RESEARCH ARTICLE

Laughter down-regulates negative emotional arousal amongst friends [version 1; peer review: 1 approved, 1 approved with reservations]

Mimi Borrelli¹, vikram sinha ², Sophie Scott³

¹Department of Experimental Psychology, University of Bristol, Bristol, UK

²School of Medical Education, King's College London SE1 1UL, London, UK

³Department of Cognitive Neuroscience, University College London, London, UK

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Abstract

Laughter is contagious, sensitive to social context, and can be used to mitigate negative emotional states. This experiment tested whether moments of transition from negative to positive affect were associated with more laughter if in familiar compared to unfamiliar company. 90 participants (47 females, mean age 20.61 years), either familiar (N=42) or unfamiliar (N=48) to the principle researcher, were randomly assigned to listen to 44 seconds of music which induced a fearful affect, positive affect or a neutral mood, followed by 30 seconds of infectious laughter (N=30/group). Filmed facial expressions were coded for four dependent variables (duration: *half smile*; *full smile*; *laugh*, and extent: *peak mirth*) of amusement in response to the laughter. Familiar participants fully smiled for longer than unfamiliar participants ($F(1,84)=4.15$, $p=.045$). There was an affect-familiarity interaction for peak mirth ($F(2,84)=4.68$, $p=.01$), time spent half smiling ($F(2,84)=5.00$, $p=.009$), and fully smiling ($F(2,84)=3.48$, $p=.035$). Post hoc analyses revealed familiar participants exhibited greater peak mirth and smiled (half and full) for longer than unfamiliar participants in the fearful affect condition. Laughter and positive emotions may be used to moderate negative arousal more amongst people known to each other than amongst strangers.

Keywords

Laughter, Mirth, emotional arousal, social behavior

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1. **Luísa Soares** , University of Madeira, Funchal, Portugal
2. **Adrienne Wood** , University of Virginia, Charlottesville, USA

Any reports and responses or comments on the article can be found at the end of the article.

Corresponding author: Mimi Borrelli (mimi.r.borrelli@gmail.com)

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Introduction

Laughter is an inherently social behaviour which is prevalent in interactions as wide ranging as tickling and conversations (Gervais and Wilson 2005; Provine 2001). Laughter is not automatic, rather highly modulated by social factors. Humorous material, for example, is rated more amusing when participants believe others have also found it amusing (Wimer & Beins, 2008).

Within interactions, laughter regulates mood and coordinates the behaviour of laughter through a group (Spoor and Kelly 2004; Deacon 1997; Provine 1992). Affect and laughter are induced in a listener both through the directly arousing acoustic properties of laughter, and indirectly as a conditioned positive affective social experiences (Owren and Bachorowski 2003). Laughter shows an in-group function: the act of laughing increases positive affect which further enhances the perceived pleasure of social interactions, promoting affiliative and cooperative behaviour (Owren and Bachorowski 2003; Martin 2007; Smoski and Bachorowski 2003). Participants laughed and smiled more, laughed longer, and rated humorous material more favourably when they heard in-group laughter as opposed to out-group laughter or no laughter at all (Platow et al. 2005).

The “undo” hypothesis theorises that positive emotions, including laughter and smiling, function to mitigate negative arousal that arises from stressful events (Levenson 1988). Cardiovascular arousal, including increased heart rate and blood pressure associated with a fearful film, dissipated more quickly when followed by happy films as compared to sad or neutral films (Fredrickson and Levenson 1998). Music-induced positive emotions preceded by the viewing of unpleasant pictures restored baseline cardiovascular and respiratory levels faster than did white noise (Sokhadze 2007).

The aim of the present study was to combine these two separate explorations of laughter and address the use of laughter to regulate negative emotional affective states amongst people known to each other. The study investigated whether more laughter and positive emotional expressions were produced by participants in familiar than unfamiliar company, in the context of transition from negative arousal to a more positive affect. Music was used to induce an affective state (positive or negative) or a non-affective state using non-arousing music as a control group. The music presentations were followed by presentation of infectious laughter. The hypothesis was that laughter produced in response to infectious laughter would be greatest following fearful affect, and would show sensitivity to social context, being greatest in familiar compared to unfamiliar company.

Methods

Participants

90 University students participated in the experiment (47 females, mean age 20.61 years (SD = 3.41, range 18-27). They provided written informed consent. Participants were recruited through personal contacts (N = 42 familiar), and through advertising (N = 48 unfamiliar).

Design

Amusement in response to the infectious laughter was the dependent variable. Manipulated mood (positive affect, negative affect, control) was the independent variable in a between-subjects design. Participants were randomly assigned, using a standardized table of random numbers on a 1:1:1 ratio, to one of the three experimental groups: 1) fearful affect; 2) positive affect; 3) neutral, ensuring 30 participants in each group. 17 participants were known to the experimenter in the fearful affect group, 11 in the positive affect group and 14 in the neutral group (Table 1). The assigned condition was written in pencil on the back of the printed consent forms.

Table 1. Demographic details of participants in each experiment.

Affect	N	Age	SD	Familiarity	n	Gender	n
Fearful	30	20.4	.22	Familiar	17	Female	15(10)
				Unfamiliar	13	Male	15(7)
Positive	30	20.56	.34	Familiar	11	Female	16(7)
				Unfamiliar	19	Male	14(4)
Neutral	30	20.87	.919	Familiar	14	Female	16(10)
				Unfamiliar	16	Male	14(4)

Note. Brackets in N Gender column denotes the number of familiar male and female participants.

Acoustic stimuli

Music induction excerpt

A single suitable musical excerpt for each target mood appropriate for the target population was chosen from a large pool of potential stimuli using a pilot study (N = 6). The final fearful and positive affect excerpts were rated as those capable with inducing the strongest fearful and positive affect, with equal arousal ratings on an 11-point arousal scale (0—not arousing 10—highly arousing). The chosen stimuli were: *Half Remembered Dream*, by Hans Zimmer (Fearful affect), *Monsieur Verdoux Paris Boulevard*, by Charlie Chaplin (positive affect). The control song *Sleepy Noise*, by Canton (neutral), was chosen based on its rating as non-arousing in the pilot study. Track tempo has been linked to arousal (Etzel et al. 2006) therefore the two emotionally arousing tracks were equated in tempi using Logic Studio's *Time Machine* and *AUpitch* algorithms which leave the pitch intact. The fearful track reached a natural crescendo in 44 sec and pilot testing confirmed this was adequate to elicit the target emotional response, therefore equivalent sections in positive affect and control track were located and cut using *Logic studio*. The laughter tracks were included unexpectedly at the end of the audio tracks.

Laughter tracks

A pilot study was used to select the most contagious laughter sequences from a selection collaborated from the internet (www.freesound.org) and from live recordings from a social gathering recorded using a Dictaphone. Laughs from people of different sex and age were used to ensure ecological validity. The final selection contained 19 laughs which had been successful in eliciting laughter in all pilot participants.

This laughter track was edited onto the end of each musical excerpt, after a one second gap, using *Logic Studio*, to create three separate audio tracks for each experimental condition, each lasting 1 minute 15 seconds. All audio experimental stimuli were presented binaurally through headphones, and played off an iPod classic at a volume of 3.4 decibels.

Procedure

Participants were tested individually. The testing location varied, but consistency was maintained through ensuring participants were always seated at a desk, in a quiet room with only the principle experimenter present. Participants were informed the experiment was an '*Investigation into effects of acoustic stimuli on facial musculature*' and instructions, presented in written form, asked participants to listen to a short acoustic extract whilst their facial reactions were recorded on camera. The facial muscle movements of interest, they were told, were out of conscious and therefore they should not suppress or force any movement, just concentrate on the sounds they would hear. Participants consented to being filmed and blindfolded. Music induction procedures commonly ask participants to close their eyes to aid acoustical concentration (Etzel et al. 2006). Participants were instead blindfolded to alleviate participants of this responsibility. Once participants were blindfolded and wearing headphones, positioned ½ m from the Camera Recorder, the experimenter opened a numbered word document which revealed the assigned experimental condition and played the audio track appropriate to this condition. Facial expressions were continuously recorded. At the end of the audio, recording was suspended, headphones and blindfold were removed, and participants completed a questionnaire which asked them to "*select one word that best represents the emotion elicited in you by the musical part of the acoustical excerpt*" and whether they recognised the musical excerpts. Participants were then debriefed, and fully informed consent obtained.

Coding

The videotaped recordings were digitalised and the 30 sec of behavioural responses from the onset of the laughter track were isolated for analysis. Playback was performed on *iTunes Movies*. Following previous research, amusement was measured using coding sheets along two dimensions: intensity and duration, which have shown maximum sensitivity to subtle differences in mirthful expressions (Platow et al. 2005). All facial image analysis coding was performed by independent observers (six for intensity of mirth, two for humour durations), who were blind to the experimental condition of participants and to the experimental hypotheses. Each observer was familiarised with two practice trials before analysis commenced.

Peak Mirth

A Mirth scale was created based on scales used in previous research. The Mirth Index created by Zigler and colleagues (Zigler, Levine, and Gould 1966) included five categories: *negative response*; *no response*; *inhibited to a half or slight smile*; *full smile*; *laugh*. The Mirth scale in this experiment adapted the Mirth Index (Zigler, Levine, and Gould 1966) by

dividing the category 'laugh' into two; *any indication of a laugh*; and *open mouth laugh*. The categories and corresponding description, in brackets, were as follows:

0. *A negative response* (a grimace)
1. *No response* (blank expression, no indication of amusement)
2. *Any indication of a smile/amusement* (open mouth, flared nostrils, trembling mouth)
3. *A half smile* (upturned corners of the mouth (symmetric or bilateral))
4. *A full smile* (big and symmetrical lip curling, likely with teeth showing)
5. *Any indication of a laugh* (audible sound, body movements (head or shoulders), distinctive breathing)
6. *Open mouth laugh* (uncontrollable, full laughter response, clearly audible, big body movements)

All six categories were found easily discernible in a pilot study. Six observers were asked to mark for each participant the highest intensity level of mirth observed within the 30 seconds of participant recordings.

Mirthful durations

The total time each participant spent in: 1) half smiles; 2) full smiles; and 3) laughter, was used as measures of mirthful duration. Two coders identified the expressions according to a coding sheet of three categories adapted from previous research (Bachorowski, Smoski, and Owren 2001; Olson 1992; Vidulich and Bayley 1966; Deckers, Jenkins, and Gladfelter 1977). The description for category 1 *Clear Smile* is 'clear upturned corners of the mouth'. Category 2 *Big Grin* is 'clearly of higher intensity than clear smiles, clear bilateral movement and visible dimples'. Category 3 *Laughter* is 'any audible obvious sound accompanying either a smile or grin'. The 'laughter' category was coded as 'vocalised' laughter. Eye movements were not included in coding facial expressions as the participants were blindfolded. Mirthful expressions were hand-timed using a stopwatch and measured in seconds (and not 'events').

Statistical data analysis

Inter-observer agreement for all duration measures was high ($r_s = .9, p < .01$), and for peak mirth it was reasonable (Kappa 55%). Average scores were calculated where observers disagreed. There were four dependent variable scores for each participant: 1) highest mirth achieved over the 30 seconds; and average time spent in 2) a half smile; 3) a full smile; and 4) laughing. A series of two-way independent-subjects analysis of variance (ANOVA) were run on each of the four variables, with induced-mood (fear, happiness, neutral) and familiarity (known, unknown) as the two between-subjects factors. Post-hoc tests were performed using the Bonferroni method. The effect sizes were calculated by hand using the mean difference equation ($ES = X_i - X_j$).

Results

Participant demographic details and group compositions are above. Mean age, gender, and familiarity of participants, did not significantly differ between the three experimental groups. No participants recognised the musical part of the excerpts presented. Self-reported emotions were consistent with intended mood induced in each of the three conditions; negative and arousing emotions in the fearful aroused condition, positive emotions in the happy condition, mostly relaxing, though also some reports of positive and negative emotions in the control condition. Some participants reported that the laughter made them feel uncomfortable. Facial expressions of participants were generally reliably categorized on the mirth scale by observers. Observers expressed particular difficulty when trying to classify faces of participants who appeared to be stopping themselves laugh, where participants were seen to flare nostrils, bite lips, raise eyebrows and fidget or display other behaviours not enlisted in the mirth scale.

Peak mirth

The peak mirth scores of familiar and unfamiliar participants did not significantly differ, $F(1, 84) = 1.73, p < .05$, and there was no significant effect of mood-induced, $F(2, 84) = 1.59, p > .05$. There was a significant interaction between the affect and familiarity, $F(2, 84) = 4.68, p = .01$ (Figure 1). Post-hoc comparisons revealed that familiar participants had significantly greater peak mirth scores ($M = 3.27, SD = 1.34$) than unfamiliar participants ($M = 1.97, SD = 1.46$) in the fearful affect condition (Figure 1). The size of this effect is 1.05.

Figure 1. Line graph showing the peak mirth scores of familiar (green solid line) and unfamiliar (green dotted line) participants, and the time familiar (solid lines) and unfamiliar (dotted lines) participants spent in full smiles (blue) and half smiles (red) in the different experimental conditions. Error bars represent the standard error of the mean. There is a significant interaction in all three dependent variables where familiar participants have higher peak mirth ratings, longer time spent smiling (full and half smiles) than unfamiliar participants in the fearful affect condition. Time spent laughing is not shown as results for this dependent variable were not significant.

Half smiles

Mood manipulations had no significant effect on subsequent time spent in half smiles, $F(2, 84) = .576, p > .05$. Duration of half smiles did not differ significantly between unfamiliar and familiar participants, $F(1, 84) = 1.86, p > .05$. There was a highly significant interaction between familiarity and affect, $F(2, 84) = 5.00, p = .009$ (Figure 1). Post-hoc analysis revealed that in the fearful affect condition familiar participants displayed half smiles for significantly longer ($M = 24.36, SD = 9.81$) than unfamiliar participants ($M = 9.39, SD = 13.30$), effect size 1.21 (Figure 1).

Full smiles

Familiar participants displayed full smiles for significantly longer ($M = 11.56, SD = 11.13$) than unfamiliar participants ($M = 6.43, SD = 9.73$), $F(1, 84) = 4.15, p = .045$, the size of this effect was small, .28. There was no significant effect of manipulated mood on subsequent time spent in full smiles, $F(2, 84) = 2.33, p > .05$. There was a significant interaction between familiarity and affect, $F(2, 84) = 3.48, p = .035$ (Figure 1). Post-hoc analysis revealed in the fearful affect condition familiar participants fully smiled for significantly longer ($M = 17.07, SD = 11.44$) than unfamiliar participants ($M = 5.59, SD = 10.35$). The effect size of this pairwise difference was 1.15 (Figure 1).

Laughter

Familiar participants did not laugh significantly more than unfamiliar participants, $F(1, 84) = .287, p > .05$, and laughter durations did not significantly differ across condition, $F(2, 84) = 3.01, p > .05$. There was no significant familiarity vs affect interaction, $F(2, 84) = 1.76, p > .05$.

Discussion

The present study asked whether laughter produced in the context of negative emotions was modulated by social context. The main finding was a significant affect-familiarity interaction in three of the four dependent variables. In the fearful affect condition participants familiar to the experimenter had significantly greater peak mirth scores, spent longer smiling (half and fully) in response to the infectious laughter than participants unfamiliar to the experimenter. Familiar participants also

laughed for longer than unfamiliar participants in the fearful affect condition, but the familiarity-affect interaction was not significant. This is perhaps because fewer participants laughed overall in this condition, making the interaction under-powered.

This experiment was designed to combine previous work showing that laughter is both sensitive to social group and can regulate affective states within interactions. Laughter is greater amongst members of a group (Smoski and Bachorowski 2003) and is increased when participants hear in-group laughter (Platow et al. 2005) or when further affiliation with one's experimental partner is desired (Grammer and Eibl-Eibesfeldt 1990). Additionally, positive affect, including smiles and laughter, down-regulate negative arousal arising from stressful events. This has been demonstrated in stressful events ranging from a forced speech task (Fredrickson et al. 2000), a fearful film (Fredrickson and Levenson 1998), viewing unpleasant pictures (Sokhadze 2007). The findings presented here uniquely demonstrate that mirthful expression following a transition from negative to positive arousal is greater when in company of in- compared to out-group, members.

Although it was theorised that the significant interaction in the fearful affect condition was driven by more laughter amongst participants who knew the experimenter, it could be driven by less laughter in participants unknown to the experimenter. Graphical representation data of the dependent variables suggest known participants express more amusement in the fearful condition. However, some participants reported that the laughter made them uncomfortable. Laughter itself is a universal laughter-provoking stimulus (Provine 1992) reported by listeners to induce in them a positive affect (Szameitat et al., 2009). However, it can be heard in a negative way, especially in people who are "gelatophobic" and fear being laughed at (Ruch, Hofmann, and Platt 2015; Ruch et al. 2014). Perhaps the unfamiliar participants, who were blindfolded and in the company of a stranger, were more likely to perceive laughter negatively in the fearful affect condition.

Previous work suggests that laughter is greater amongst members of a group compared to strangers (Smoski and Bachorowski 2003; Platow et al. 2005; Grammer and Eibl-Eibesfeldt 1990). In this experiment, however, time spent fully smiling was the only dependent with a significant effect of familiarity; familiar participants fully smiled more than the unfamiliar participants. Familiar company only increased the duration of half smiles and extent of mirth in the context of negative emotions. Similarly, although laughter has been found to accompany the transition from negative-to-positive affect (Fredrickson et al. 2000; Fredrickson and Levenson 1998; Sokhadze 2007; Sroufe and Wunsch 1972), there was no significant effect of "affect" alone. These results suggest that the strongest stimulus to laugh and express is when participants are amongst familiar company and experience a transition from a fearful to positive affective state. This is a stronger stimulus to laugh than just being in familiar company or just experiencing transition from a negative-to-positive affect.

Humour is involved in the formation, maintenance, and regulation of close interpersonal relationships (Lefcourt 2001; Shiota et al. 2004). Interactions associated with laughter increase feelings of closeness and attraction to one's confederate more than do equally enjoyable but non-humorous experiences (Fraley and Aron 2004). Positive emotions and laughter in humorous communications reinforce mutual feelings of affection, strengthen attachment, and contribute to greater relationship satisfaction (Smoski and Bachorowski 2003). Couples in highly satisfied marriages are better able to regulate negatively aroused states during conflictive interactions using positive affect, including laughter, affection and humour, than couples in less satisfied marriages (Gottman and Levenson 1992; Levenson and Gottman 1983; Carstensen, Gottman, and Levenson 1995) and have greater degrees of marital stability six years later (Gottman et al. 1998). Instructions to suppress negative emotions when discussing negative topics disrupted communication, inhibited relationship formation, and increased the blood pressure of the suppressor's partner (Butler et al. 2003). It follows that laughter, a communicative group-sensitive behaviour, may have functional and evolutionary role in downregulating negative affective states in familiar company to facilitate successful group cohesion and group bonding. There is likewise less functional a role for laughter amongst strangers when faced with stressful situations.

The limitations of this experiment include the use of a blindfold. The involvement of eyes in smiles is important to distinguish between Duchenne ("emotional") and non-Duchenne ("social") smiles when coding smiles in social interaction (Ekman, Davidson, and Friesen 1990). It is possible that the smiles recorded in this experiment were both "social" and "emotional" smiles. However, since participants were not directly interacting socially with a companion, "social" smiles were thought to be negligible. Participants were positioned in-front of a camera which could make participants feel self-conscious, and thereby inhibit emotional expressions.

Participants were blindfolded to both aid concentration on acoustic stimuli, and to block out the distraction of a camera. The benefits of using a blindfold for these purposes was thought to outweigh the benefit of including the eyes in rating of degrees of mirth. Another difficulty was found when coding faces for amusement in participants who appeared to be withholding laughter, and often used facial muscles other than the mouth. Future studies may benefit from including an

additional “withholding laughter” category on mirth coding scales. “Familiarity” was coded categorically as unfamiliar or familiar, but it is recognized that this variable varies continuously. Future experiments could focus on whether the degree of familiarity influences the degree of mitigation from negatively arousing states. A strength of this experimental design was the use naturalistic methodology to evoke laughter, a sensitive emotion notoriously difficult to evoke in experimental situations. The design also included induction of a positive affective state which demonstrated the humorous response was specific to negative arousal as opposed to arousal in general as has been theorized (Berlyne 1972).

One interesting alternative explanation to the findings in this experiment relates to the ‘relief’ hypothesis of laughter (Ramachandran, Blakeslee, and Sacks 1998; Hayworth 1928; Keltner and Bonanno 1997). This hypothesis states that laughter accompanies the elicitation of positive affect, namely relief, following a negative state. The relief hypothesis can also provide unifying framework explaining why the focus of jokes worldwide tends to centre of taboo topics and slapstick (Freud 1989; Kotthoff 2006; Gervais and Wilson 2005). Future experiments will need to tease out these two alternative explanations of laughter.

Conclusion

In summary mirth intensity, smiles (half and full) were greater in known compared to unknown participants following induction of a fearful affect. This positive affect can be used to regulate negative affective states amongst people known to each other. The stimulus to laugh may be highest when in familiar companies and following a negatively arousal situation.

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Appendix A Development of the Mirth Scale

Measuring amusement

Mirth scale

A mirth scale was used to measure the extent of amusement expressed by participants. Mirth scales are more objective than self-reports and thus not so susceptible to gender differences and demand characteristics. Observers assign a mirth score to the facial displays of participants. There is however no standardised mirth scale used by all observers, not even an agreed definition of *Mirth* (Martin, 2007), and typically new scales are generated to fit the data accordingly. A four-point scale is common (Pollio, Mers & Lucchesi, 1972) but higher gradations have been used (e.g. Darwin, 1872). Where these scales differ is mainly through the number of smiling categories (1 or 2), the number of laughing categories (1 or 2) and the inclusion of any negative categories. Video data was informally observed to get an understanding of the range and type of expressions shown by participants in this population. Since expressions appeared to be widespread, the full range of categories was thought best to achieve maximum sensitivity; two laughing intensities, two smiling intensities, one slight amusement, one neutral face and one negative face (see Table II). Category labels were defined based on observations and using definitions from the two scales shown in Table a. The same instructions were given to observers, to assign the highest category of mirth reached by each participant according to this scale, within the 30 sec playback period. Practice on two trials to familiarise coders with the technique was carried out beforehand, following previous work (Whor & Schwarting, 2007).

Table a. The Mirth scales used to develop Mirth scale in primary experiment.

Mirth scale: Vuchnich, Tucker, & Sobell, 1979)		Mirth scale: Leventhal & Mace (1968)	
0	<i>Neutral, straight face, listening with no indication of amusement</i>	0	<i>Negative grimace</i>
1	<i>Smile movement or lip curl</i>	1	<i>No response</i>
2	<i>A grin; smile with teeth showing</i>	2	<i>Half or slight smile</i>
3	<i>A laugh, smile or grin accompanied by body movements usually associated with laughter</i>	3	<i>Full smile</i>
4	<i>A big laugh</i>	4	<i>Laugh</i>
		Note. Redlich, Levine, & Sohler (1951) report high reliability for this scale	

Note. Some express concern about distinguishing between genuine *Duchenne* and socially polite *Non-Duchenne* laughter and smiles (Martin & Lefcourt, 1983). Mouth expressions in both are identical, but *Duchenne* expressions involve contractions of the orbicularis muscle surrounding the eyes (Duchenne de Bologne, 1862). *Duchenne* laughter is accompanied by audible laughter (Martin & Lefcourt, 1983). But the eyes are not available for observation using the current methods, and social smiles were not considered a confound in this situation.

Appendix B Participant questionnaire: A short questionnaire:*To be filled out by participant:*

Age:		Gender:		Did you recognise the music?	
Undergraduate student:				Subject enrolled in:	
What emotion did the music elicit in you?					
Do you have any hearing difficulties, if so please state what:					
Native language:					
Did you suspect the experiment was about laughter before we started?					
Any Comments?					

Thank you for taking part in this study.

To be filled out by experimenter:

Participant number:		Experimental Group (N1/P2/C3):	
Place where tested:			
Decipher true nature:		Recognise the music?	
Time tested:		Date tested:	
Smile at all?		Laugh at all?	

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Adrienne Wood

University of Virginia, Charlottesville, USA

This paper presents an ambitious study that incorporates several hypotheses about laughter: 1) That people will laugh more with a friend vs a stranger, 2) That people will laugh more following a mild negative mood induction, as a sort of “undoing” of that negative mood, and 3) That the “undoing” effect will be moderated by being in the presence of a friend or stranger. These hypotheses are extremely interesting and merge ideas about laughter as social signals with ideas about laughter as emotion regulation.

The study design has several limitations that the authors need to address in the discussion more fully. The most important, in my mind, is that this turned out to not be a study about laughter production because the participants did not do much laughing. The key dependent variables are measures of smiling. And yet the introduction focuses on laughter and the discussion begins by saying “The present study asked whether laughter produced in the context of negative emotions was modulated by social context.” It is more accurate to say that the study is about whether *hearing* laughter after a negative mood induction has behavioral consequences that depend on social context. Similarly, the title might be more accurate as “Hearing laughter down-regulates...” rather than “Laughter...” because the latter implies the participants were laughing. There are other methodological limitations, described below, that are also worth mentioning in the discussion. For instance, it is unclear with the current design whether the participants’ mirth displays are responses to the laughter stimuli, to the mood manipulation, or both. Finally, my biggest concern about the analyses that isn’t an issue of interpretation is the use of ANOVA for a categorical outcome variable, Peak Mirth.

Introduction:

1. The introduction is quite short and all the references are at least 15 years old. I recommend incorporating more recent work.
2. The paragraph about the “undoing” hypothesis confuses laughter—which you established in the previous paragraph as being a highly social behavior—with positive emotions. For instance, the Fredrickson and Levenson (1998) paper is not about laughter undoing

negative arousal; it's about happiness undoing arousal. It's not directly relevant here.

Method:

1. The familiar and unfamiliar participants were recruited through different channels, and may therefore differ systematically in any number of sociodemographic or personality dimensions. People tend to be friends with similar others, so is it possible that the "familiar" participants are all more similar in personality to the experimenter, and may share a tendency towards positive affect? This represents a confound in the study design.
2. What did you do to reduce experimenter demand, given that the experimenter had to know which condition the participants were in (familiar vs unfamiliar)? The experimenter might have unintentionally acted differently with friends versus strangers.
3. Why did you only code the first 30 seconds of participants' behavior when the laugh track played for 75 seconds?
4. Did you use a correlation to quantify the inter-observer agreement? I don't think this is the best approach because one person could be systematically biased to underestimate the duration, but still be highly correlated with the other rater.

Results:

1. Please report the means and standard deviations for self-reported mood in the 3 emotion conditions (manipulation check).
2. The Peak Mirth dependent variable is categorical, so a regular ANOVA is not appropriate. For instance, see Jaeger (2008) for details.
3. Could you more clearly explain the mean difference equation for calculating effect sizes? I assumed it was the difference between two groups' means, but then I realized that isn't right because the reported effect for Peak Mirth (1.05) is not the difference between means (3.27 and 1.97). it's also not Cohen's d, as far as I can tell.
4. We can't conclude that the prolonged smiling in the familiar-fear condition (compared to unfamiliar-fear) condition is really about laughter down-regulating the fear. You would have needed a control condition in which people didn't hear laughter after listening to fear-inducing music. Then you would know that the smiles are actually a response to the laughter-following-fear as opposed to just being a response to the fear (and not the laughter). In other words, the effect could equally be summarized as, "people smile more after hearing scary music if they are with a friend," with no reference to the laugh track. Another solution would be to code the mirth displays of the participants while they listened to the music—then you can see whether the laughter indeed caused them to smile, or whether they were smiling more even while the fearful music was playing.

Discussion:

1. As I mentioned at the top, please modify the entire paper so it does not mislead the reader into thinking your results are about participant laughter production. For instance, examples from the discussion where you imply that the findings are all about participant's laughter: "Although it was theorised that the significant interaction in the fearful affect condition was

driven by more laughter amongst participants who knew the experimenter, it could be driven by less laughter in participants unknown to the experimenter.” And here: “These results suggest that the strongest stimulus to laugh and express is when participants are amongst familiar company and experience a transition from a fearful to positive affective state.”

2. In the discussion, if you’re going to state that (descriptively but not significantly) “familiar participants also laughed for longer than unfamiliar participants in the fearful affect condition”, then please report the supporting means and SDs in the results section.
3. Please clarify how your pre-recorded laughter induction is “naturalistic,” as you say in the discussion: “A strength of this experimental design was the use naturalistic methodology to evoke laughter, a sensitive emotion notoriously difficult to evoke in experimental situations.” Readers might object to this statement since it is a fairly unnatural situation the participants find themselves in, listening to decontextualized laughter while blindfolded.
4. You mention the “relief” hypothesis of laughter in the discussion. Could you say more about how this is different from the “undoing” hypothesis and where they make different predictions?

Minor:

1. This line in the introduction is circular, with laughter coordinating the behavior of laughter: “Within interactions, laughter regulates mood and coordinates the behaviour of laughter through a group”.
2. I think you need to change the “less than” sign to “greater than” in this sentence from the Peak Mirth results: “The peak mirth scores of familiar and unfamiliar participants did not significantly differ, $F(1, 84) = 1.73, p < .05$ ”.
3. The paragraph from the Discussion that begins “Humor is involved in the formation, maintenance...” feels more appropriate for the intro (plus the intro could use more meat anyway).

I hope this feedback is useful. I look forward to seeing the next version of the paper and future work on this topic.

References

1. Jaeger TF: Categorical Data Analysis: Away from ANOVAs (transformation or not) and towards Logit Mixed Models. *J Mem Lang*. 2008; **59** (4): 434-446 [PubMed Abstract](#) | [Publisher Full Text](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

No

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Nonverbal behavior, social interaction, laughter

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 08 July 2022

<https://doi.org/10.5256/f1000research.55344.r140601>

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Luísa Soares

University of Madeira, Funchal, Portugal

The paper is interesting, and innovative. It also has scientific support to enrich the clinical psychologists in science and in practice. The procedures are very well presented and analyzed in the results and discussion.

The theoretical review is very updated and with good classical literature. The references are well presented. However, the English needs minor review.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: clinical psychology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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