment of participants was similar to that one of the pre-studies, this time mainly via the email distribution list of the University of Tübingen, but again also through other forms of public announcements. The announcements invited persons who perceived themselves as either very shy or outgoing. Inclusion criteria were again German as native language and normal hearing and normal or corrected-to-normal vision. Exclusion criteria were a history of neurological or psychiatric illness, or substance abuse or any medication at the time of data acquisition. To assure this, all participants were examined using the Structured Clinical Interview for DSM-IV (Wittchen et al., 1997), prior to their inclusion in the study. In this examination, it was revealed that fourteen participants met the clinical criteria of social anxiety disorder (4 women, 10 men). Table 4 shows the sociodemographic and psychometric characteristics

of the study sample. All participants gave written informed consent before their inclusion in the study and received a monetary compensation for their participation.

Table 4. Socio-demographic and psychometric data of the main study (adopted from Ritter et al. (2015, p. 179))

	mean (SD)
age (years)	24.2 (3.2)
MWT-B	31.2 (2.8)
BDI-II	4.0 (4.1)
LSAS	29.6 (25.9)
STAI state (X1)	34.6 (8.3)
STAI trait (X2)	44.7 (2.9)
Gelotophobia	1.9 (0.7)

MWT-B = "Mehrfachwahl-Wortschatz-Intelligenz-Test", a short test of premorbid intelligence; BDI-II = Beck Depression Inventory; LSAS = Liebowitz Social Anxiety Scale; STAI = State Trait Anxiety Inventory; Gelotophobia as measured by the PhoPhiKat-45.

2.2.2 Stimuli

The stimulus material of the main study consisted of sixty short video sequences of laughing faces with duration of 1.5s each. In these video sequences three different types of laughter (joyful/friendly [JOY], tickling [TIC] and taunting/unfriendly [TAU] laughter) were portrayed.

The video sequences were selected from the greater stimuli corpus based on the results of the pre-studies. Only those stimuli with a recognition rate above chance level and with an at least average level authenticity rating (i.e., ≥ 3,5 on the 9-point SAM) were selected. The final stimulus set comprised sixty video laughter sequences and was balanced for laughter type (JOY = 18, TIC = 20, TAU = 22), recognition rates of the three laughter types (unbiased hit rates ± SEM (Wagner, 1993): JOY = 0.45 ± 0.03, TIC = 0.52 ± 0.03, TAU = 0.47 ± 0.04; analysis of variance (ANOVA): $F(1.7, 22.6) = 1.9$, $p = 0.182$), and the genders of the actors (f = 27, m = 33).

2.2.3 Experimental design and task

The main experiment was conducted with the same software ("Presentation") and hardware components (LG Flatron L1953PM 17-inch flat screen; Sennheiser HD 515 headphone) as utilized in the pre-studies. *"The participants were seated in a comfortable position approximately 70 cm from the screen wearing headphones. The*

volume of sound presentation was adjusted to a comfortable volume for each participant. The screen had a resolution of 800 × 600 pixels and presented visual stimulus components were approximately the same size as a real face.

The main experiment was divided into two sessions with a short break in between. To modulate the ambiguity of the laughter signal, participants were presented with either audiovisual (AV) or audio (A) recordings of laughter. During each session all stimuli were presented under two different sensory conditions: unimodal auditory (A) and bimodal audiovisual (AV).” (Ritter et al., 2015, p. 179) The stimulus sequence was randomized. The two sessions differed with respect to the instructed interactional focus: *“In one session, the participants were asked to imagine they were directly addressed by the presented laughter (SELF). During the other session they were instructed to imagine they were watching an actor practicing a specific type of laughter (i.e., an imaginary technique which can be used as cognitive reappraisal for emotion regulation, OTHER). The order of these two conditions was balanced across the participants, and the stimulus order within sessions was fully randomized. After each stimulus a horizontal 4-point scale with the symbols “>> > < <<” and the words “Anlachen” (German for friendly/socially inclusive laughter) and “Auslachen” (German for unfriendly/ socially exclusive laughter) at opposite ends of the scale was presented (see Fig. 1). The participants were instructed to respond with “>>” if they decided that the laughter clearly belonged to the category at the open sides of the symbols. “>” indicated a decision where the participants were not absolutely sure but judged the laughter sequence as more likely belonging to the respective category. Responses were required within a time frame of 5 s following stimulus onset, and the participants were instructed to respond as quickly as possible to the stimuli. Responses were given with the right hand by pressing one of four buttons on a Cedrus RB-730 Response Pad (Cedrus Corporation, San Pedro, CA, USA). The response scale was flipped horizontally for half of the participants to avoid effects attributable to the arrangement of response alternatives. A scale with an even number of response options was chosen to prevent a central response tendency.”* (Ritter et al., 2015, p. 179f)

After each response, a short visual feedback on the answer recorded by the computer was presented.

The volume was individually adjusted to a comfortable level and a short training

session based on stimuli not included in the main experiment was run in order to familiarize the participants with the experimental setting. Before starting the main experiment, the experimenter made sure that participants fully understood the procedure and their task and that they were familiar with the use of the response device.
Laughter ratings and response times were recorded as outcome parameters.

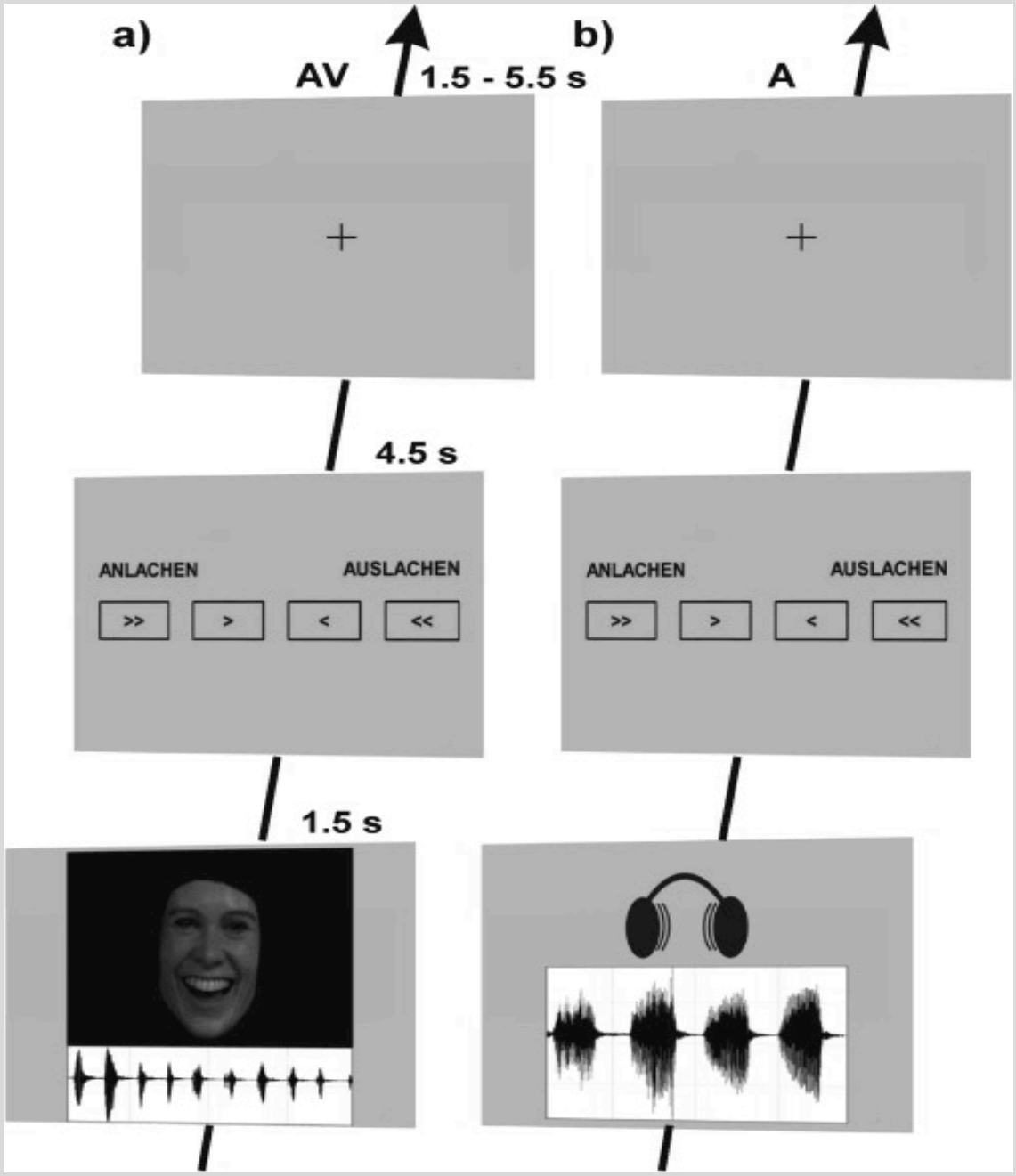

Figure 1. Trial design

Two exemplary experimental trials. (a) illustrates a trial with audiovisual (AV) laughter presentation while (b) shows an auditory (A) trial, respectively. The participants' task was to evaluate on a four-point scale if and how clearly the laughter expressed a friendly (German: "Anlachen") or an unfriendly (German: "Auslachen") social intention. Time specifications on the time axis indicate the durations of stimulus presentation, additional response window and inter-trial-interval. This figure is adopted from Ritter et al. (2015, p. 180).

2.2.4 Additional measures

2.2.4.1 Social anxiety

The severity of social anxiety was assessed using the Liebowitz Social Anxiety Scale (LSAS, German self-report version; Stangier and Heidenreich, 2003). This instrument comprises 24 items portraying 11 social interactional and 13 public performance situations which people with a high level of social anxiety potentially fear and/or avoid. Each item has to be rated on a 4-point-Likert-scale concerning both fear and avoidance. The LSAS has a high reliability and a high convergent validity with other measures of social anxiety (Heimberg et al., 1999; Fresco et al., 2001). In the present study, the self-report version of this scale was used.

2.2.4.2 General anxiety

State and trait anxiety was measured using the State-Trait-Anxiety-Inventory (STAI, German version; Laux et al., 1981). It consists of two questionnaires with 20 items each. The items contain statements which are rated on a 4-point-Likert-scale with respect to the degree to which the participant agrees with the statement. STAI-X1 captures state anxiety while STAI-X2 captures trait anxiety (STAI-X2).

2.2.4.3 Gelotophobia

The German version of the PhoPhiKat-45 was used to assess individual levels of gelotophobia, i.e., the fear of being laughed at. The factors gelotophilia and katagelasticism were also recorded as part of the PhoPhiKat-45 but not included in the analysis. This 45-items instrument employs a 4-point-Likert-scale and is based on the works of Ruch and Proyer (2009) who developed the PhoPhiKat-45 as an instrument to measure the perception and use of laughter as captured in the three above mentioned factors.

2.2.4.4 Verbal intelligence

As a control of premorbid intelligence, the Mehrfach-Wortschatz-Intelligenz-Test (MWT-B; Lehrl, 1977) was applied to measure verbal intelligence. The MWT-B comprises 37 items and possesses a high reliability and validity exhibiting a correlation of $r = 0.72$ with measures of global intelligence (Lehrl et al., 1995).

2.2.4.5 Depression

Since depression has a great influence on the perception of social cues, the Beck Depression Inventory (BDI-II, German version; Hautzinger et al., 2009) was utilized as a self-report measure to control for depressive symptoms in participants additional to the clinical interview conducted by a psychiatrist. The BDI-II is a 21-item self-report questionnaire measuring the severity of affective, motivational, cognitive and somatic symptoms of depression. It has a high reliability and validity and is able to differentiate between different grades of depression (Beck et al., 1988; Kuhner et al., 2007).

These psychometric measures were included either as covariate of interest (LSAS) or control variables (STAI X1 and X2, PhoPhiKat- 45, MWT-B, BDI-II).

2.3 Data analysis

The data of the pre-studies as well as of the main study were statistically analyzed using IBM SPSS Statistics Version 19 (IBM Corporation, Armonk, NY, USA).

2.3.1 Pre-studies

The laughter type recognition performance was evaluated using unbiased hit rates (H_u). To this end, the raw hit rates of each participant were calculated for each laughter type (joyful laughter, tickling laughter, taunting laughter) and each modality (auditory, visual, audiovisual). Then, the unbiased hit rates were calculated by multiplying the raw hit rate by the positive predictive value resulting in unbiased hit rates for each laughter type (joyful laughter, tickling laughter, taunting laughter) and each modality (auditory, visual, audiovisual). The reason for using unbiased hit rates was that they are a more precise measure of classification performance than the raw hit rate since they account for false alarms and biases in the use of response categories (Wagner, 1993). Prior to further analysis, the unbiased hit rates were arcsine transformed. Simultaneously, posterior probabilities were calculated for each laughter type (joyful laughter, tickling laughter, taunting laughter) and each modality (auditory, visual, audiovisual) indicating chance level. Then, unbiased hit rates and posterior probability for each laughter type and modality were compared using t-tests in order to investigate whether stimuli were recognizable in each laughter type and modality. In order to test the hypothesis about

the audio-visual integration, a 3 × 3 repeated-measures ANOVA with modality (A, V, AV) and laughter type (TAU, TIC, JOY) as within-subject factors was conducted. The results were Greenhouse-Geisser corrected, in order to account for potential violations of sphericity (Geisser and Greenhouse, 1958). Main effects of the within-subject factors and their interactions were further examined using post-hoc t-tests on the outcome parameters.

In order to test the hypotheses about the emotional dimensions of laughter, mean ratings of valence, arousal, dominance and authenticity were calculated for each stimulus. Then, a one-way ANOVA with laughter type (TAU, TIC, JOY) as factor was conducted for each of the three dimensional ratings (valence, arousal, dominance). To account for heteroscedasticity detected by a Levene's test (Levene, 1960), the results were corrected using the Welch's t-test (Welch, 1947). Main effects were further examined using post-hoc t-tests on the outcome parameters.

Since the authenticity rating served only to exclude stimuli which were perceived as being unauthentic from the stimulus material for the main study, the analysis of the authenticity rating remained descriptive: The mean and standard deviation were calculated and it was assessed how many stimuli were above a defined level of 3.5 above which the authenticity was assumed to be high enough for the stimuli to serve as realistic cues.

2.3.2 Main study

"The laughter rating values were transformed from symbols to numerical values (1 = clearly unfriendly laughter [German: "Auslachen"]; 2 = rather unfriendly laughter; 3 = rather friendly laughter [German:"Anlachen"]; 4 = clearly friendly laughter).

In order to avoid biases in the response time data due to outliers based on inattention all responses above two standard deviations from the individual mean response time were excluded from further analysis of the response time data." (Ritter et al., 2015, p. 181)

"First, the Kolmogorov-Smirnov test was conducted to ascertain a normal distribution of behavioral data and population parameters. Then linear associations between LSAS and the other population parameters (age, gender, MWT-B, BDI-II, STAI-X1/X2, PhoPhiKat-45) were investigated using bivariate correlation analyses. For normally

distributed and dichotomous parameters the Pearson coefficient (r) was employed, and for non-normally distributed parameters the Spearman coefficient (r_S).

Subsequently, in order to evaluate the influence of cognitive reappraisal (i.e., the task-effect), cue modality and laughter type as well as SA on the evaluation of laughter, a 2 × 2 × 3 repeated- measures ANOVA with task (SELF, OTHER), modality (A, AV) and laughter type (TAU, TIC, JOY) as within-subject factors and LSAS-scores as covariate was conducted for each of the two outcome parameters. The results were Greenhouse-Geisser corrected, in order to account for potential violations of sphericity (Geisser and Greenhouse, 1958). Main effects of the within-subject factors and their interactions were further examined using post-hoc t-tests on the outcome parameters after correction for the variance associated with LSAS-scores.

The exact nature of interaction effects between LSAS and the within-subject factors was elucidated using a twofold post-hoc analysis: 1.) Regression analyses between LSAS and the separate factor levels of the respective within-subject factor in order to identify those factor levels which exhibit a significant interaction with LSAS. 2.) Regression analyses between LSAS and the individual outcome differences between the separate factor levels.

Then, it was tested whether the observed linear associations between SA and behavioral correlates of laughter perception proved to be specific for SA after correction for potential confounders. To this end, partial correlations with the LSAS-scores as independent variable, the outcome parameters as dependent variables and the parameters linearly associated with LSAS as controlling variables were conducted. Due to the fact that solely the persistence of initially observed effects was tested and not a change in the direction of the linear association after including the control variables in the model, one-sided testing was applied for the partial correlations.

Finally, a linear relationship between observed interpretation and attention biases was investigated using a bivariate correlation analysis (Pearson).” (Ritter et al., 2015, p. 181)

2.4 Ethics

The study was approved by the Ethics Committee of the University of Tübingen and was performed in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Written informed consent was given by all subjects before inclusion in the study.

3. Results

3.1 Pre-studies

3.1.1 Laughter type

Raw hit rates (table 5) as well as unbiased hit rates (table 6) including their standard deviation (SD) for each laughter type (joyful laughter, tickling laughter, taunting laughter) and each modality (auditory, visual, audiovisual) are shown in the following:

Table 5. Raw hit rates (rhr) for each laughter type (TAU, TIC, JOY) and each modality (A, V, AV)

	Modality							
	A		V		AV		TOTAL	
Laughter Type	**rhr**	SD	**rhr**	SD	**rhr**	SD	**rhr**	SD
TAU	**0.50**	0.14	**0.30**	0.10	**0.56**	0.13	**0.45**	0.11
TIC	**0.74**	0.08	**0.67**	0.15	**0.71**	0.10	**0.71**	0.09
JOY	**0.72**	0.15	**0.80**	0.07	**0.78**	0.12	**0.77**	0.10
TOTAL	**0.65**	0.06	**0.59**	0.07	**0.68**	0.07	**0.64**	0.06

Table 6. Unbiased hit rates (H_u) for each laughter type (TAU, TIC, JOY) and each modality (A, V, AV)

	Modality							
	A		V		AV		TOTAL	
Laughter Type	**H_u**	SD	**H_u**	SD	**H_u**	SD	**H_u**	SD
TAU	**0.41**	0.12	**0.24**	0.09	**0.46**	0.11	**0.37**	0.09
TIC	**0.35**	0.06	**0.27**	0.08	**0.36**	0.08	**0.33**	0.06
JOY	**0.41**	0.11	**0.39**	0.07	**0.48**	0.11	**0.42**	0.09
TOTAL	**0.39**	0.07	**0.30**	0.07	**0.43**	0.09	**0.37**	0.07

T-tests between unbiased hit rates and respective posterior probabilities showed significant differences for each laughter type in each modality (table 7):

Table 7. T-tests between unbiased hit rates (H_u) and respective posterior probabilites (pp)

		M	SD	SEM	t	df	Sig. (2-tailed)
Pair 1	H_u _A_TAU - pp_A_TAU	0.24	0.09	0.02	10.501	13	0.000
Pair 2	H_u _A_TIC - pp_A_TIC	0.30	0.08	0.02	14.454	13	0.000
Pair 3	H_u _A_JOY- pp_A_JOY	0.33	0.12	0.03	10.339	13	0.000
Pair 4	H_u _V_TAU - pp_V_TAU	0.13	0.07	0.02	7.131	13	0.000
Pair 5	H_u _V_TIC - pp_V_TIC	0.21	0.09	0.02	9.022	13	0.000
Pair 6	H_u _V_JOY - pp_V_JOY	0.28	0.09	0.02	11.738	13	0.000
Pair 7	H_u _AV_TAU - pp_AV_TAU	0.29	0.09	0.01	11.690	13	0.000
Pair 8	H_u _AV_TIC - pp_AV_TIC	0.32	0.09	0.02	13.551	13	0.000
Pair 9	H_u _AV_JOY - pp_AV_JOY	0.41	0.13	0.03	11.612	13	0.000

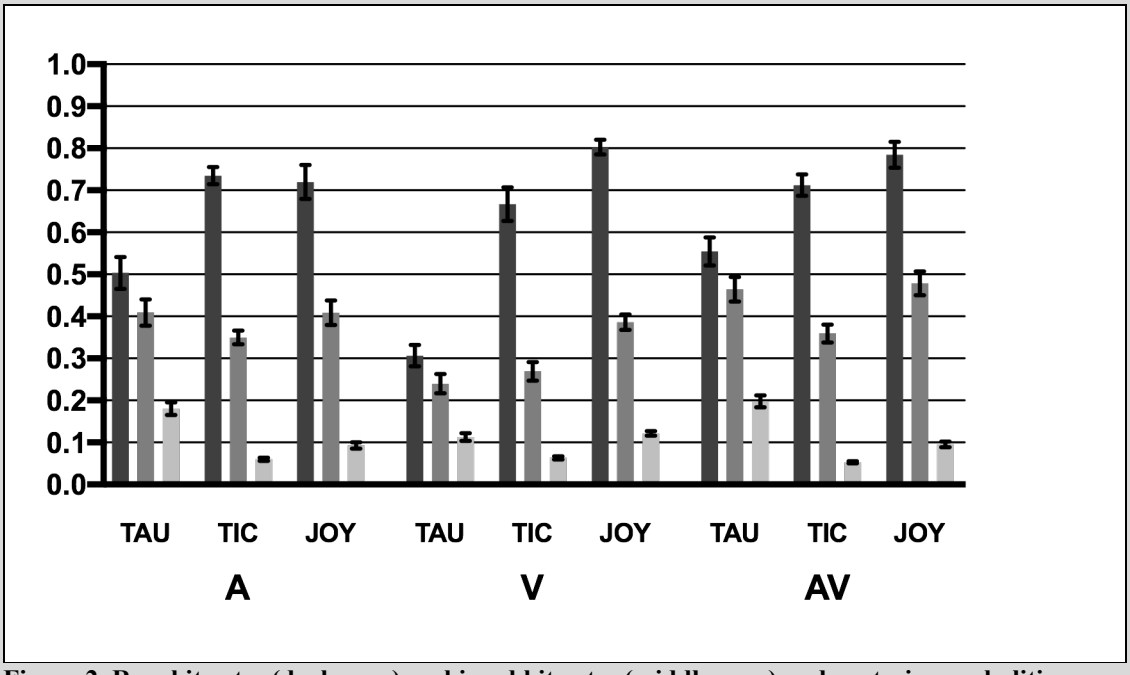

Figure 2. Raw hit rates (dark grey), unbiased hit rates (middle grey) and posterior probalities (light grey) for each laughter type and each modality

The 3 × 3 repeated-measures ANOVA is shown in table 8:

Table 8. ANOVA for laughter ratings with modality (A, V, AV) and laughter type (TAU, TIC, JOY) as within-subject factors (results were Greenhouse-Geisser corrected)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
mod	0.475	1.674	0.284	49.354	0.000
Error(mod)	0.125	21.762	0.006		
ltype	0.247	1.908	0.129	12.009	0.000
Error(ltype)	0.267	24.798	0.011		
mod * ltype	0.13	3.229	0.04	13.712	0.000
Error(mod*ltype)	0.123	41.973	0.003		

The following main effects were revealed to be significant:

1. Modality ($F(1.67, 21.76) = 49.35$, $p < 0.001$): Post-hoc t-tests showed significant differences between all three modalities: AV and A ($t(13) = 3.18$, $p = 0.007$), AV and V ($t(13) = 8.37$, $p < 0.001$), and A and V ($t(13) = 8.41$, $p < 0.001$). The highest recognition rate was found in the audiovisual modality ($m = 0.43$, $SD = 0.09$) followed by the auditory modality ($m = 0.39$, $SD = 0.07$). The lowest recognition rate was found in the visual modality ($m = 0.30$, $SD = 0.07$).
2. Laughter type ($F(1.91, 24.80) = 12.01$, $p < 0.001$): Post-hoc t-tests revealed that joyful laughter ($m = 0.42$, $SD = 0.09$) had a higher recognition rate than taunting laughter ($m = 0.37$, $SD = 0.09$; $t(13) = 2.79$, $p = 0.015$) and tickling laughter ($m = 0.33$, $SD = 0.06$; $t(13) = 5.06$, $p < 0.001$) while there was no significant difference between taunting laughter and tickling laughter ($t(13) = 2.12$, $p = 0.054$).
3. Interaction between modality and laughter type ($F(3.23, 41.97) = 13.71$, $p < 0.001$): This interaction is due to a different distribution of the recognition rates of the three laughter types in the three modalities: For taunting laughter, the unbiased hit rates significantly differed from each other in each modality: A: $m = 0.41$, $SD = 0.12$; V: $m = 0.24$, $SD = 0.09$, AV = 0.46, $SD = 0.11$; AV-A: $t(13) = 2.68$, $p = 0.019$; AV-V: $t(13) = 9.30$, $p < 0.001$; A-V: $t(13) = 9.15$, $p < 0.001$. For tickling laughter, the visual modality had significant lower unbiased hit rates ($m = 0.27$, $SD = 0.08$) than the auditory modality ($m = 0.35$, $SD = 0.06$; $t(13) = 4.59$, $p = 0.001$) and the audiovisual one ($m = 0.36$; $SD = 0.08$; $t(13) = 4.78$, $p <$

0.001) while there was no significant difference between the unbiased hit rates for the audiovisual and auditory modality ($t(13) = 0.56$, $p = 0.589$). For joyful laughter, the audiovisual modality ($m = 0.48$, $SD = 0.11$) had significant higher unbiased hit rates than the auditory modalitiy ($m = 0.41$, $SD = 0.11$; $t(13) = 4.24$, $p = 0.001$) and the visual modality ($m = 0.39$, $SD = 0.07$; $t(13) = 4.62$, $p < 0.001$) while no significant difference could be revealed between the unbiased hit rates for the auditory and visual modality ($t(13) = 1.11$, $p = 0.286$).

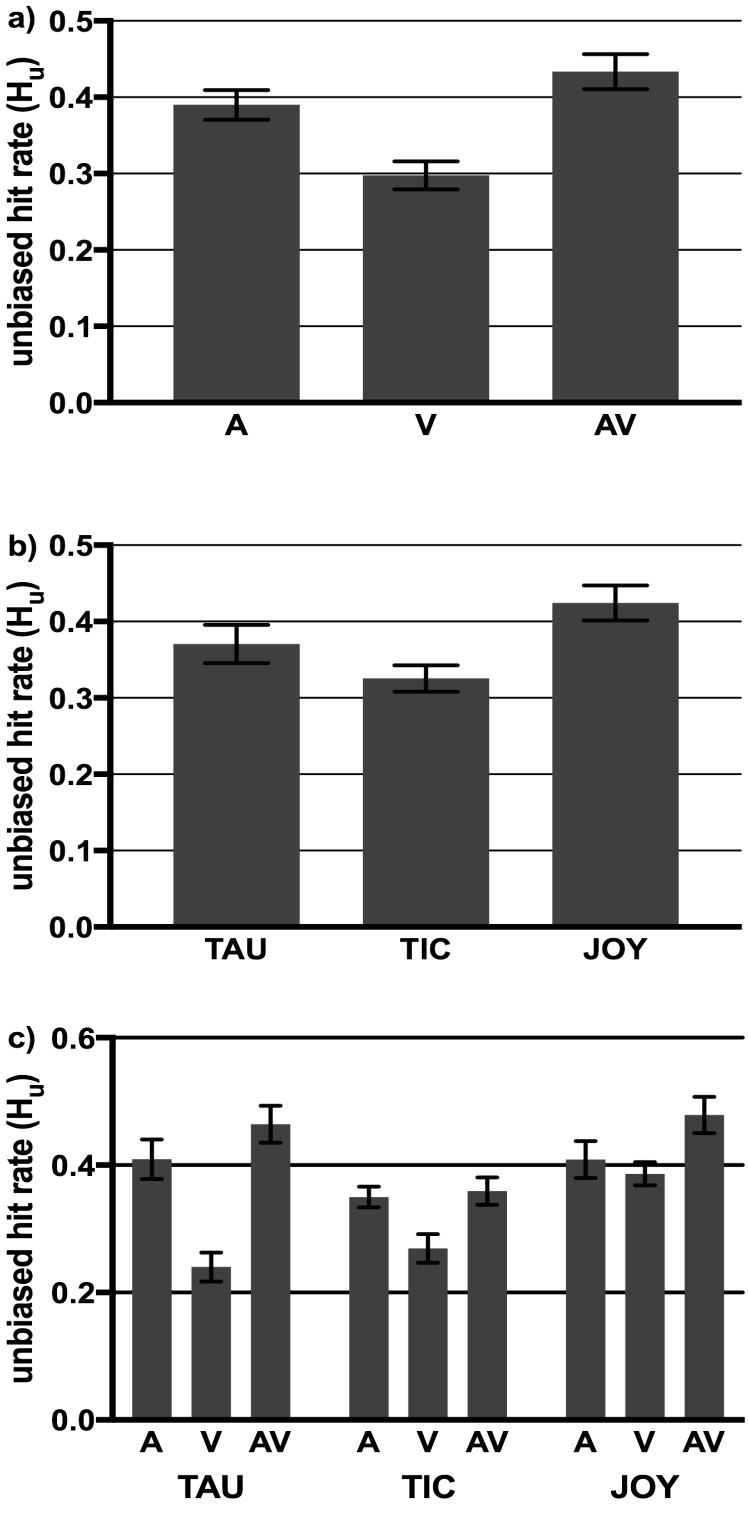

Figure 3. Laughter type main effects
a) shows the unbiased hit rates for the three modalities auditory (A), visual (V) and audiovisual (AV); b) shows the unbiased hit rates for the three laughter types taunting laughter (TAU), tickling laughter (TIC) and joyful laughter (JOY); c) shows the interaction effect of modality and laughter type.

3.1.2 Valence

The mean valence ratings for each laughter type (TAU, TIC, JOY) are shown in table 9:

Table 9. Valence ratings for each laughter type (TAU, TIC, JOY) including their number (N), mean (M), standard deviation (SD), standard error of the mean (SEM), minimum (Min) and maximum (Max)

	N	M	SD	SEM	Min	Max
TAU	303	5.09	1.64	0.09	1.07	7.93
TIC	108	6.46	0.94	0.09	3.36	7.93
JOY	150	6.25	0.78	0.06	3.71	8.21
TOTAL	561	5.67	1.48	0.06	1.07	8.21

A Levene's test detected heteroscedasticity of the three laughter types (Levene-statistic = 68.8, $p < 0.001$). Therefore, the ANOVA with laughter type as factor was corrected using the Welch's t-test. This revealed a main effect for laughter type ($t = 66.5$, $p < 0.001$). Post-hoc tests which were again corrected for heteroscedasticity showed that TAU was significantly rated as being more negative than JOY ($t(450.6) = –10.16$, $p < 0.001$) and TIC ($t(328.9) = –10.47$, $p < 0.001$) while there was no significant difference between TIC and JOY ($t(256) = 1.95$, $p = 0.052$).

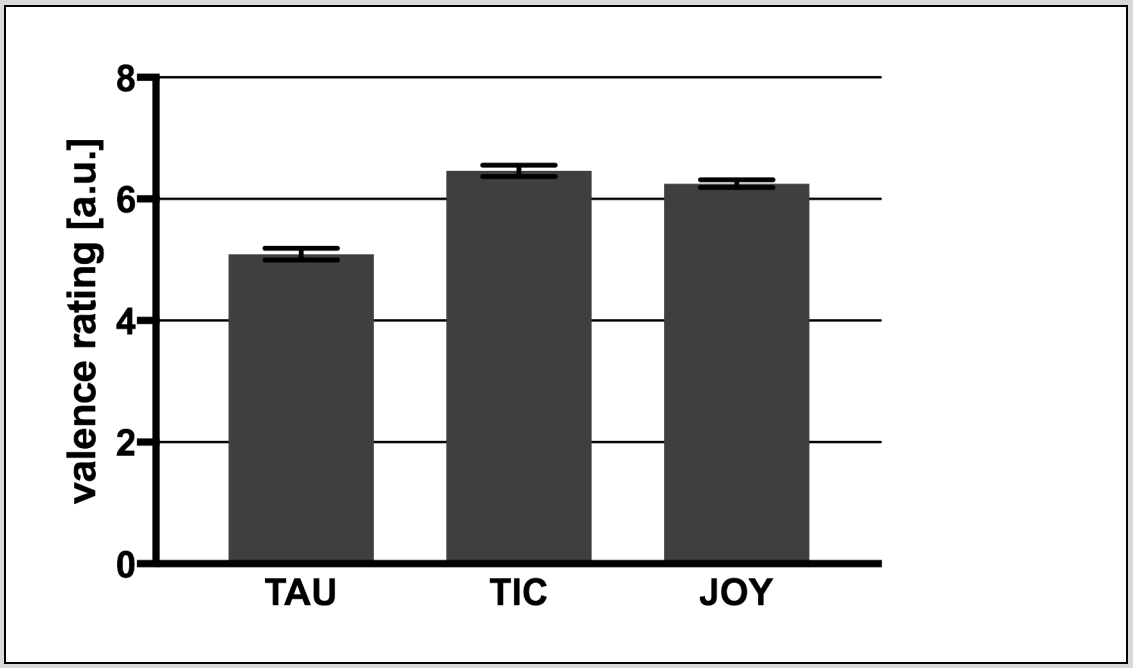

Figure 4. Mean valence ratings for each laughter type

3.1.3 Arousal

The mean arousal ratings for each laughter type (TAU, TIC, JOY) are shown in table 10:

Table 10. Arousal ratings for each laughter type (TAU, TIC, JOY) including their number (N), mean (M), standard deviation (SD), standard error of the mean (SEM), minimum (Min) and maximum (Max)

	N	M	SD	SEM	Min	Max
TAU	303	5.62	1.50	0.09	1.86	8.50
TIC	108	7.24	0.92	0.09	4.50	8.93
JOY	150	4.55	0.96	0.08	2.14	6.64
TOTAL	561	5.65	1.56	0.07	1.86	8.93

A Levene's test detected heteroscedasticity of the three laughter types (Levene-statistic = 28.3, $p < 0.001$). Therefore, the ANOVA with laughter type as factor was corrected using the Welch's t-test. This revealed a main effect for laughter type ($t = 260.8$, $p < 0.001$). Post-hoc tests which were again corrected for heteroscedasticity showed that TIC was significantly rated to have a higher arousal than TAU ($t(308.0) = 13.09$, $p < 0.001$) and JOY ($t(256) = 22.70$, $p < 0.001$) while TAU was significantly rated to have a higher arousal than JOY ($t(423.3) = 9.28$, $p < 0.001$).

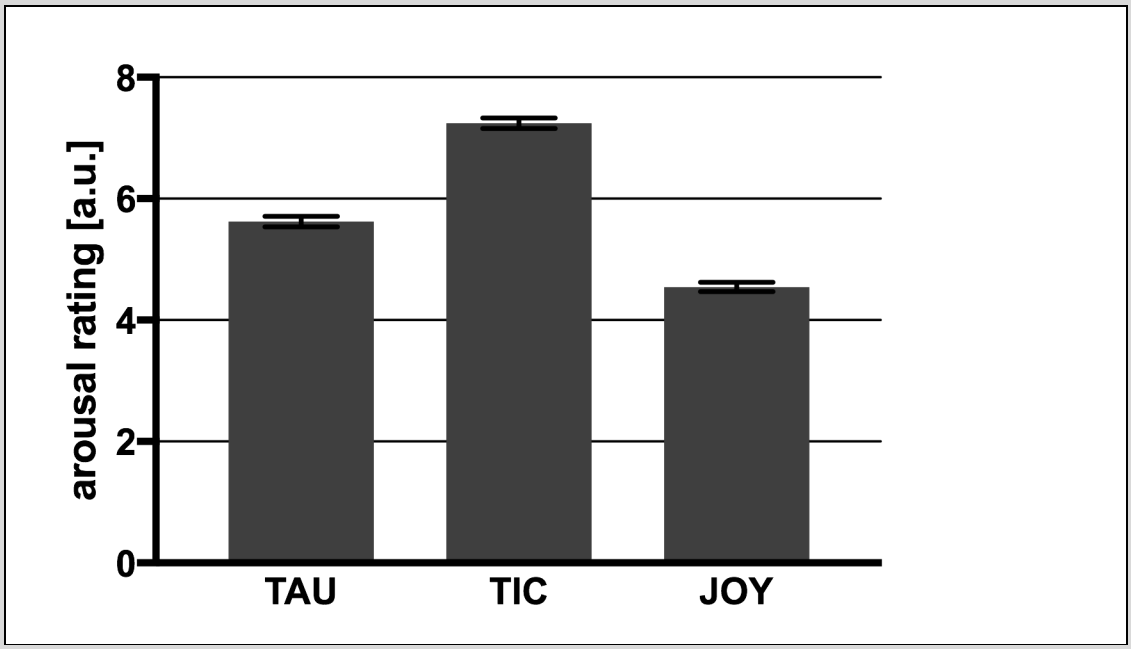

Figure 5. Mean arousal ratings for each laughter type

3.1.4 Dominance

The mean dominance ratings for each laughter type (TAU, TIC, JOY) are shown in table 11:

Table 11. Dominance ratings for each laughter type (TAU, TIC, JOY) including their number (N), mean (M), standard deviation (SD), standard error of the mean (SEM), minimum (Min) and maximum (Max)

	N	M	SD	SEM	Min	Max
TAU	303	5.77	0.87	0.05	2.79	8.07
TIC	108	5.38	0.68	0.07	3.79	6.93
JOY	150	4.57	0.77	0.06	2.86	6.43
TOTAL	561	5.37	0.96	0.04	2.79	8.07

Since there was no indication for heteroscedasticity (Levene-statistic = 2.2, $p = 0.108$) a one-way ANOVA was conducted which revealed a main effect for laughter type ($F(2) = 108.41$, $p < 0.001$). TAU was significantly rated as expressing more dominance than TIC ($t(241.1) = 4.66$, $p < 0.001$) and JOY ($t(451) = 14.22$, $p < 0.001$) while TIC was significantly rated as expressing more dominance than JOY ($t(256) = 8.74$, $p < 0.001$).

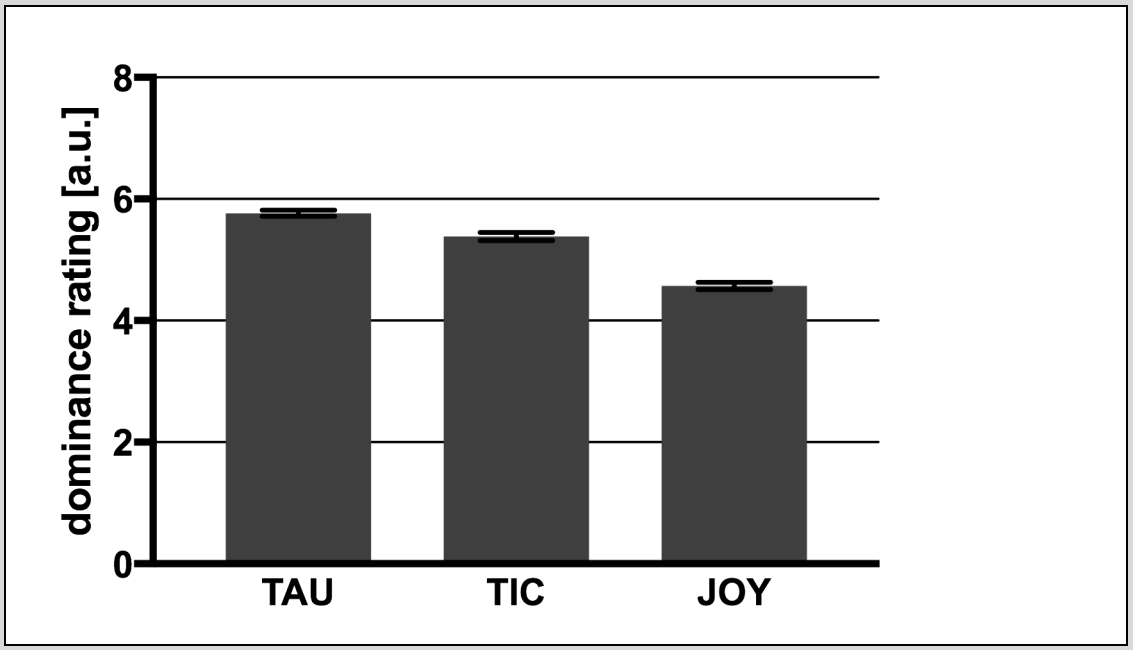

Figure 6. Mean dominance ratings for each laughter type

3.1.5 Authenticity

The mean authenticity ratings for each laughter types (TAU, TIC, JOY) are shown in table 12:

Table 12. Authenticity ratings for each laughter type (TAU, TIC, JOY) including their number (N), mean (M), standard deviation (SD), standard error of the mean (SEM), minimum (Min) and maximum (Max)

	N	M	SD	SEM	Min	Max
TAU	101	4.53	1.75	0.17	1.57	8.07
TIC	36	5.13	1.87	0.31	1.71	8.21
JOY	50	5.76	1.25	0.18	2.71	7.50
TOTAL	187	4.97	1.73	0.13	1.57	8.21

141 stimuli received a mean authenticity rating ≥ 3.5.

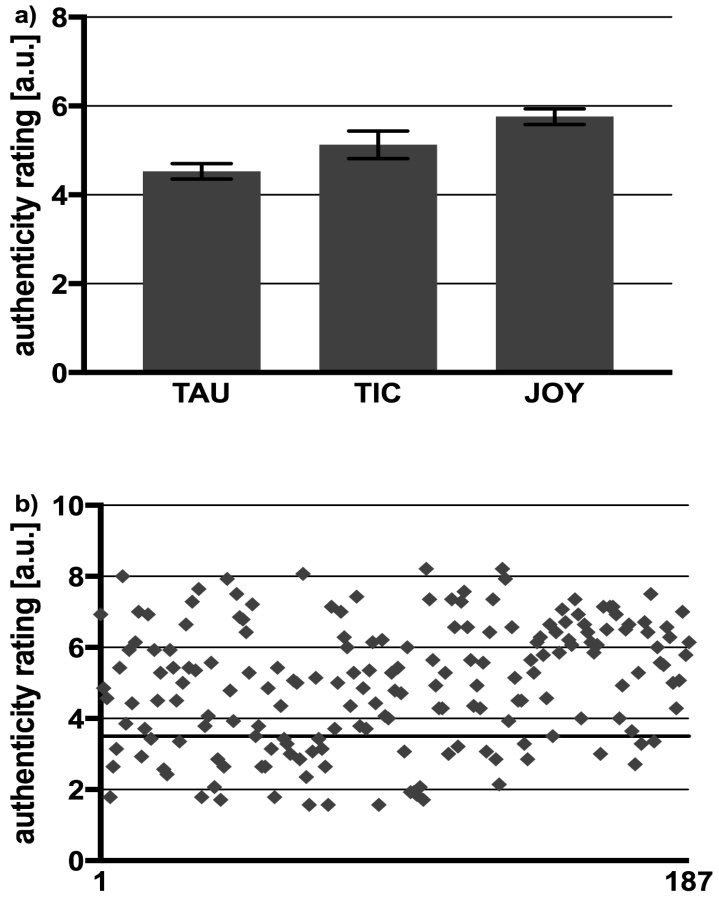

Figure 7. Authenticity ratings
a) shows mean authenticity ratings for each laughter type; b) shows mean authenticity ratings for each stimulus. The horizontal line marks the cutoff line of 3.5.

3.2 Main study

The following chapter is partly adopted from Ritter et al. (2015) where the main results of the main study have been published before. Respective passages are put in quotation marks and italics.

3.2.1 Population parameters

"A normal distribution was ascertained for the behavioral variables as well as for all population parameters (…) *with the exception of gender and state anxiety (STAI-X1). LSAS scores were found to be correlated with general state anxiety (STAI-X1: r_S = 0.59, $p < 0.001$), general trait anxiety (STAI- X2: $r = 0.45$, $p < 0.001$), gelotophobia ($r = 0.83$, $p < 0.001$) and BDI-II scores ($r = 0.49$, $p < 0.001$). LSAS scores were not significantly associated with verbal intelligence (MWT-B), age or gender (abs(r) ≤ 0.08, $p > 0.05$)."* (Ritter et al., 2015, p. 181)

Table 13. Correlations between LSAS, MWT, BDI, gelotophobia, STAI-X2 and age. ** indicates that correlation is significant on the 0.01 level (2-tailed).

		LSAS	MWT	BDI	Gelotophobia	STAI X2	Age
LSAS	Pearson Correlation	1	-0.023	0.488**	0.833**	0.447**	-0.076
	Sig. (2-tailed)		0.864	0.000	0.000	0.000	0.563
	N	60	60	60	60	60	60
MWT	Pearson Correlation	-0.023	1	-0.059	0.028	-0.236	0.417**
	Sig. (2-tailed)	0.864		0.652	0.829	0.070	0.001
	N	60	60	60	60	60	60
BDI	Pearson Correlation	0.488**	-0.059	1	0.418**	0.368**	-0.042
	Sig. (2-tailed)	0.000	0.652		0.001	0.004	0.750
	N	60	60	60	60	60	60
Gelotophobia	Pearson Correlation	0.833**	0.028	0.418**	1	0.491**	-0.034
	Sig. (2-tailed)	0.000	0.829	0.001		0.000	0.797
	N	60	60	60	60	60	60
STAI-X2	Pearson Correlation	0.447**	-0.236	0.368**	0.491**	1	-0.092
	Sig. (2-tailed)	0.000	0.070	0.004	0.000		0.482
	N	60	60	60	60	60	60
Age	Pearson Correlation	-0.076	0.417**	-0.042	-0.034	-0.092	1
	Sig. (2-tailed)	0.563	0,001	0.750	0.797	0.482	
	N	60	60	60	60	60	60

Table 14. Correlations between LSAS, STAI-X1 and gender

** indicates that correlation is significant on the 0.01 level (2-tailed).

			LSAS	STAI X1	Gender
Spearman's rho	LSAS	Correlation Coefficient	1	0.592**	-0.041
		Sig. (2-tailed)		0.000	0.753
		N	60	60	60
	STAI X1	Correlation Coefficient	0.592**	1	0.194
		Sig. (2-tailed)	0.000		0.137
		N	60	60	60
	Gender	Correlation Coefficient	-0.041	0.194	1
		Sig. (2-tailed)	0.753	0.137	
		N	60	60	60

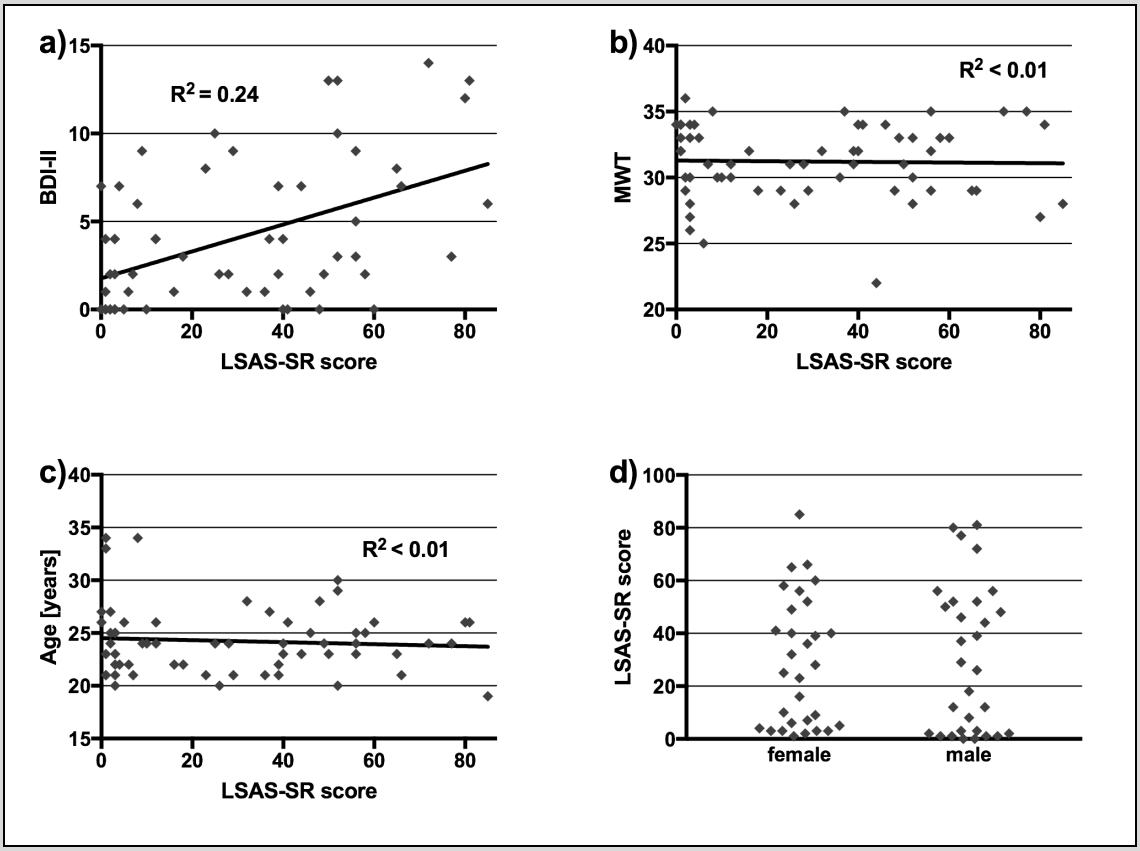

Figure 8. Correlations between LSAS and a) BDI, b) MWT, c) age, and d) gender

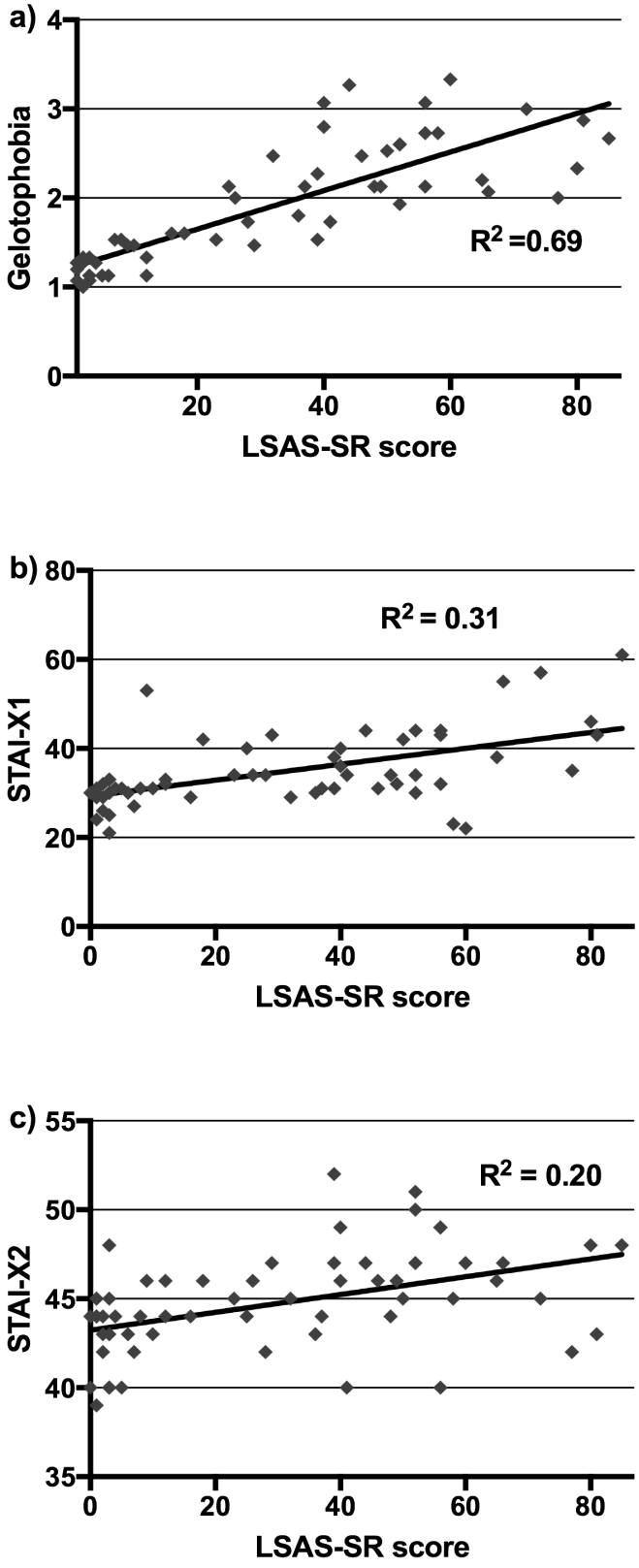

Figure 9. Correlations between LSAS and a) gelotophobia, b) STAI-X1, and c) STAI-X2

3.2.2 Laughter ratings

The mean laughter ratings for each task (SELF, OTHER), each modality (A, AV) and each laughter type (TAU, TIC, JOY) are shown in table 15:

Table 15. Mean laughter ratings for each task (SELF, OTHER), each modality (A, AV) and each laughter type (TAU, TIC, JOY)

	Modality								
	A			AV			TOTAL		
Laughter Type	**SELF**	**OTHER**	**TOTAL**	**SELF**	**OTHER**	**TOTAL**	**SELF**	**OTHER**	**TOTAL**
TAU	**2.19**	**2.09**	**2.14**	**2.16**	**2.02**	**2.09**	**2.17**	**2.05**	**2.11**
SD	0.36	0.35	0.33	0.34	0.35	0.32	0.31	0.30	0.28
TIC	**2.55**	**2.59**	**2.57**	**2.55**	**2.58**	**2.56**	**2.55**	**2.58**	**2.57**
SD	0.57	0.55	0.53	0.53	0.52	0.50	0.51	0.51	0.49
JOY	**3.03**	**3.17**	**3.10**	**3.00**	**3.07**	**3.03**	**3.02**	**3.12**	**3.07**
SD	0.35	0.40	0.35	0.34	0.34	0.31	0.32	0.33	0.30
TOTAL	**2.59**	**2.61**	**2.60**	**2.57**	**2.55**	**2.56**	**2.58**	**2.58**	**2.58**
SD	0.31	0.35	0.31	0.27	0.27	0.25	0.26	0.28	0.25

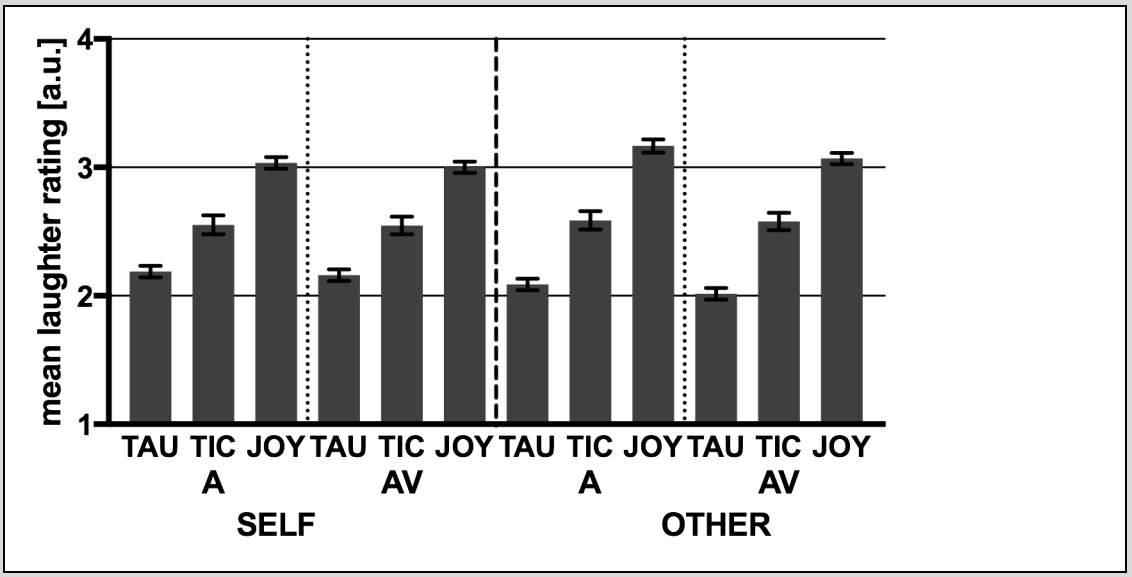

Figure 10. Mean laughter ratings for each task, each modality and each laughter type

The 2 × 2 × 3 repeated-measures ANOVA is shown in table 15:

Table 16. ANOVA for laughter ratings with task (SELF, OTHER), modality (A, AV) and laughter type (TAU, TIC, JOY) as within-subject factors and LSAS-scores as covariate (results were Greenhouse-Geisser corrected)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
task	0.232	1	0.232	2.239	0.140
task * LSAS	0.357	1	0.357	3.455	0.068
Error(task)	6.001	58	0.103		
mod	1.664	1	1.664	10.301	0.002
mod * LSAS	1.522	1	1.522	9.422	0.003
Error(mod)	9.368	58	0.162		
ltype	61.868	1.605	38.539	74.302	0.000
ltype * LSAS	2.254	1.605	1.404	2.707	0.083
Error(ltype)	48.294	93.108	0.519		
task * mod	0.083	1	0.083	2.269	0.137
task * mod * LSAS	0.027	1	0.027	0.728	0.397
Error(task*mod)	2.129	58	0.037		
task * ltype	1.001	1.939	0.516	15.507	0.000
task * ltype * LSAS	0.095	1.939	0.049	1.473	0.234
Error(task*ltype)	3.745	112.491	0.033		
mod * ltype	0.112	1.811	0.062	0.979	0.372
mod * ltype * LSAS	0.231	1.811	0.127	2.019	0.142
Error(mod*ltype)	6.621	105.032	0.063		
task * mod * ltype	0.044	1.993	0.022	0.988	0.375
task * mod * ltype * LSAS	0.018	1.993	0.009	0.392	0.676
Error(task*mod*ltype)	2.596	115.618	0.022		

The following main effects were revealed to be significant. As described before, main effects of the within-subject factors and their interactions were further examined after correction of the laughter ratings for the variance associated with LSAS-scores. In the following, both raw mean laughter ratings (M) and laughter ratings corrected for the variance associated with LSAS (M_{corr}) including their standard deviation are shown:

1. Modality ($F(1, 58) = 10.30$, $p = 0.002$): Stimuli presented only in the auditory modality were rated as being more socially inclusive ($M = 2.60$, $SD = 0.31$; $M_{corr} = 2.79$, $SD = 0.27$) than audiovisual ones ($M = 2.56$, $SD = 0.25$; $M_{corr} = 2.64$, $SD = 0.24$).

2. Laughter type ($F(1.61, 93.11) = 74.30$, $p < 0.001$): Post-hoc t-tests showed significant differences between all three laughter types: TAU and TIC ($t(59) = -10.37$, $p < 0.001$), TAU and JOY ($t(59) = -24.10$, $P < 0.001$), and TIC and JOY ($t(59) = -7.23$, $p < 0.001$). The laughter type with the most social exclusive ratings was TAU ($M = 2.11$, $SD = 0.28$; $M_{corr} = 2.15$, $SD = 0.28$), followed by TIC ($M = 2.57$, $SD = 0.49$; $M_{corr} = 2.73$, $SD = 0.47$) and JOY ($M = 3.07$, $SD = 0.30$; $M_{corr} = 3.25$, $SD = 0.25$).
3. Task X laughter type ($F(1.94, 112.49) = 15.51$, $p < 0.001$): Under the SELF-condition mean laughter ratings of TAU got more positive ($M_{SELF} = 2.17$ ($SD = 0.31$), $M_{corr\_SELF} = 2.20$ ($SD = 0.31$); $M_{OTHER} = 2.05$ ($SD = 0.30$), $M_{corr\_OTHER} = 2.10$ ($SD = 0.29$); $diff_{SELF\text{-}OTHER} = +0.12$, $diff_{corr\_SELF\text{-}OTHER} = +0.10$) whereas TIC and JOY got more negative (JOY: $M_{SELF} = 3.02$ ($SD = 0.32$), $M_{corr\_SELF} = 3.17$ ($SD = 0.29$); $M_{OTHER} = 3.12$ ($SD = 0.33$), $M_{corr\_OTHER} = 3.33$ ($SD = 0.27$); $diff_{SELF\text{-}OTHER} = -0.10$, $diff_{corr\_SELF\text{-}OTHER} = -0.16$; TIC: $M_{SELF} = 2.55$ ($SD = 0.51$), $M_{corr\_SELF} = 2.68$ ($SD = 0.50$); $M_{OTHER} = 2.58$ ($SD = 0.51$), $M_{corr\_OTHER} = 2.80$ ($SD = 0.47$); $diff_{SELF\text{-}OTHER} = -0.03$, $diff_{corr\_SELF\text{-}OTHER} = -0.12$). Using post-hoc t-tests between these differences it could be revealed that there were significant differences between TAU and JOY ($t(59) = -8.75$, $p < 0.001$), and TAU and TIC ($t(59) = -6.52$, $p < 0.001$) while there was no significant difference between the differences between the two task conditions of TIC and JOY ($t(59) = -1.11$, $p = 0.270$).

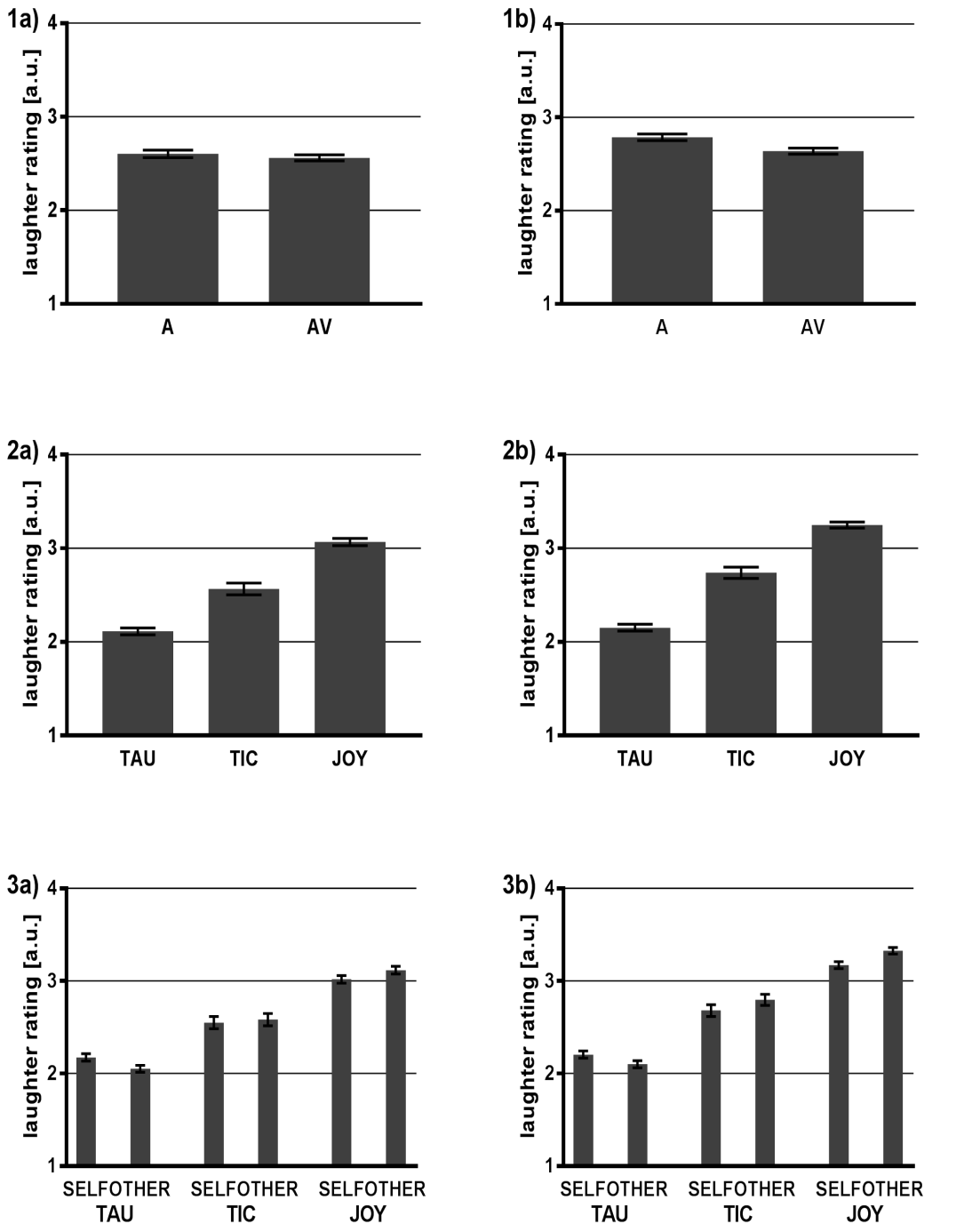

Figure 11. Laughter rating main effects
1a) and 1b) show laughter ratings for each modality: 1a) raw mean laughter ratings, 1b) mean laughter ratings corrected for LSAS-scores;
2a) and 2b) show laughter ratings for each laughter type: 2a) raw mean laughter ratings; 2b) mean laughter ratings corrected for LSAS-sores;
3a) and 3b) show the interaction effect between task and laughter type with raw mean laughter ratings (3a) and mean laughter ratings corrected for LSAS-scores (3b).

"Interactions between social anxiety (LSAS) as covariate and the within-subject factors:

1. *Overall laughter ratings X LSAS ($F(1,58) = 14.6$, $p < 0.001$): The post-hoc regression analysis indicated a significant negative relationship between social anxiety scores (LSAS) and the overall laughter rating ($\beta = -0.004$, $t(58) = -3.82$, $p < 0.001$). This association was confirmed for both tasks ($t(58) \geq -2.86$, $p \leq 0.006$), both modalities ($t(58) \geq -2.12$, $p \leq 0.038$) and the three laughter types ($t(58) \geq -2.46$, $p \leq 0.017$), except for TAU ($p = 0.351$).*
2. *Modality X LSAS ($F(1, 58) = 9.42$, $p = 0.003$): The tendency to rate laughter as more unfriendly with increasing social anxiety was greater under the auditory than under the audiovisual condition. This effect can be described in the negative linear relationship between the individual mean laughter rating difference for the two modalities (i.e., A-AV) and LSAS ($\beta = -0.004$, $t(58) = -3.07$, $p = 0.003$)."* (Ritter et al., 2015, p. 181f)

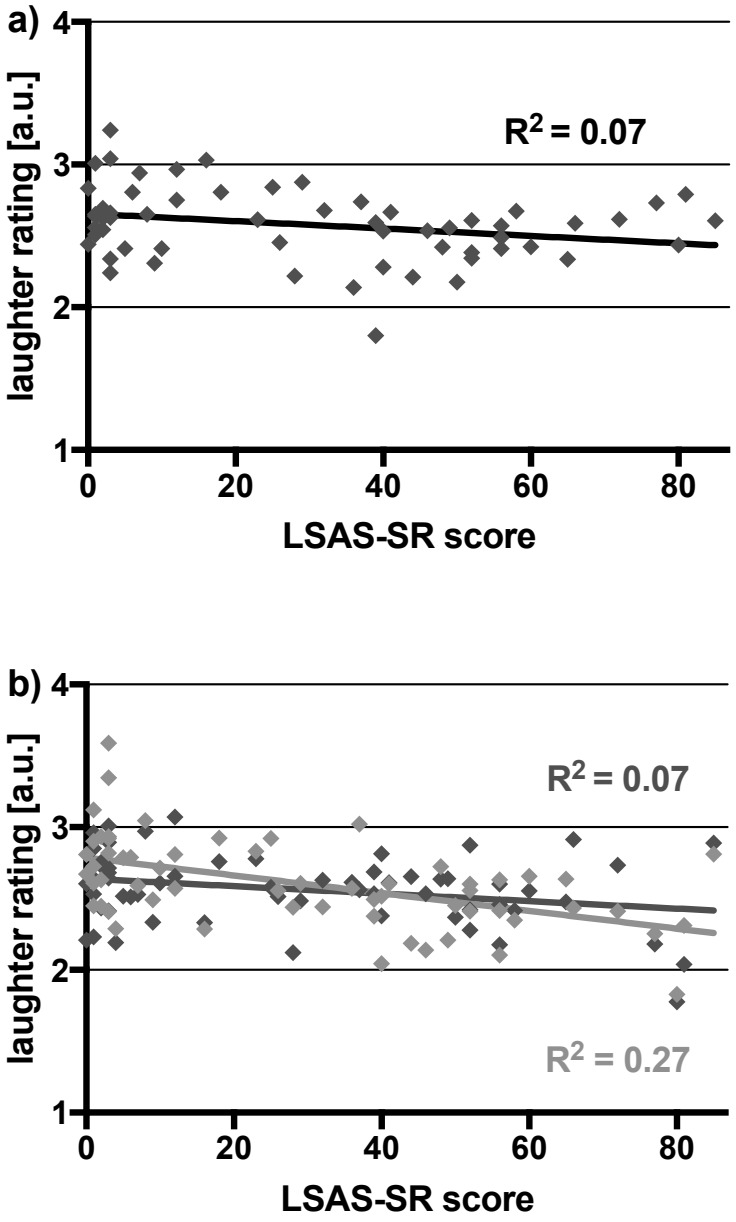

Figure 12. Relationship between laughter rating and social anxiety scores
a) shows the linear association between overall mean laughter rating and LSAS-SR scores. b) shows the linear associationn between laughter rating and LSAS-SR scores for the two modalities: auditory (light grey) and audiovisual (dark grey).

"No significant interaction was observed between LSAS and the factors Task [F(1, 58) = 3.46, p = 0.068] *and Laughter Type* [F(1.61, 93.11) = 2.71, p = 0.083]. *Finally all 2nd or 3rd order interactions for LSAS and the within-subject factors were non-significant.*

For the detected interaction effects between mean laughter ratings and LSAS, the partial correlation analyses controlling for general state anxiety (STAI-X1), general trait anxiety (STAI-X2), gelotophobia and depressive symptoms (BDI-II) led to the following results:

1.) *Overall laughter ratings: The negative linear relationship between LSAS and the mean overall laughter rating ($r = -0.45$, $p < 0.001$) remained significant after controlling for STAI-X1 ($r = -0.47$, $p < 0.001$), STAI-X2 ($r = -0.41$, $p = 0.001$) and BDI-II ($r = -0.42$, $p = 0.001$). However, after controlling for gelotophobia, the strength of the relationship was reduced to a non-significant level ($r = -0.21$, $p > 0.05$).*

2.) *Mean laughter rating difference between the modalities A and AV: The correlation between LSAS and the individual mean laughter rating difference A-AV ($r = -0.37$, $p = 0.002$) as a measure of the interaction between LSAS and the factor modality remained significant after controlling for STAI-X1 ($r = -0.29$, $p = 0.013$), STAI-X2 ($r = -0.28$, $p = 0.016$) and BDI-II ($r = -0.42$, $p < 0.001$), but not after controlling for gelotophobia ($r = -0.08$, $p > 0.05$)."* (Ritter et al., 2015, p. 182)

3.2.3 Response times

The mean response times for each task (SELF, OTHER), each modality (A, AV) and each laughter type (TAU, TIC, JOY) are shown in table 17:

Table 17. Mean response times for each task (SELF, OTHER), each modality (A, AV) and each laughter type (TAU, TIC, JOY) (in ms)

	Modality								
	A			AV			TOTAL		
Laughter Type	**SELF**	**OTHER**	**TOTAL**	**SELF**	**OTHER**	**TOTAL**	**SELF**	**OTHER**	**TOTAL**
TAU	**2789**	**2727**	**2758**	**2744**	**2709**	**2727**	**2766**	**2718**	**2742**
SD	556	515	521	462	487	459	484	470	465
TIC	**2885**	**2850**	**2868**	**2859**	**2842**	**2850**	**2872**	**2846**	**2859**
SD	547	547	533	518	522	503	509	500	494
JOY	**2785**	**2640**	**2712**	**2805**	**2692**	**2748**	**2795**	**2666**	**2730**
SD	548	508	509	466	451	438	478	459	456
TOTAL	**2819**	**2739**	**2779**	**2803**	**2748**	**2775**	**2811**	**2743**	**2777**
SD	531	506	509	462	466	453	476	463	462

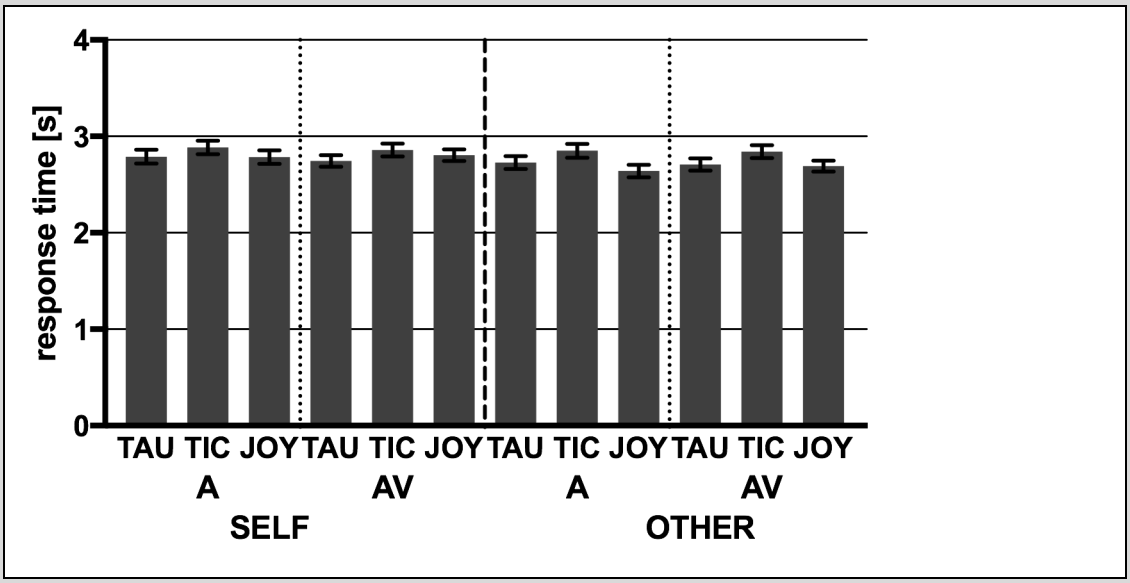

Figure 13. Mean response times for each task, each modality and each laughter type (in s)

The 2 × 2 × 3 repeated-measures ANOVA is shown in table 18:

Table 18. ANOVA for response times with task (SELF, OTHER), modality (A, AV) and laughter type (TAU, TIC, JOY) as within-subject factors and LSAS-scores as covariate (results were Greenhouse-Geisser corrected)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
task	91606.069	1	91606.069	0.41	0.524
task * LSAS	85661.08	1	85661.08	0.384	0.538
Error(task)	12947120.55	58	223226.216		
mod	843411.427	1	843411.427	8.821	0.004
mod * LSAS	73.061.329	1	73061.329	0.764	0.386
Error(mod)	5545890.956	58	95618.81		
ltype	2023491.377	1.98	1021945.856	16.122	0.000
ltype * LSAS	536320.914	1.98	270863.984	4.273	0.017
Error(ltype)	7279718.545	114.842	63388.887		
task * mod	22015.646	1	22015.646	0.633	0.429
task * mod * LSAS	2854.591	1	2854.591	0.082	0.775
Error(task*mod)	2016362.602	58	34764.872		
task * ltype	129736.611	1.924	67413.875	2.704	0.073
task * ltype * LSAS	185247.619	1.924	96258.563	3.861	0.025
Error(task*ltype)	2782469.208	111.62	24928.096		
mod * ltype	266507.561	1.813	146994.659	4.872	0.012
mod * ltype * LSAS	47760.479	1.813	26342.725	0.873	0.411
Error(mod*ltype)	3172977.18	105.156	30173.867		
task * mod * ltype	32934.711	1.975	16675.106	0.819	0.442
task * mod * ltype * LSAS	58314.155	1.975	29524.921	1.45	0.239
Error(task*mod*ltype)	2332531.774	114.555	20361.714		

The following main effects were revealed to be significant. As described before, main effects of the within-subject factors and their interactions were further examined after correction of the response times for the variance associated with LSAS-scores. In the following, both raw mean response times (M) and response times corrected for the variance associated with LSAS (M_{corr}) including their standard deviation are shown:

1. Modality ($F(1,58) = 8.82$, $p = 0.004$): Participants were significantly slower to respond to unimodally auditorily presented stimuli (M = 2779 ms, SD = 509 ms; M_{corr} = 2726 ms, SD = 479 ms) than to audiovisual ones (M = 2775, SD = 453 ms; M_{corr} = 2624 ms, SD = 463 ms; $t(59) = 4.58$, $p < 0.001$).

2. Laughter type ($F(1.98, 114.84) = 16.12$, $p < 0.001$): Responses to TIC were slower than to JOY ($t(59) = 8.82$, $p < 0.001$) and TAU ($t(59) = 4.98$, $p < 0.001$). while the responses to TAU were slower than to JOY ($t(59) = 3.59$, $p = 0.001$). The mean response times were: TAU: M = 2742 ms (SD = 465 ms), M_{corr} = 2659 ms (SD = 467 ms); TIC: M = 2859 ms (SD = 494 ms), M_{corr} = 2778 ms (SD = 500 ms); JOY: M = 2730 ms (SD = 456 ms), M_{corr} = 2580 ms (SD = 451 ms).
3. Modality X laughter type ($F(1.81, 105.16) = 4.87$, $p = 0.012$): A modality effect could be shown to be significant for JOY ($t(59) = 5.91$, $p < 0.001$; M_A = 2712 ms (SD = 509 ms), M_{corr_A} = 2670 ms (SD = 480 ms); M_{AV} = 2748 ms (SD = 438 ms), M_{corr_AV} = 2491 ms (SD = 452 ms); $diff_{A-AV}$ = -36 ms, $diff_{corr\_A-AV}$ = 179 ms) as well as for TAU ($t(59) = 3.58$, $p = 0.001$; M_A = 2758 ms (SD = 521 ms), M_{corr_A} = 2708 ms (SD = 489 ms); M_{AV} = 2727 ms (SD = 459 ms), M_{corr_AV} = 2610 ms (SD = 470 ms); $diff_{A-AV}$ = 31 ms, $diff_{corr\_A-AV}$ = 98 ms), but not for TIC ($t(59) = 1.28$, $p = 0.205$; M_A = 2868 ms (SD = 533 ms), M_{corr_A} = 2796 ms (SD = 515 ms); M_{AV} = 2850 ms (SD = 503 ms), M_{corr_AV} = 2760 ms (SD = 509 ms); $diff_{A-AV}$ = 18 ms, $diff_{corr\_A-AV}$ = 36 ms.).

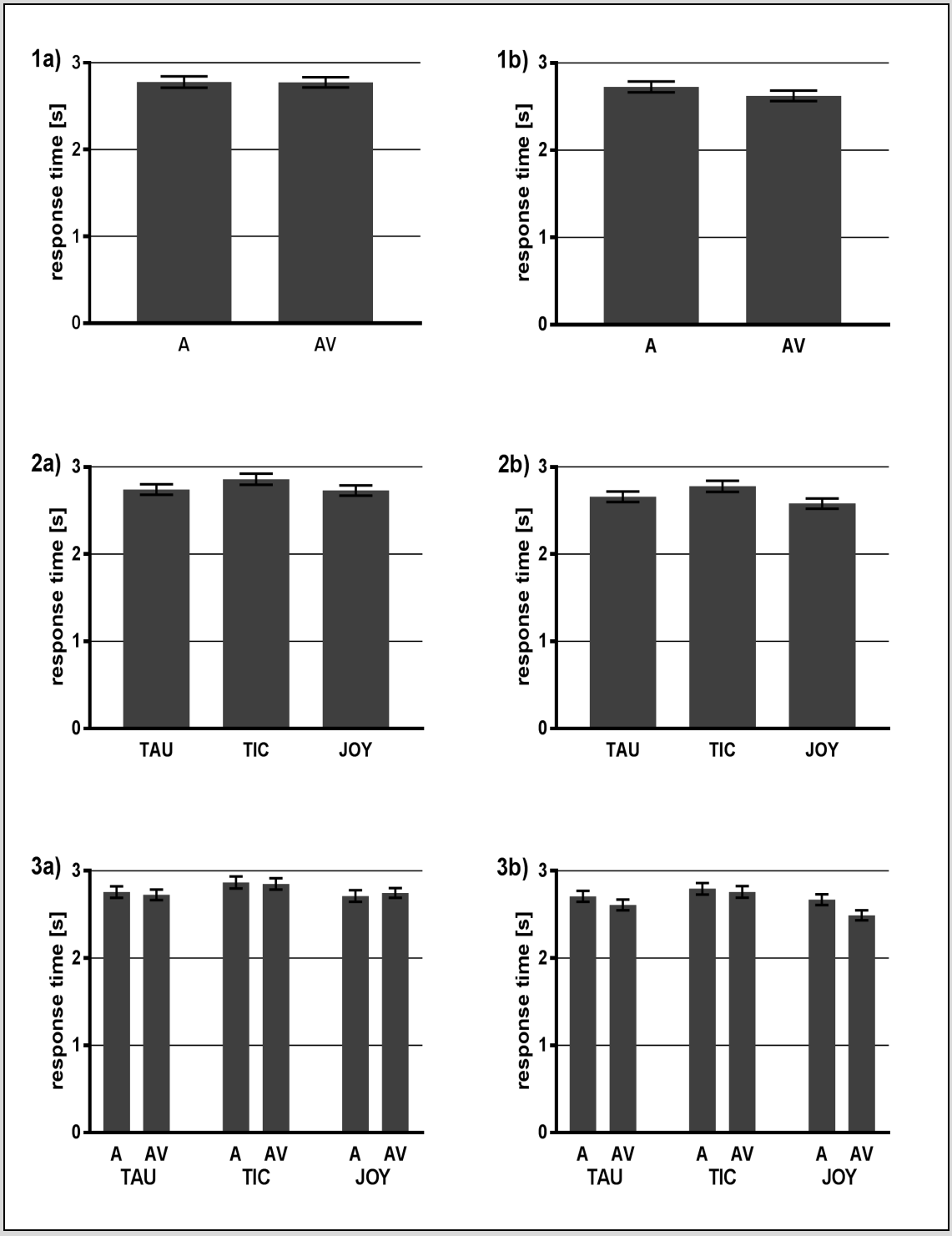

Figure 14. Response time main effects
1a) and 1b) show response times for each modality: 1a) raw mean response times, 1b) mean response times corrected for LSAS-scores;
2a) and 2b) show response times for each laughter type: 2a) raw mean response times, 2b) mean response times corrected for LSAS-scores;
3a) and 3b) show the interaction effect between modality and laughter type with raw mean response times (3a) and mean response times corrected for LSAS-scores (3b).

"Interactions between social anxiety (LSAS) as covariate and the within-subject factors:

1. *Laughter type X LSAS ($F(2.0,114.8) = 4.3$, $p = 0.017$): Increasing social anxiety was significantly associated with an increasing mean response time difference between JOY and TAU ($\beta = 2.35$; $t(58) = 2.7$, $p = 0.008$). Such an association was also observed for the difference between JOY and TIC ($\beta = 2.16$; $t(58) = 2.5$, $p = 0.017$), but not for the difference between TIC and TAU ($\beta = 0.20$; $t(58) = 0.2$, $p = 0.835$).*
2. *Task X laughter type X LSAS ($F(1.9, 111.6) = 3.9$, $p = 0.025$): The linear relationship between LSAS and the response time difference between JOY and TAU was present under both task conditions (SELF: $\beta = 2.41$; $t(58) = 2.6$, $p = 0.011$; OTHER: $\beta = 2.29$; $t(58) = 2.1$, $p = 0.037$) with no significant difference in this association between the task conditions ($\beta = 0.12$; $t(58) = 0.1$, $p > 0.05$). In contrast, the linear relationship between LSAS and the response time difference between JOY and TIC was significant only under the OTHER condition ($\beta = 3.45$; $t(58) = 3.5$, $p = 0.001$) and was significantly greater under the OTHER than under the SELF condition ($\beta = 2.6$; $t(58) = 2.2$, $p = 0.035$). The linear association between LSAS and the response time difference between TAU and TIC, however, was non-significant for both task conditions (all $abs(\beta) \leq 1.55$, all $abs(t(58)) \leq 1.4$, all $p > 0.05$).*

None of the remaining main effects or interactions between within- and between-subject factors was found to be significant." (Ritter et al., 2015, p. 182)

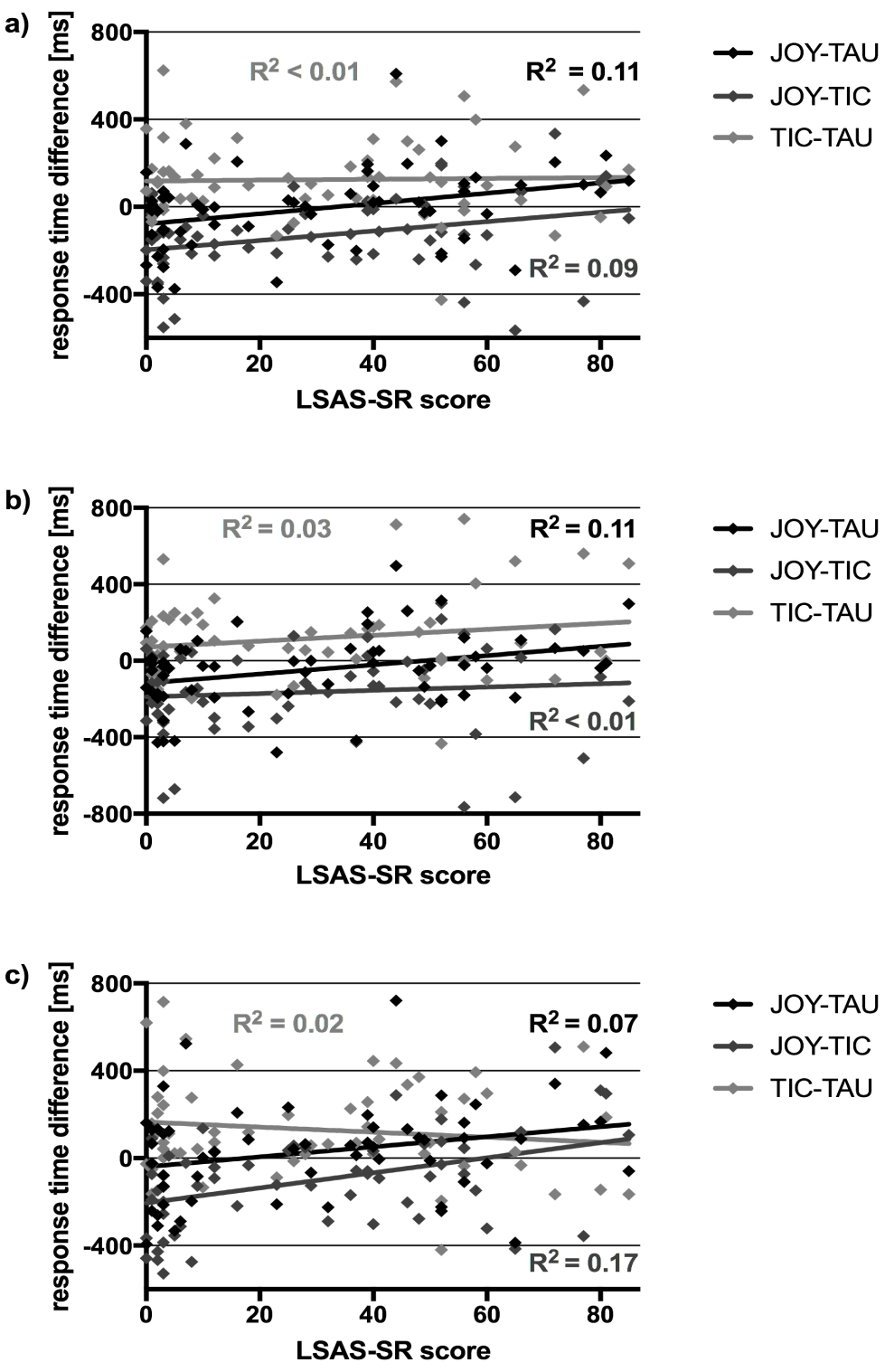

Figure 15. Relationship between response time differences of two of the three laughter types and social anxiety

a) shows the relationship under both task conditions, b) under the SELF-condition, and c) under the OTHER-condition.

"For the detected interaction between LSAS and laughter type and the 2nd order interaction between LSAS, task and laughter type, partial correlations with STAI-X1, STAI-X2, gelotophobia, and BDI-II as control variables revealed the following results: The linear relationship between LSAS and the response time difference JOY-TAU ($r = 0.34$, $p = 0.004$) remained significant after controlling for STAI-X1 ($r = 0.26$, $p = 0.024$), STAI-X2 ($r = 0.29$, $p = 0.013$) and BDI-II ($r = 0.25$, $p = 0.030$), but not after controlling for gelotophobia ($r = 0.02$, $p > 0.05$). The relationship between LSAS and the response time difference JOY-TIC ($r = 0.31$, $p = 0.009$), on the other hand, was rendered insignificant after controlling for STAI-X1, STAI-X2, BDI-II, or gelotophobia (all $r \leq 0.19$, all $p > 0.05$). Similarly, the linear relationship between LSAS and the increase in response time differences between JOY and TIC under the OTHER condition as compared to the SELF condition ($r = 0.27$, $p = 0.018$) driving the observed interaction between task, laughter type and LSAS became non-significant after controlling for STAI-X1 or BDI-II (all $r \leq 0.18$, all $p > 0.05$). After controlling for STAI-X2 or gelotophobia, however, this linear relationship retained its statistical significance (all $r \geq 0.25$, all $p \leq 0.029$)." (Ritter et al., 2015, p. 182)

3.2.4 Correlation of laughter ratings and response times

"Overall mean laughter ratings and response time differences between JOY and TAU were found to be significantly correlated ($r = 0.24$, $p = 0.009$)." (Ritter et al., 2015, p. 182)

4. Discussion

To my knowledge, this is the first behavioral study using multimodal laughter stimuli to investigate information processing biases in SA and the effects of cognitive reappraisal as a means of emotion regulation on biased perception although simultaneously, another study based on the same stimulus material validated in the current study was conducted in order to investigate cerebral mediators of cognitive biases in SA using functional magnetic resonance imaging (Kreifelts et al., 2014).

4.1 Pre-studies

As described in the introduction chapter, the aim of the pre-studies was to validate the produced stimulus material and, based on this validation, to select appropriate stimuli for eliciting information processing biases in SA.

4.1.1 Laughter type

The three laughter types joyful laughter, tickling laughter and taunting laughter were recognizable based on the auditory, visual and audiovisual signal represented by significant differences between unbiased hit rates and posterior probabilities for each laughter type and each modality. Therefore, the basic prerequisite for the validity of the present study is met.

The pre-study also showed an integration effect for laughter represented by significantly higher unbiased hit rates for audiovisually presented stimuli than for unimodally presented ones. Likewise, the two unimodal modalities differed significantly from each other in their unbiased hit rates with auditorily presented stimuli being more often recognized than visual ones suggesting that the emotional information conveyed by laughter is mainly carried by the auditory signal. Therefore, laughter seems to be different to other nonverbal emotional cues for which an opposite pattern of modality-dependent effects could be shown in previous research: Lambrecht et al. (2014) presented dynamic stimuli with congruent facial and prosodic expressions of five emotional categories in three different sensory modalities (A, V, AV) to healthy participants, which resulted in higher recognition rates for visually than for auditorily presented stimuli. Likewise, using dynamic visual and non-linguistic video clips expressing fear and disgust, Collignon et al. (2008) found a visual dominance in affect

perception displayed by the tendency of participants to categorize emotional expressions which were incongruent in the two modalities based on the vocal signal. However, when the reliability of the visual signal was reduced by adjusting the visual signal-to-noise ratio of the video clips to a lower level, individuals based their categorizing of incongruent bimodal stimuli preferentially on the auditory modality. Under the assumption that the emotional information of laughter is mainly conveyed by the auditory signal and thus, the visual signal has a much lower reliability than the auditory one, the finding of the present study that the recognizability of auditorily presented stimuli was significantly higher than those presented in the visual modality are in line with the results of Collignon et al.

Moreover, the data of the pre-study show that although all three laughter types were best recognized in the audiovisual modality and worst recognized in the visual one, the differences between the unbiased hit rates of the single modalities varied significantly between the laughter types: For taunting laughter, recognition rates were significantly different from each other in each modality; for tickling laughter, recognition rates in the audiovisual and auditory modality were similar (i.e., no significant difference); for joyful laughter, there was no significant difference between the auditory and the visual modality. This finding suggests that the sensory modality by which the emotional information of laughter is mainly conveyed may vary for different laughter types. Since recognition rates for taunting laughter were considerably lower in the visual modality than in die auditory modality in comparison to the other laughter types (for joyful laughter, the difference between A and V was not even significant) and these recognition rates for taunting laughter were in the visual modality even lower than recognition rates for tickling laughter, it can be assumed that the higher reliability of the acoustic signal may be driven by misattributions of visually presented taunting laughter.

4.1.2 Valence

Joyful laughter was rated as being more positive than taunting laughter. This finding fits to the hypotheses proposed about the dimensional rating of laughter which were based on the PAD emotional state model (Russell and Mehrabian, 1977) since joyful laughter serves the social function of group bonding (Provine, 2013) and thus, the laughing person intends to convey a pleasant emotional state to the addressed person. Taunting

laughter, on the other hand, rather serves the function of social segregation (Eibl-Eibesfeldt, 1970) and hence, intends to convey an unpleasant emotional state to the laughter-perceiving individuals.

Further, tickling laughter was as well rated as being more positive than taunting laughter. This can also be explained by the function of the different laughter types: The evolutionary old laughter type of tickling laughter serves the reinforcement of play behavior (Panksepp and Burgdorf, 2003) which in the context of bodily interactions takes place within one's social group and thus conveys a rather pleasant emotional state. In the present study, tickling laughter had even a higher mean valence rating (6.46) than joyful laughter (6.25), which, however, did not proof to be a significant difference so that it cannot be concluded that there are differences in the pleasantness of joyful and tickling laughter.

The findings that joyful and tickling laughter were rated as being more positive than taunting laughter, which can plausibly be explained, support the assumption that the utilized stimulus material is ecologically valid and suitable to investigate information processing biases in socially anxious individuals.

4.1.3 Arousal

The analysis of the mean arousal ratings showed that all three laughter types were rated significantly differently: Tickling laughter was rated to have the highest arousal followed by taunting laughter while joyful laughter was rated to have the lowest arousal. As especially very ticklish people know, being tickled represents a situation of high arousal, which also manifests in one's behaviors such as laughing, blushing, screaming or even crying. In a self-report study, it could be shown that ticklish people also have greater propensities to giggling, laughing, blushing and crying in general (Fridlund and Loftis, 1990). A possible explanation for this could be that ticklish individuals exhibit a higher arousability suggesting that tickling laughter is associated with a highly aroused emotional state. Likewise, it was found that chimpanzees emit play panting which some researchers even call laughter (Goodall, 1989; Plooij, 1984) especially when they receive stimulation leading to a high arousal which can consist of being tickled but also of being chased or grabbed (Matsusaka, 2004).

The finding that taunting laughter was rated to express a higher arousal than joyful laughter may be due to the script the production of the video sequences was based on. This script instructed the actors to imitate joyful laughter by imagining a situation in which they meet an old friend whom they have not seen for a long time. Thus, the resulting laughter is an inviting welcoming laughter, but on a low degree of arousal. Nevertheless, joyful welcoming laughter in other situations may have a higher degree of arousal. For example, laughing at a joke is as well a joyful laughter which serves the social function of group bonding, but leads to a higher arousal level. Likewise, taunting laughter can appear in more or less strong aroused forms. It serves the function of social segregation (Eibl-Eibesfeldt, 1970) and thus may elicit an emotional state of fear in the laughter-perceiving person which is an emotional state described by a high arousal (Russell and Mehrabian, 1977). The sender of the laughter, however, whose emotional state was asked to assess in the present study may vary in his/her arousal with respect to the concrete situation.

4.1.4 Dominance

Taunting laughter was rated to express more dominance than both of the other laughter types. This can be explained by the function taunting laughter serves in social communication: By aiming to socially segregate an individual by ridiculing and humiliating him/her through taunting laughter, the laughing person puts him-/herself in a dominant position, which leads to a feeling of submissiveness in the addressed individual. This is also reflected by findings about the PAD emotional state model which show that fear that is elicited through taunting laughter is very low on the dominance scale indicating a submissive feeling in the anxious person (Russell and Mehrabian, 1977). Since the task of the present study consisted of assessing what degree of dominance the presented stimuli express and not how the addressed persons feels, the ratings are inverse to the feelings of a fearing person, or to say in other words: The expression of dominance in a social cue leads to the feeling of submissiveness in the addressed person and vice versa.

Joyful laughter, on the other hand, leads to pleasant emotions such as joy and happiness in the addressed individual and meanwhile serves the social function of group bonding (Provine, 2013). As the PAD emotional state models shows, these positive emotions are

connected with a high degree of dominance, i.e. joyful and happy individuals feel rather free to act in a variety of ways than to be urged to specific actions by a dominant person (Russell and Mehrabian, 1977). Therefore, it can be easily explained why in the present study, joyful laughter was rated to express least dominance of the three laughter types.
Tickling laughter was significantly rated to express less dominance than taunting, but more dominance than joyful laughter. The reason for this may be similar to the explanation of the arousal ratings of tickling laughter: By empathizing with the tickled person, the participants of the present study may have felt rather submissive as a tickled person does as well since being tickled represents a situation in which one is at the mercy of the tickling person and can no longer control one's own behavioral and vegetative responses such as laughing, screaming, blushing and even crying. As we defined dominance as the feeling of being free and unrestricted to act in a variety of way (Mehrabian, 1980), the emotional state while being tickled appears to be very un-dominant. In opposition to taunting laughter, however, tickling is not intended to cause the addressed person negative social consequences and thus does not lead to anxious and fearful feelings in the addressed individual. This might be the reason why taunting laughter was rated as expressing even more dominance than tickling laughter.
As explained, the hypothesis of the present study about the dominance rating of laughter was verified as well suggesting the applicability of the tested stimulus material for the investigation of information processing biases in SA.

4.1.5 Authenticity

With 141 out of 187 presented stimuli being rated above the defined limit (i.e., ≥ 3.5 on the 9-point SAM) the hypothesis that the majority of laughter stimuli would be assessed as being authentic was verified suggesting that the stimulus material is close enough to natural laughter in order to be utilized in a study about information processing biases in SA.
Moreover, statistical analyses revealed that joyful laughter was significantly rated to be more authentic than taunting laughter while there was no significant difference between tickling laughter and each of the other laughter types. This might be due to the capability of the actors to express joyful laughter more authentic than taunting laughter

since actors tended to overexpress dominance to make their laughter taunting enough to be recognized.

4.1.6 Selection of the stimulus material for the main study

Since the hypotheses of the pre-studies all could be corroborated the present stimulus material appears to be ecologically valid and appropriate to evoke responses in stimulus-perceiving individuals that are close to those in natural social situations. Therefore, the present stimulus material seems to be particularly apt to evaluate information processing biases in socially anxious individuals.

4.2 Main study

4.2.1 Laughter main effects

The main effects which were revealed by the two ANOVAs about laughter ratings and response times refer to the perception of laughter in general. Since in the data analysis, the main effects were investigated after correction of the outcome parameters for the variance associated with LSAS-score, these effects refer to a fictive population that is very low socially anxious with an LSAS-score of 0. In this chapter, first these main effects (first about laughter ratings, then about response times) will be discussed. Effects attributable to social anxiety will then be explained in the following.

4.2.1.1 Laughter ratings

In opposition to the pre-studies, in the main study stimuli were presented only in two modalities, auditory and audiovisual. Stimuli presented only in the auditory modality were rated as being more socially inclusive than audiovisual ones. This can be explained by the greater ambiguity of unimodally presented stimuli. As extendedly demonstrated in the introduction chapter, perception biases arise when individuals are faced with unclear and ambiguous situations. Since in the data analysis, the laughter rating main effects were investigated after correction of the outcome parameters for the variance associated with LSAS-score and thus, the ANOVA shows effects for a fictive population that is very low socially anxious with an LSAS-score of 0, the difference in the perception of the two modalities is indicative for a positive interpretation bias in low socially anxious individuals. This fits into previous research about information

processing biases in SA in which it was postulated that the interpretation bias in SA may be dichotomous: In two independent studies, Hirsch and Mathews (1997; 2000) found that non-anxious individuals exhibit a positive inferential bias that anxious subjects lack suggesting that the negative interpretation bias in socially anxious individuals may be accompanied by a lack of a physiological benign interpretation bias. Later, using a different paradigm this finding could be reproduced by further research both in subclinical socially anxious undergraduates (Beard and Amir, 2009) as well as in patients with SAD (Amir et al., 2012).

The three laughter types were all rated to be significantly different from each other regarding their social inclusiveness/exclusiveness with taunting laughter being rated as the most exclusive and joyful laughter as the most inclusive laughter type. This finding is similar to the results of the valence rating in the pre-studies in which taunting laughter was rated to be more negative than joyful and tickling laughter while the difference between joyful laughter and tickling laughter did not proof to be significant. A possible explanation for this difference in the findings of the pre-studies and the main study is that in the main study, the stimuli had been selected due to their recognizability and authenticity evaluated in the pre-studies. Therefore, the laughter types were assumably better recognized in the main study and thus, the difference between joyful laughter and tickling laughter reached a significant level. Moreover, it is important to take into account that the task that was set to the participants in the main study was different to the one in the pre-studies: In the main study, participants were not asked to assess the valence but the social inclusiveness/exclusiveness of the presented laughter. Thus, independent on whether the stimuli of the main study were better recognizable due to their selection, it would be plausible that tickling laughter in spite of its positive valence was perceived as less socially inclusive than joyful laughter.

The finding that the three laughter types were significantly different regarding their social inclusiveness/exclusiveness can serve as a plausibility check for the validity of the utilized stimulus material.

The difference in the perception of the three laughter types was a significant one under both task conditions (SELF and OTHER). However, under the SELF-condition the differences were smaller than under the OTHER-condition, which is demonstrated by an interaction effect between task and laughter type: Under the SELF-condition mean

laughter ratings of JOY and TIC were rated as less social inclusive than under the OTHER-condition whereas for TAU an opposite tendency was observed. This finding could be indicative for a cognitive mechanism which makes individuals perceive laughter as more mediocre when directly directed at them. The function of this mechanism could be a protection against misinterpretations which could lead to social consequences. Therefore, interpreting taunting laughter as not that taunting as it may be and joyful laughter as not that social inclusive as it may be prevents radical social reactions that in a number of cases may be overreactions which would lead to huge preventable consequences.

4.2.1.2 Response times

The response time main effects were observed for the experimental conditions modality, laughter type and the interaction between the two of them. Participants were significantly slower to respond to unimodally auditorily presented stimuli than to audiovisual ones. This can easily be explained by the greater ambiguity unimodally presentation has leading to a prolonged process to decide how social inclusive/exclusive the presented stimulus is. The significant longer response times for tickling laughter than for the other two laughter types can simultaneously be explained by the greater ambiguity tickling laughter has since under the experimental circumstances, it is presented separated from its natural and obligatory trigger, tickling. Thus, it is prima facie hard to recognize. Moreover, this great ambiguity of tickling laughter appears to be the reason for the interaction effect between modality and laughter type: Because of the difficulty to recognize tickling laughter without its natural trigger, the ambiguity is in the audiovisual presentation already that great that in the unimodal auditory presentation its ambiguity is not in such a rate increased that response times would significantly be prolonged.

4.2.2 Information processing biases

This chapter is partly adopted from Ritter et al. (2015) where the results of the main study as well as their discussion have been published before. Respective passages are put in quotation marks and italics.

4.2.2.1 Interpretation bias

The data of the main study demonstrate a negative interpretation bias displayed by the tendency of individuals with increasing severity of social anxiety to interpret laughter as socially exclusive. So the first hypothesis of the main study could be confirmed. As described in the introduction, this finding is in accordance with previous studies reporting a negative interpretation bias in SA for verbal (Amir et al., 2005), prosodic (Quadflieg et al., 2007) and facial (Heuer et al., 2010; Winton et al., 1995) expressions. Now, previous research could be extended since the present study shows that the negative interpretation bias can be found also for dynamic audiovisual perception conditions which approximate real life communication conditions and for a primordial nonverbal signal with high prevalence in human social communication.

However, a significant interpretation bias for taunting laughter could not be demonstrated, which can be explained most likely by a negative ceiling effect for this laughter type as already low socially anxious individuals rated taunting laughter as socially exclusive.

The third hypothesis of the main study consisted of the postulation that this negative interpretation bias would be stronger for unimodal auditory laughter stimuli than for audiovisual stimulation, which the results again confirmed. As described in Ritter et al. (2015, p. 182f), "*this is in line with the assumption that a negative interpretation bias in SA can be observed mostly for ambiguous social cues (e.g., Amir et al., 2005; Heuer et al., 2010). The ambiguity in the auditory laughter stimuli can be assumed to be greater than in the audiovisual stimuli based on the lack of audiovisual sensory redundancy in purely auditory stimuli. This interpretation is corroborated by generally slower responses to auditory stimuli which is again in accordance with the pertinent literature on audiovisual integration of nonverbal social signals (Collignon et al., 2008; de Gelder and Vroomen, 2000; Kreifelts et al., 2007; Massaro and Egan, 1996).*"

Further, there were no significant response time differences between auditory and audiovisual laughter presentation: This finding "*argues against an audiovisual integration deficit for nonverbal social cues in SA as source of the observed effect. Nevertheless, despite a plethora of studies exploring behavioral and cerebral correlates of audiovisual integration in healthy populations, there is still little data about the alteration of audiovisual emotional integration processes in patients with psychiatric*

conditions (Kreifelts et al., 2013). Therefore, the modality-dependent interpretation bias in SA observed in the present study underlines the necessity for further research in this area to clarify multimodal sensory integration processes of social cues in SA but also other psychiatric disorders. Furthermore, this research is needed to disambiguate sensory integration processes from other aspects of the processing of multimodal social cues." (Ritter et al., 2015, p. 183)

4.2.2.2 Attention bias

The fourth hypothesis of the main study postulated an attention bias towards threatening cues which would be displayed by a linear relationship between SA and faster response times to taunting laughter than to joyful laughter. This hypothesis could not be confirmed by the main study. However, instead, increasing response time differences between joyful laughter and each of the other two laughter types could be found which were based on a prolongation of mean response times for joyful laughter with increasing severity of SA while the response times for the other two laughter types increased only marginally. This can be seen as evidence not for an attention bias towards threatening cues but for an attention bias away from joyful laughter with increasing severity of SA. The meaning of this finding can be described as discussed in Ritter et al. (2015, p. 183): *"While it could be shown in several studies that socially anxious individuals are hyper-vigilant towards threatening social cues (Gilboa-Schechtman et al., 1999; Mogg and Bradley, 2002), our data also emphasize a tendency to allocate attention away from positive/inclusive social stimuli as source of the attention bias in individuals with SA. These data support two recent studies. In the first study, it was shown that an attention bias away from positive social cues mediated the effect of SA on the response to a social stressor (Taylor et al., 2010). The second study demonstrated that an attention training towards positive cues leads to a diminished anxiety reactivity to a stressor (Taylor et al., 2011). Together, these data suggest a causal function of the attention bias away from positive cues in the maintenance of SA. It appears that joyful laughter represents a positive stimulus intended to convey positive and inclusive social information (e.g., group bonding; Provine, 2013). However, also tickling laughter can be seen as a positive social cue as it serves the reinforcement of play behavior. Nevertheless, socially anxious individuals did not allocate their attention away from tickling laughter.*

The reason for this may be that the positive communicative function of tickling laughter is context-dependent (i.e., play behavior, body contact). This interpretation is supported by the fact that, unlike joyful laughter, tickling laughter was not perceived as clearly socially inclusive (i.e., positive in the context of the experiment). It remains an open question for future research, however, how tickling laughter may influence attention in SA in different experimental contexts (e.g., under implicit, task-irrelevant processing conditions). Moreover, it should be noted as a caveat for further research that a potential biased distribution of left-handed participants in the study may have obscured an association of overall response times and SA."

4.2.2.3 Interrelations of information and attention biases

As described in the introduction, theoretical considerations (Hirsch et al., 2006; Mathews et al., 1997) as well as empirical data (Amir et al., 2010) support interrelations and shared mechanisms of interpretation and attention biases in SA. Since the present stimulus material and experimental design were able to elicit both bias types at the same time and in an interrelated manner, they appear as useful means for further research in this area (Ritter et al., 2015).

4.2.2.4 Specificity of the revealed biases for social anxiety

The effects of SA on laughter ratings as well as on response times all remained significant after controlling for measures of general anxiety and depressive symptoms. This indicates that both the interpretation bias (including its increase under unimodal stimulus presentation) and the attention bias found in the present study are indeed specific for SA. However, the cognitive biases found in the present study were not specific to SA after controlling for gelotophobia. The conclusions that can be drawn from the present study about the relationship between SA and gelotophobia can be described as discussed in Ritter et al. (2015, p. 183): *"When including gelotophobia as control variable, the relationship between SA and the above biases was fully explained. Thus, concomitant gelotophobia in SA can be interpreted as a relevant component in SA mediating the effects of SA on laughter perception. Judging from the very high degree of shared variance between SA and gelotophobic symptoms, our data indicate that in most cases gelotophobia is an inherent feature of SA. However, since the present study*

was designed to assess gelotophobic symptoms in individuals with different degrees of SA, this does not necessarily mean that the majority of gelotophobic individuals also suffer from a high degree of SA as was already clarified by Sarid et al. (2011)."

4.2.3 Emotion regulation

The second hypothesis of the main study postulating that the negative interpretation bias would decrease under cognitive reappraisal conditions could not be confirmed. In contrast, the attention bias away from joyful laughter when compared to tickling laughter was significantly enhanced by cognitive reappraisal in contrast to the attention bias when comparing response times to joyful and taunting laughter. This effect, however, was fully explained not only by gelotophobic symptoms but also by measures of general state and trait anxiety as well as of depressive symptoms so that it cannot be claimed specific for SA.

This negative finding may be due to a methodological issue as described in Ritter et al. (2015, p. 183): *"On the one hand, the explicit evaluation of social inclusiveness expressed in laughter allows the parallel assessment of interpretation and attention biases. On the other hand, however, such a task may render the design less sensitive to emotion regulation effects when compared with studies which used cognitive reappraisal strategies to modulate emotional experience rather than the evaluation of social cues (Goldin et al., 2009a; Goldin et al., 2009b). A means to overcome this potential weakness of the design - while preserving its strengths - in future studies could be to increase power by increasing the SA gradient through a comparison between low socially anxious individuals with cases of severe social anxiety disorder while abstaining from any hypotheses on linear effects."* Since laughter as a communication signal has not only the capability to express the emotional state of the laughing person, but also to evoke emotions in the laugher-perceiving individual, another potential experimental design for future research regarding this issue could comprise the task to assess not only the emotion / intention that is expressed by the laughing person, but to investigate the emotions that are induced in the receiver of the laughter as well. Such an investigation of the induced emotions could consist of a self-assessment of the laughter-perceiving individuals as well as of measurements of physiological parameters such as heart rate or skin conductance.

5. Summary

5.1 Summary in English language

Social anxiety (SA) is the fear of embarrassment and humiliation in social situations caused by the expectation of negative evaluation from others. In some individuals, this fear reaches a pathological level called social anxiety disorder (SAD). A core mechanism in the maintenance of this disorder is thought to be a distorted perception in socially anxious individuals which is due to cognitive biases: Socially anxious persons tend to interpret neutral or ambiguous stimuli as threatening (i.e., interpretation bias) as well as they are hyper-vigilant towards threatening stimuli (i.e., attention bias). Moreover, previous research suggests that socially anxious individuals have deficits in emotion regulation. The goal of the present study was to use laughter as a new ecologically valid stimulus material to investigate cognitive biases and their modulation through emotion regulation and cue ambiguity in individuals with varying degrees of social anxiety. To this end, laughter sequences were produced and evaluated in four pre-studies with regard to their recognizability, valence, arousal, dominance and authenticity, in order to select appropriate laughter stimuli for the study. The pre-studies showed that the utilized stimuli were recognizable with regard to their expressing laughter type and that there was an integration effect in the sense that recognition rates were higher in audiovisual than in unimodal (auditory or visual) presentation.

After that, the selected laughter cues were presented to individuals with varying degrees of social anxiety and their assessment of the presented laughter sequences was recorded: A combination of a negative laughter interpretation bias and an attention bias away from joyful/social inclusive laughter in SA was observed. Both biases were not attributable to effects of general anxiety and were closely correlated with the concept of gelotophobia, the fear of being laughed at. Thus, the study demonstrates altered laughter perception in SA. Furthermore, it highlights the usefulness of laughter as a highly prevalent social signal for future research on the interrelations of interpretation and attention biases in SA and their modulation through emotion regulation.

5.2 Deutsche Zusammenfassung (Summary in German language)

Sozial ängstliche Menschen haben die Angst, sich in sozialen Situationen zu blamieren oder beschämt zu werden. Grund hierfür ist die bei ihnen vorhandene Erwartung, dass sie, ihr Erscheinungsbild oder ihr Verhalten von anderen in negativer Weise bewertet wird. Während soziale Ängste in der Bevölkerung generell weit verbreitet sind, erreichen diese Ängste bei manchen Individuen ein pathologisches Maß, welches zu sozialem Rückzug führt und die Betroffenen in ihrer Lebensweise in erheblichem Maße einschränken kann. Diese Form der sozialen Ängstlichkeit wird als Soziale Phobie bezeichnet und stellt eine anerkannte psychiatrische Krankheitsentität dar. Es wird davon ausgegangen, dass eine bei Sozialphobikern bestehende verzerrte Wahrnehmung die Hauptursache für die oft über mehrere Jahre bis Jahrzehnte überdauernde Chronifizierung einer Sozialen Phobie darstellt. Als Ursache hierfür konnten durch eine Vielzahl von Forschungsarbeiten folgende kognitive Veränderungen ausgemacht werden: Sozial ängstliche Personen neigen dazu, neutrale oder mehrdeutige Reize als bedrohlich zu interpretieren (negative Interpretationsverzerrung) und haben eine gesteigerte Aufmerksamkeit gegenüber bedrohlichen Stimuli (Aufmerksamkeitsverzerrung). Außerdem scheinen sozial ängstliche Menschen in ihren Möglichkeiten der Emotionsregulation eingeschränkt zu sein.

Das Ziel der vorliegenden Studie war es, mithilfe von Lachen als Stimulusmaterial kognitive Verzerrungen und ihre Modulation durch das Anwenden von Emotionsregulationsmechanismen und Veränderungen der Stimuluseindeutigkeit bei Personen mit unterschiedlicher Ausprägung von sozialer Angst zu untersuchen. Dafür wurden passende Lachsequenzen hergestellt und in vier Vorstudien im Hinblick auf die Erkennbarkeit des in ihnen ausgedrückten Lachtyps, auf ihre Authentizität sowie der durch sie ausgedrückten Valenz, des Arousals und der Dominanz evaluiert. Die Ergebnisse zeigten, dass die verwendeten Stimuli im Hinblick auf die von ihnen ausgedrückten Lachtypen erkennbar waren. Außerdem konnte ein audiovisueller Integrationseffekt festgestellt werden: Audiovisuell gezeigte Stimuli wurden besser erkannt als unimodal (auditiv oder visuell) präsentierte.

In der darauf folgenden Hauptstudie wurden die aufgrund der Ergebnisse der Vorstudien ausgewählten Lachsequenzen Probanden mit unterschiedlicher Ausprägung von sozialer Ängstlichkeit gezeigt. Dabei konnten eine negative

Interpretationsverzerrung sowie eine Aufmerksamkeitsverzerrung weg von freudigem Lachen festgestellt werden. Beide Veränderungen waren spezifisch für soziale Ängstlichkeit und korrelierten eng mit dem Konzept der Gelotophobie, der Angst vor dem Ausgelacht-werden. Die vorliegende Studie demonstriert daher eine veränderte Wahrnehmung von Lachen bei sozial ängstlichen Menschen. Ferner unterstreicht sie die Nützlichkeit von Lachen als ein häufig vorkommendes soziales Signal für zukünftige Forschung auf dem Gebiet der kognitiven Veränderungen bei Menschen mit sozialer Ängstlichkeit und deren Modulation durch Emotionsregulationsmechanismen.

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7. Erklärung zum Eigenanteil

Die vorliegende Arbeit ist Teil eines größeren Projektes zur Untersuchung der Wahrnehmung und neuronalen Verarbeitung unterschiedlicher Lachtypen bei Patienten mit Sozialer Phobie der Arbeitsgruppe Affektive Neuropsychiatrie an der Universitätsklinik für Psychiatrie und Psychotherapie und wurde unter Betreuung von Herrn Prof. Dr. Dirk Wildgruber durchgeführt.

Die Konzeption der Studie erfolgte durch Herrn Prof. Dr. Dirk Wildgruber und Herrn Dr. Benjamin Kreifelts.

Die Versuche wurden nach Einarbeitung durch Herrn Dr. Benjamin Kreifelts und Frau Dr. Carolin Brück von mir eigenständig durchgeführt. Eine Ausnahme bildet die Durchführung der Datenerhebung der Vorstudie DOM/AUT, welche Frau Dr. Carolin Brück übernahm.

Die statistische Auswertung sämtlicher Experimente der Vor- sowie Hauptstudie erfolgte von mir eigenständig unter Supervision von Herrn Dr. Benjamin Kreifelts.

Herr Dr. Benjamin Kreifelts war an der Verfassung der Veröffentlichung mitbeteiligt. Herr Prof. Dr. Dirk Wildgruber, Frau Dr. Carolin Brück sowie Frau Dr. Heike Jacob standen während der Verfassung der Veröffentlichung beratend zur Seite und haben das Manuskript der Veröffentlichung korrigiert.

Die vorliegende Dissertationsschrift inklusive der Textübernahmen aus der Veröffentlichung als auch der Tabellen und Abbildungen mit Ausnahme der Abbildung 1, welche von Herrn Dr. Benjamin Kreifelts erstellt wurde, wurde von mir eigenständig verfasst. Herr Prof. Dr. Dirk Wildgruber hat das Manuskript korrigiert.

Ludwigsburg, den 11.06.2017

8. Veröffentlichungen

Teile der vorliegenden Dissertationsschrift wurden bereits in folgender Publikation veröffentlicht:

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