

Full Length Article

Does Singing Facilitate Social Bonding?

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Abstract

Psychobiological effects of amateur choral singing were studied in a naturalistic controlled within-subjects trial. A mixed group of novice and experienced singers (N = 21) filled out brief *ad hoc* questionnaires of psychological wellbeing and gave samples of saliva for measuring levels of salivary oxytocin, cortisol, and dehydroepiandrosteron (DHEA) at the beginning of 2 rehearsal sessions and 30 minutes later. The singing condition included warm-up vocal exercises and repertoire pieces. In the chatting condition, dyads of participants talked to each other about recent positive life experiences. Within-subjects, repeated measures analysis of variance (ANOVA) on self-reported and physiological measures revealed significant Time X Condition interactions for psychological wellbeing and oxytocin. Comparisons of mean scores showed patterns of changes favouring singing over chatting. There were no significant interactions for cortisol, DHEA as well as for the cortisol-DHEA-ratio. These results suggest that singing enhances individual psychological wellbeing as well as induces a socio-biological bonding response.

Keywords: *Amateur singing, Psychological wellbeing, Oxytocin, Cortisol, Dehydroepiandrosteron*

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Introduction

Why do people like gathering and singing together in groups? Some evolutionary theorists suggest that singing may have evolved as a means to facilitate social bonding [1], group cohesion [2], or to enhance pro-social, cooperative behaviors as well as empathy between individuals [3]. One implication of these theories is that singing should provoke the release of so-called social hormones such as, for example, oxytocin [4]. The present research was designed to test this assumption in a naturalistic setting.

Recent studies suggest that singers even without any formal training may experience flow (a psychological concept related to perceived happiness) during group singing [5]. Members of amateur choral societies frequently report a range of psychological, e.g., enhanced feelings of positive affect and energy, and physical benefits, e.g. improved posture, breathing, or physiological arousal, in response to singing [6] (for a recent review see [7]). In fact, psychological benefits of

group singing have been affirmed in a systematic review as one of the robust findings of a body of research [8], which is otherwise characterized by lack of theory-building and frequent methodological flaws [7]. Notably, chronic illness is not uncommon among amateur choristers [9,10]. According to qualitative self-reports, singing is often used as a means to manage the psychological side-effects of a range of psychosomatic and physical disorders including arthritis, lung problems, chronic pain, or cancer [11].

Psychoneuroendocrine responses to music have been studied in various naturalistic settings including music listening and singing [12,13]. For example, Beck, Cesario, Yousefi & Enamoto [14] reported differential effects of rehearsing and singing in public on immune and stress responses in semi-professional singers. Some participants showed several-fold increases of salivary Immunoglobulin A (s-IgA) after two hours of singing. S-IgA is a protein that is released in the mucous tissues of the upper respiratory tract and considered the first line of defense against bacterial and viral infections [15]. By contrast, cortisol, a stress hormone that is key to the hypothalamic-pituitary-adrenal-system (HPA-axis; [16] was found to increase during public choral performance [14]. Kreutz, Bongard, Rohrmann, Hodapp, & Grebe [17] found that increases of S-IgA were present during singing only, but not during listening to choral music. In the same study, cortisol concentrations decreased during the latter condition and remained constant during singing.

Oxytocin (OT) is a hormone that is associated with procreation in animals [18] as well as with intimate relationships and buffering stress in humans [19,20]. Accordingly, it is considered as a biological correlate of social

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affiliation throughout life [21,22]. Increases of OT were found in patients after open-heart surgery, when they listened to soothing music [23]. In one study, which is most similar to the present endeavor, Grape, Sandgren, Hansson, Ericson, & Theorell [24] found that OT increased in both amateur and professional singers after 30 minutes of a singing lesson. In the same study, the amateur singers only reported increasing joy and elatedness after singing.

Dehydroepiandrosteron (DHEA) is an androgen produced by the adrenal cortex affecting various bodily functions. Recently, DHEA has been implicated as anti-ageing [25,26]. Because DHEA functions as antagonistic to cortisol, increase in the cortisol/DHEA ratio is associated with higher infection risk in older adults [27]. Positive effects of exercise on immunity using this measure have been observed in older adults [28]. Music-related studies on DHEA have remained inconclusive. Whereas DHEA was found unchanged, decreased cortisol/DHEA ratios have been observed in at least three studies [29-31].

In sum, these various strands of research converge in suggesting positive psychological effects of amateur singing on individual health. Therefore, it was hypothesized that singing in groups leads to significant increases in individual self-reported measures of wellbeing and in decreases of negative affect. Moreover, it was expected that group singing would induce significant increases of oxytocin. Finally, it was expected that singing leads to significant decrease of the cortisol-DHEA ratio, which is considered a biological marker of psychophysiological wellbeing. Contrary to singing, it is expected that talking to each other does not evoke similar psychologically beneficial and/or hormonal effects as does singing.

Materials and methods

Recruitment of Participants

Participants were recruited by advertisement via television (Westdeutscher Rundfunk, WDR, Cologne). There were no limitations as to which individuals might apply for participation in terms of demographic variables, ethnicity, health status, or the like. However, individuals with little or no prior singing experience were particularly encouraged to be interviewed for the study. The interviews were conducted in small groups and involved informal questioning of the prospective choristers about their motivations and prior singing experiences. In addition, they were asked to reproduce a musical scale played by the choir master by singing a few tones, in order to see, if prospective participants would show a minimum of motivation for singing at all. There were no rejections on the basis of the interviews, because all applicants met these requirements. However, the recruitment procedure ceased with the inclusion of the 40th chorister for logistic reasons as well as to ensure a sufficient sample for the prospective research study. Participants attended a series of 10 rehearsals in which a pre-selected repertoire of pieces was

prepared for public performance at the end of the rehearsal period. Participation was free of charge and subject to varying numbers of attendees between rehearsals.

Participants

A total of 40 choristers originally took part in the study. 10 individuals dropped out over the rehearsal period, but gave no reason for leaving the choir, except for a few individuals who indicated a conflict with other obligations. The 2 experimental sessions were attended by 24 and 25 individuals, respectively. Within this cohort 21 participants (16 female, 5 male; age groups: 18-24: 1; 25-49: 7; 50-65 years: 14) were identical in both sessions. The arbitrarily selected age groups suggest a median age of over 50 years in this cohort. 9 participants reported no previous experience in choral singing at all. The other 12 participants had been singing at least for one year with a maximum of 40 years (Median = 5.5 years). None of the singers were currently enrolled in any other chorus. 12 individuals reported to be taking pharmaceutical medication. Of these, 9 were suffering from chronic illness, whereas 4 indicated other reasons for their prescriptions. To respect individual integrity and privacy, participants were not required to provide more detailed health information. Thus, to explore the potential influences of these between-subjects measures, choral experience and taking medication were considered in the ANOVA model.

Questionnaires

General questionnaires on basic demographics (sex, age group), music and singing background as well as health status and medication were administered. They were designed to inform about previous experiences in instrumental and singing lessons as well as the years of singing activities, particularly memberships in choral societies.

To assess psychological changes during the different conditions, an ad hoc questionnaire of subjective feelings was developed. It consisted of four target items, two positive: (“I am feeling well” [“Ich fühle mich wohl.”]; “I am in good spirits.” [“Ich fühle mich guter Dinge.”]); and two negative: “I am feeling tired” [“Ich fühle mich müde.”]; “I am feeling bored.” [“Ich fühle mich gelangweilt.”]. In addition, four filler items were included, which were not considered in the analyses. Each item was rated on a 7-point Likert-type rating scale, with 1=“not at all” [“trifft gar nicht zu”] and 7=“very much so” [“trifft völlig zu”].

Design and Procedure

2 out of 10 subsequent rehearsal sessions (sessions 7 and 8) were selected to implement the research protocol. Each involved one baseline and one follow-up measurement after 30 minutes. At these points of time each participant filled out the psychological feelings questionnaire and gave saliva. All

participants provided informed consent individually before the study began.

In the singing condition (session 7), which was led by the choir master, every attempt was made to preserve the naturalistic character of this intervention. Importantly, no interruptions by the experimenter or changing tasks took place in the 30-minute period between the baseline and follow-up measurements. The rehearsal began with approximately 10 minutes of warm-up exercises that was followed by rehearsing sections of pre-selected repertoire pieces. The rehearsed music was chosen by the television producers as part of a preconceived programme for a public performance of the choir in a philharmonic concert hall in Cologne, which took place after the last session of the rehearsal period had been completed. However, the television crew documenting the development of the project in other rehearsal sessions and at the concert was not present during the data collection sessions. The programme included three pieces in four-part choral arrangements for soprano, alto, tenor, and bass. Indeed, the particular piece that was rehearsed during the remaining approximately 20 minutes after the warm-up was a four-part version of *California Dreamin'*, a well-known pop song composed by John Phillips and first performed by The Mamas and the Papas in 1965 (see *Appendix*). The two pieces that were rehearsed at other occasions were *Irgendwo auf der Welt [Somewhere in this world]*, composed by Werner Richard Heymann in 1932, and *Falling Slowly*, composed by Glen Hansard and Markéta Irglová in 2006.

The rehearsal was conducted in sections from individual as well as combinations of parts of the song such that – with some intermission in which the choir master gave instructions on technical and expressive aspects of the performance – all choristers were engaged in singing for at least 10 minutes before the second measurement took place.

By contrast, in the chatting condition (session 8), the participants were instructed to have a chat with their neighbor sitting next to them about recent positive life events for 10 minutes. To model the exposure to the choir master's verbal instructions at the time of the singing rehearsal, a short paragraph on the origins of singing were read aloud to the participants, before they swapped seats with their neighbors in order to form new pairs to continue chatting about recent positive life events for another period of ten minutes. Then again, a short paragraph was read aloud about the origins of singing. The whole procedure was repeated a third time such that for each ten-minute pairwise chats, novel pairs of chatters were formed.

Participants were asked to remain seated throughout in the singing and chatting conditions. The conductor ensured by appropriate gestures that the loudness level during chatting should not exceed a certain limit. Participants reported no complaints or difficulties while chatting to each other.

Hormone collection and analysis

Saliva was collected by Salivetts® (Sarstedt, Germany). Participants were asked to spit into the tubes until filled with about 10-15mm of saliva from the bottom. Salivettes were kept ice-chilled and sent to the lab¹ via express mail. Saliva samples were centrifuged at 4 °C at 1500g for 15 min, and the liquid samples stored at –20 °C until assayed. The dry samples were reconstructed in the assay buffer immediately before analysis. Trained medical personnel conducted all preparations and processing of the saliva samples in strict accordance to the instruction manuals of the respective ELISA kits (see below). In particular, routines to guard against potential inference effects were installed where appropriate and multiple measurements were performed and the concentrations of samples were calculated according to relevant standard curves.

Determination of Hormone concentrations

Determination of hormones was performed using commercial ELISA kits (DRG Instruments GmbH, Marburg, Germany). The use of the specific kits (Oxytocin: EIA-3117; cortisol: SLV-2930, Dehydroepiandrosterone: SLV-3012) was consistent with previous research (e.g., [19]). Details concerning the assay procedures, norms, and quality control measures are presented in the respective user's manuals.

Data analysis

The IBM SPSS Statistics® package 20.0 was used for all descriptive and inferential statistics. A series of 2 x 2 repeated measures analyses of variance (ANOVAs) were run with condition (singing/chatting) as the within-subjects and time (baseline/30 minutes later) as the repeated measure. With a given minimum sample of $n=21$ and an expected effect size $f=.4$ ("large effect") the critical F-value required to detect significant interactions was determined at $F(1,20)=3.861$.

Results

Table 1 shows the mean scores of the self-reported positive and negative feelings at the beginning of each session and 30 minutes later. A significant Time X Condition interaction emerged for positive feelings [$F(1,20)=9.655$, $p<0.01$, $\eta^2=.326$], and this effect was robust after the inclusion of either taking medication or choral experience as a between-subjects factors. Subsequent comparisons of means show that positive feelings increased significantly after both singing [$t(21)=5.593$, $p<.01$] and chatting [$t(20)=2.400$, $p<.01$]. A significant interaction was also observed for negative feelings [$F(1,20)=4.735$, $p<.05$, $\eta^2=.191$]. This interaction dropped to a trend ($p<.1$) after the inclusion of either taking medication

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		Condition			
		Singing		Chatting	
		M	SEM	M	SEM
Positive feelings	Before session	3.705	0.276	3.952	0.241
	30 minutes later	5.386	0.267	4.546	0.273
Negative feelings	Before session	2.727	0.252	2.762	0.277
	30 minutes later	1.864	0.201	2.796	0.349

Table 1: Positive and negative feelings before and after singing and chatting; M = Mean; SEM = Standard Error of Mean.

or choral experience as a between-subjects factor. Subsequent comparisons of means show that negative feelings decreased significantly after singing [$t(21)=3.0448, p<.01$], but not after chatting [$t(20)=.336, p=.741$].

Table 2 shows the mean scores of the biological markers at the beginning of each session and 30 minutes later. A significant Time X Condition interaction emerged for oxytocin (OT) [$F(1,21)=7.988, p<0.05, \eta^2=0.276$], and this interaction was unchanged by the inclusion of taking medication and choral experience as between-subject factors. Subsequent comparisons of means show that OT increased significantly after singing [$t(21)=12.300, p<.001$], but not after chatting [$t(21)=1.289, p=.21$]. The median of oxytocin concentration increases was 39.46 % (SD=29.13) with the lowest at 15.97 and highest individual increase at 142.62 %. It should be noted, however, that high relative increases do not necessarily reflect high absolute levels of concentrations. In other words, although no single decrease of OT concentrations was observed across subjects in the singing condition, the absolute levels varied considerably from individual to individual.

A final set of ANOVAs was run for cortisol, DHEA, and for the cortisol/DHEA ratio. No significant interactions emerged in any of these analysis. The direction of changes of mean cortisol/DHEA values, which were of greatest interest in the present study, was contradictory to the hypothesis being tested. However, these differences did not even mark a trend.

These findings remained unaffected by logarithmic transformation of the hormone measures.

Discussion

It was hypothesized that singing in groups leads to significant increases of behavioral as well as of biological indicators of psychophysiological wellbeing. In particular, we expected higher values in these measures after singing as compared to chatting. These hypotheses were confirmed for self-reported positive and negative feelings as well as for oxytocin, a hormone that is associated with stress reduction as well as social bonding [3,4]. No changes were found with respect to the cortisol/DHEA ratio. The implications of these findings will be discussed below.

The finding that psychological measures of wellbeing increased during singing is in line with previous research using different measurement instruments such as the Positive and Negative Affect Schedule (PANAS; [17]), the Profile of Mood States (POMS; [34]), or visual analogue scales [24]. Thus the present findings corroborate the view that half an hour of singing is sufficient to enhance perceived psychological wellbeing. It is of note that in our study chatting in dyads also led to relatively smaller amounts but still significant increases in positive feelings. Chatting, however, was not associated with reduced negative feelings as represented in a combined measure of tiredness and boredom, whereas singing did show such a significant decrease at group

		Condition			
		Singing		Chatting	
		M	SEM	M	SEM
Oxytocin (pg/mL)	Before session	13.044	1.141	14.282	1.404
	30 minutes later	18.083	1.316	15.898	1.392
Cortisol (ng/mL)	Before session	2.611	.135	2.233	.134
	30 minutes later	2.997	.110	3.017	.308
DHEA (pg/mL)	Before session	217.41	35.86	197.11	27.96
	30 minutes later	184.30	41.77	139.07	21.44
Cortisol/DHEA	Before session	28.051	64.114	16.880	13.951
	30 minutes later	33.262	27.042	29.350	21.056

Table 2: Oxytocin, cortisol, dehydroepiandrosteron (DHEA) and cortisol/DHEA ratios before and after singing and chatting; M = Mean; SEM = Standard Error of Mean; ng/mL were converted to pg/mL for cortisol before calculating the cortisol/DHEA ratio.

level. Note that baseline values in both conditions were already in a more positive range for positive feelings and in a more negative range for negative feelings. This means that participants showed little indication of irritation or stress at the beginning of each session. In a previous study, in which singing was compared to listening to choral music, a quite different pattern of psychological changes was found. In particular, positive affect was unchanged after listening, whereas negative affect increased [17]. Therefore, listening to music may not always be superior to induce positive affect as compared to other vocal interventions such as chatting about pleasant life events.

To our knowledge, this is the first study to reveal that concentrations of salivary oxytocin (OT) increased during singing but not during chatting in the same group of individuals. A previous study also has shown increases of OT after singing [24]. However, that study looked at singers receiving individual singing lessons and did not include a control condition. The present findings thus confirm the main hypothesis that singing induces a sociobiological bonding response that is similar to those elicited during intimate social relationships [22]. Interestingly, such social bonding responses are not evoked by verbal communication, even when positive topics during conversations are encouraged. These patterns of findings thus offer support to evolutionary theories suggesting that singing and music emerged to enhance social bonding and mutual attachment in larger groups of individuals. Informal follow-up questioning of the choristers in this study indicated a high interest in sustaining the choral activities in the same group. In fact, a previous survey among 3145 choristers [35] revealed an average experience of 19.5 years of singing. This means that since the first commencement in singing activities (mostly during childhood and adolescence), singing was absent for only 4 to 5 years in the choristers' lives as adults. In other words, amateur choristers often ascribe high priority to singing as their main long-standing leisure activity in adulthood. In light of the present finding, such strong attachment to group singing may be explained, at least in part, by sociobiological bonding responses as observed in the present study.

An important facet of OT responses in social relationship is so-called affect synchrony. According to one study, the "temporal coordination between the parent and infant's affective behavior is an important component of sensitive parenting that contributes to infant development" (p. 753) [38]. In fact, these authors observed that OT accounted for a significant amount of variance in predicting parental affect synchrony with their infants. However, affect synchrony also occurs in intimate relationships among adults with the implication of reducing attachment anxieties and buffering stress.

Finally, there was no effect observed with respect to changes of the cortisol/DHEA ratio. Determination of this ratio is considered an improvement over measuring these hormones in isolation. Previous research has shown this ratio to decrease in response to music, while DHEA was unchanged

(see [36] for a summary). The change of means in the present study did not point into this direction. Clearly, further research is needed that should include extensive baseline measurements and a longer intervention period to uncover patterns of changes of this ratio in a more systematic fashion.

Limitations

One obvious limitation of the present study arises from the 2 conditions, in which singing in a group was compared to chatting in dyads only. Although an attempt was made to model the choirmaster's instructions in the singing condition as short oral presentations in the chatting condition, there cannot be certainty whether the collaborative use of the singing voice is the only remaining difference between the two conditions. For example, the song lyrics could have induced more positive feelings than the verbal exchange of positive life events.

With respect to the *ad hoc* measures of positive and negative feelings in this study, it is of interest that both quantitative and qualitative responses of different kinds have produced converging evidence by showing that positive emotions might increase after singing [6]. For example, reduction of tiredness after both singing and listening to music occurred in another study on group singing [34]. The present findings confirm that singing is effective in inducing positive changes in these psychological variables.

Although positive feelings were assessed, there were no direct behavioural measures taken with respect to social bonding. In fact, it seems feasible to ask about the degree of enjoyment of participating in the respective activities. However, an even stronger indicator of attachment obviously is commitment. A large proportion of members of the chorus subscribed to continue singing with their choirmaster beyond the official termination of the choir. This continued interest in singing with the same group of people suggests that social bonding was successfully evoked during the sequence of 10 rehearsal sessions.

Another limitation arises from the fact that in the previous study on oxytocin-increasing effects of singing, OT was measured in plasma while the present study used saliva samples instead. However, previous studies suggest significant correlations between plasma and salivary OT at the level of $r=.46$ ([37], p. 673), and $r=.41$ ([38], p. 756). Since both measures were also associated with behavioural variables in each of the cited studies, they appear to reflect relevant biological activity of this hormone.

Conclusions

The present study shows that group singing may lead to increases in positive feelings, decreases in negative feelings as well as to increases in the release of the hormone oxytocin, which has previously been implicated in intimate social bonding [32,33,38]. By contrast, the cortisol-DHEA ratio

remained unaffected. Taken together, these findings support the theory that singing facilitates social bonding.

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Biographical Statement

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Appendix

California Dreamin'

Singgemeinschaft Hard

John Phillips/Michelle Phillips
Arr. Axel Girardelli

The musical score is arranged for three voices: Frauen (Soprano), Tenor, and Bass. It is in 4/4 time and the key of B-flat major. The score consists of four systems of music. Each system includes vocal lines with lyrics and a piano accompaniment line. The lyrics are: "All the leaves are brown and the sky is grey. I've been for a walk on a winter's day. I'd been save and warm, if I was in L. A. I'd be safe and warm if I was in L. A." The piano accompaniment features a prominent bass line and chords that support the vocal melody. There are some corrections in the lyrics, such as "save" instead of "safe" and "L. A." instead of "L. A." in some instances.

California Dreamin' Seite 2

Ca - li - for - nia, Ca - li - for - nia dream - in on such a win - ter's
Ca - li - for - nia dream - in'
Ca - li - for - nia dream - in'

day.
day.
day.
Stepped in - to a church

I passed a-long the way. Oh, I get down on my knees,
get down on my knees
get down on my knees

I pre - tend to pray.
and I pre - tend to pray,
I pre - tend to pray.
you know the prea - cher likes the

Prea - cher likes the cold
cold,
Prea - cher likes the cold
he knows I'm gon - na stay
knows I'm gon - na stay
knows I'm gon - na stay

California Dreamin' Seite 3

Ca - li - for - nia Ca - li - for nia dream - in' on such a win-ter's
Ca - li - for - nia dream - in'
Ca - li - for - nia dream - in'

day.
day.
day.

15
15

All the leaves are brown
All the leaves are brown, and the sky is grey.
All the leaves are brown -

and the sky is grey - , I've been for a walk
I've been for a walk
and the sky is grey - I've been for a walk

on a win-ter's day.
on a win-ter's day, If I di - dn't
on a win-ter's day.

California Dreamin' Seite 4

First system of musical notation for 'California Dreamin''. It consists of three staves: Treble, Alto, and Bass. The lyrics are: 'If I did - n't tell her I could leave to - day'.

Second system of musical notation. The lyrics are: 'Ca - li - for - nia, Ca - li - for - nia dream - in', Ca - li - for - nia dream - in' on such a win - ter's Ca - li - for - nia, Ca - li - for - nia dream - in',

Third system of musical notation. The lyrics are: 'Ca - li - for - nia dream - in', Ca - li - for - nia dream day, on such a win - ter's day, Ca - li - for - nia dream - in', Ca - li - for - nia dream

Fourth system of musical notation. The lyrics are: '- in' day. on such a win - ter's day. - in' day.