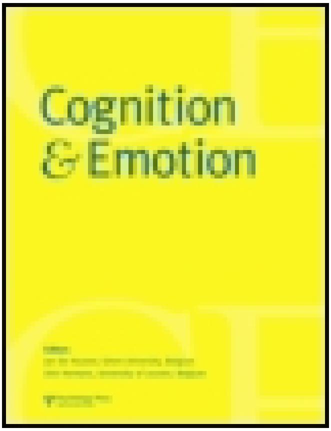

Cognition and Emotion
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/pcem20

Respiratory feedback in the generation of emotion

Pierre Philippot , Gaëtane Chapelle & Sylvie Blairy
Published online: 09 Sep 2010.

COGNITION AND EMOTION, 2002, *16* (5), 605–627

Respiratory feedback in the generation of emotion

Pierre Philippot and Gaëtane Chapelle

Université de Louvain, Louvain-la-Neuve, Belgium

Sylvie Blairy

Université du Québec à Montréal, Canada

This article reports two studies investigating the relationship between emotional feelings and respiration. In the first study, participants were asked to produce an emotion of either joy, anger, fear or sadness and to describe the breathing pattern that fit best with the generated emotion. Results revealed that breathing patterns reported during voluntary production of emotion were (a) comparable to those objectively recorded in psychophysiological experiments on emotion arousal, (b) consistently similar across individuals, and (c) clearly differentiated among joy, anger, fear, and sadness. A second study used breathing instructions based on Study 1's results to investigate the impact of the manipulation of respiration on emotional feeling state. A cover story was used so that participants could not guess the actual purpose of the study. This manipulation produced significant emotional feeling states that were differentiated according to the type of breathing pattern. The implications of these findings for emotion theories based on peripheral feedback and for emotion regulation are discussed.

It is commonly agreed that emotion is best conceived of as a multicomponent process whose most central components include appraisal, facial expressions, physiological responses, and subjective feeling states (i.e., Buck, 1985; Ekman, 1984; Russell, 1991; Scherer, 1984). One of the oldest debates in emotion psychology addresses the specification of the relations existing among these different components. Historically, this debate can be traced back to William James' (1884) peripheral theory of emotion, which stated that subjective feeling states were merely the phenomenological result of body state. This position was vigorously counter-attacked by Cannon (1927) who attempted to prove that

Correspondence should be addressed to Pierre Philippot, Faculté de Psychologie, Université de Louvain, place du Cardinal Mercier, 10, B- 1348 Louvain-la-Neuve, Belgium, e-mail: Philippot@clis.ucl.ac.be

The studies presented in this paper have been made possible by a grant from the Fonds National de la Recherche Scientifique de Belgique. The authors appreciate helpful comments by Robert S. Feldman, Ursula Hess, Arvid Kappas, and two anonymous reviewers on earlier drafts of this paper.

http://www.tandf.co.uk/journals/pp/02699931.html DOI:10.1080/02699930143000392

body changes followed subjective feeling states. As reviewed at the occasion of the centennial anniversary of William James' (1890) Principles of Psychology (*Personality and Social Psychology Bulletin*, 1990), this theoretical debate is far from being closed.

Presently, three main conceptions of the relationship between emotional feelings and body states can be found in the literature. One conception—that we will label the ''undifferentiated arousal model''—states that autonomic responses increase as a function of emotional intensity but that their pattern is undifferentiated across emotions (Reisenzein, 1983; Schachter, 1964). At the functional level, the undifferentiated arousal model predicts that the perception of emotional intensity can be influenced by arousal intensity (i.e., that individuals' perception of the intensity of their emotional states is not only a function of their evaluation of the situation but also of the intensity of their state of arousal). Research in this area has focused on the effect of the manipulation of undifferentiated arousal on the intensity—but not on the quality—of subjective feeling state. As reviewed by Reisenzein (1983) or Kirouac (1995), the strong and consistent finding from this line of research is the intensification of the emotional feeling state following exposure to an arousing stimulus, an effect known as ''activation transfer'' (Zillmann, 1979, 1983). From this perspective, to influence subjective feeling intensity, arousal must be (a) consciously perceived and (b) subjectively attributed to the impact of the emotional situation.

Another conception, which we will label the ''cognitive appraisal model'', proposes that body changes in emotion are a function of cognitive appraisal (e.g., Pecchinenda & Smith, 1996; Scherer, 1984; Smith & Kirby, 2000) or of the direct output from appraisal, action readiness (Frijda, 1986). More precisely, this model suggests that the activation of a specific appraisal dimension would induce specific body changes. For instance, novelty appraisal would induce a pause in breathing and a deceleration followed by an acceleration of heart rate. The pattern of body changes with a specific emotional state would be the sum of the changes induced by each appraisal component. As different feeling states result from different appraisal patterns, they are also characterised by different patterns of body changes. In the cognitive appraisal model, the role played by body changes in the elicitation of feeling state is less explicitly stated and definitely marginal, the central role being played by cognitive appraisal.

A third conception, which we will label the ''central network model'' states that emotions are centrally organised by neural or cognitive networks that connect the different emotion components together. For some, these networks are innate neural structures (e.g., Ekman, 1999; Izard, 1979; Tomkins, 1980); for others, they are cognitive networks or schemata that develop as a function of individuals' experiences (e.g., Lang, 1979, 1984; Philippot & Schaefer, 2001; Teasdale, 1996). Although the theories we gather under the central network model differ in many ways, they all share similar features with respect to the patterning and function of body changes in emotion. First, they all postulate that patterns of body changes are differentiated according to the type of emotion experienced, even if cognitive network theories predict more idiosyncratic patterns than theories postulating innate neural structures. Second, they posit that the activation of the body state typical of an emotion elicits that emotion, a process known as peripheral feedback. Third, they suggest that peripheral feedback occurs automatically, at an implicit level (i.e., without awareness of the process; Cacioppo, Berntson, & Klein, 1992; Damasio, 1994; Teasdale, 1996). The implication of these three postulates is that a specific emotion could be induced by manipulating one's body state, outside of this person's awareness of the process.

At the empirical level, the central network model is supported by research addressing the relation between facial expression and subjective feeling states, the research area investigating the ''facial feedback hypothesis''. A wealth of evidence has documented that manipulating facial expression affects feeling state (Laird, 1984; Manstead, 1988; Matsumoto, 1987; McIntosh, 1996). The effect size of the so-called facial feedback is generally small (around 13% of explained variance) but reliably significant. The impact of facial muscle manipulation has been extended to physiological changes, such as heart rate or skin temperature (Hess, Kappas, McHugo, Lanzetta & Kleck, 1992; Kappas, 1989; Levenson, 1992; Levenson, Carstensen, Friesen, and Ekman, 1991; Levenson, Ekman & Friesen, 1990). Further, Stepper and Strack (1993) have documented that manipulating posture also has an impact on subjective feeling states and affects later judgement of valenced material, extending previous findings from Duclos et al. (1989) showing that posture affects mood. Overall, there exists empirical evidence that manipulating facial or postural muscles affects subjective feeling states, and possibly physiological states, outside of individuals' awareness of the process. Still, the underlying mechanism of facial feedback is the object of a controversy (e.g., Izard, 1990; Laird, 1984; McIntosh, 1996) and the interpretation of the effect of facial manipulation on physiological changes in terms of facial feedback has been questioned (e.g., Boiten, 1996; Zajonc & McIntosh, 1992).

We propose that three questions must be addressed to further our understanding of the relationship between body state and subjective feelings. First, are subjectively differentiated feeling states characterised by different body states? Second, does body state influence the intensity and/or the quality of subjective feelings? Third, does this influence operate implicitly (i.e., outside of individuals' awareness of the process), or explicitly? This latter question is particularly important as explicit knowledge about body changes may not relate to actual body changes (Rimé, Philippot, & Cisamolo, 1990; Philippot & Rimé, 1997) and as several recent theories issued from the central network model are based on a distinction between implicit and explicit processing (e.g., Damasio, 1994; Teasdale, 1996; for a review see Philippot & Schaefer, 2001). The undifferentiated arousal model postulates that emotional body states are undifferentiated and have an explicit impact on feelings intensity but not quality. The central network model posits that emotional body states are differentiated and influence the quality of feeling states and that these effects can occur at an implicit level. The cognitive appraisal model is vague and unspecific about whether and how changes in physiological patterns might influence emotional feeling states.

At the empirical level, the first question—the peripheral differentiation of emotion—is still the object of a controversy, with different reviews reaching different conclusions (Levenson, 1992; Stemmler, 1992; Zajonc & McIntosh, 1992). With respect to the second and third questions, the activation transfer research mentioned above has shown that arousal can explicitly affect the intensity of feeling state, provided that it is attributed to an emotional cause; the facial and postural feedback research has demonstrated that muscular feedback can influence subjective feeling state outside of individuals' awareness of the process. Yet, despite its theoretical importance, the possibility of a visceral—and not solely muscular—feedback on the quality of emotional feelings has not been pursued at an experimental level. From this perspective, physiological state should be manipulated, not in intensity but in quality, in order to observe the impact of such manipulations on the nature rather than the intensity of feeling states. Further, it should be established whether this effect occurs without individuals explicitly using body state as a source of information to determine their emotional feeling state. The present studies aim at exploring these neglected questions.

Specifically, they will examine the effects of respiration manipulation on emotional feeling state. We chose to manipulate body state through respiration for four reasons. First, like facial musculature, breathing is under both voluntary and automatic control, allowing for the same types of manipulation as those commonly used in facial feedback research. Second, clinical evidence has repeatedly confirmed relations between breathing and at least one feeling state, anxiety (e.g., Beck & Scott, 1988). Moreover, these studies have also demonstrated the clinical efficacy of respiration manipulation in reducing anxiety through breathing retraining. Third, a recent literature review suggests that reliable respiratory differences might be found between positive or negative feeling states, as well as tense or relaxed feeling states (Boiten, Frijda, & Wientjes, 1994). Fourth, although they can easily be achieved noninvasively, respiration changes affect many physiological responses, such as cardiovascular changes or skin conductance. They thereby constitute an easy but potent avenue to manipulate the whole physiological state of the organism.

In order to induce specific emotions through respiratory manipulations, one has to determine which are the respiratory patterns that correspond to these emotions. One source of such information is constituted by the results of psychophysiological research that observed respiratory changes during emotion induction. Boiten et al. (1994) have reviewed the psychophysiological literature pertaining to respiratory changes occurring during emotion. They note that there is very little empirical work on the topic and that the available studies are fraught with methodological shortcomings. As a result, they conclude that ''it is difficult to draw specific and detailed conclusions concerning the influence of emotion upon respiration'' (Boiten et al., 1994, p. 119). Yet, they were able to identify some consistency across studies that can be summarised as four types of breathing related to emotional state. Fast and deep breathing was associated with excitement, such as in anger, fear, or sometimes even joy. Rapid shallow breathing was typical of tense anticipation, including concentration, fear, and panic. Slow and deep breathing was most often observed in relaxed resting state. Finally, slow and shallow breathing was associated with states of withdrawal and passiveness, such as depression or calm happiness.

As can be seen from these descriptions, few of the four types of breathing identified can be unequivocally associated with a specific emotional state. Two remarks concerning these observations are of importance. First, that psychophysiological research has not identified specific breathing patterns differentiating basic emotions does not necessarily means that such patterns do not exist. This lack of definitive evidence maybe due to under-sophisticated recording of breathing that most often measures only frequency (see the discussion by Boiten et al., 1994, in this respect) or to problems in inducing emotion in psychophysiological experiments (see the discussion of this point by Stemmler, 1989). Second, although no unequivocal correspondence between breathing patterns and emotions can be drawn, these descriptions suggest that: (a) fast and deep breathing might characterise anger, (b) rapid shallow breathing might characterise fear, (c) slow breathing whether deep or shallow might characterise a state of relaxed happiness, and (d) slow and shallow breathing might characterise sadness. These propositions have to be considered cautiously, as, for instance, pattern (a) might also characterise joyful or fearful excitement and pattern (d) might also characterise calm happiness. In sum, although suggestive, the results of Boiten et al.'s review do not provide an empirical basis precise enough to construct breathing instructions specific to basic emotions.

Another source of information regarding emotional breathing patterns pertains to previous studies investigating whether breathing manipulations induce differentiated emotional feeling states. The only existing work has been conducted by Bloch, Lemeignan, and Aguilera (1991) who propose that each of six emotions they qualify as basic (joy, sadness, anger, fear, erotic love, and tenderness) is characterised by a specific facial, postural, and respiratory pattern they labelled ''emotional effector pattern''. [The respiratory components of the patterns were derived from visual inspection of polygraphic records of either actors expressing specific emotions or participants reliving these emotions under deep hypnosis (Bloch, 1994, personal communication), the original report (Bloch & Santibanez, 1972) cannot be obtained.]

The patterns obtained with this procedure differ in several respects from the observations of Boiten et al. (1994). Bloch et al.'s (1991) joy pattern, referring to laughter (quick and deep nasal inspiration, followed by oral expiration with small jolts) is quite different from the pattern associated with calm happiness by Boiten, although it presents some similarities with Boiten's pattern of excitement, but for inspiration only. Bloch et al.'s anger pattern (regular, quick, and deep nasal breathing) corresponds to our prediction derived from Boiten et al. With respect to fear, Bloch et al. propose a quick and shallow inspiration through the mouth, followed by a pause and a long expiration. In contrast, our prediction based on Boiten et al. is that fear is characterised by shallow and fast breathing. Finally, Bloch's proposition for sadness (quick nasal inspiration with jolts followed by a quick expiration through the mouth) does not correspond to our prediction derived from Boiten et al. (i.e., slow and shallow breathing).

In their work, Bloch et al. (1991) have demonstrated that extensively training actors to reproduce these emotional effector patterns results in the induction of the corresponding emotion feeling state. Unfortunately, in these studies, participants were explicitly (a) told that the aim of the training was to produce emotion through respiratory, facial, and postural changes, and (b) informed of which emotional effector pattern was intended to induce which emotion. Hence the effect of these manipulations on feeling states may simply be the result of experimenter's demand. Further, breathing was not manipulated independently from posture or facial expression, hence preventing estimation of the specific impact of each source of peripheral feedback.

In order to confront the divergence between Bloch's patterns and those suggested by Boiten, and given the fact that Bloch et al. (1991) report positive results, we examined in a preliminary study whether the respiratory component of their emotional effector patterns is in itself sufficient to induce a specific emotional feeling state. We replicated the study of Bloch et al. (1991) for four emotions (joy, anger, fear, and sadness) with two major changes. First, in order to avoid experimental demands, we used a procedure in which participants were oblivious to the fact that the actual topic of the study was emotion or emotion induction. Second, in order to disentangle the effect of facial and postural feedback from those of a possible respiratory feedback, we only manipulated breathing, keeping facial expression and posture constant. The results revealed that participants tended to report the target emotion in the joy and anger breathing condition[1], $F(9, 153) = 1.97$, $p < .10$.

In sum, the findings of Bloch et al. (1991) are only partially replicated in the breathing conditions of joy and anger. There are three possibilities accounting for these weak results. First, respiratory feedback may have no effects on emotional feeling states. Second, it is possible that respiratory feedback alone is not a sufficient condition to induce emotional feeling state; it may additionally require the corresponding facial and postural pattern. Along this line, Bloch (personal communication, 16 July 1994) argues that not only the whole

[1]It should be noted that only 20 participants took part in this study and that, although it used a within-subject design its statistical power is consequently weak.

respiratory, facial, and postural pattern needs to be activated, but also that no emotion can be induced if the ''correct'' pattern is not exactly reproduced. (This notion of correctness has also been debated in the context of the facial feedback hypothesis, see for instance, McIntosh, 1996.) Finally, a third possibility is that the respiratory instructions used by Bloch et al. (1991) are not the most appropriate to induce discrete emotions. Indeed, it is unclear how Bloch et al.'s respiratory patterns were originally established (i.e., no statistical analysis are reported and the original report, Bloch & Santibanez, 1972, cannot be obtained). Further, the breathing patterns for joy attempts to mimic laughter, while the one for sadness attempts to mimic crying. Although expressive emotional components, such as laughter or tears, tend to be associated with joy and sadness respectively, this does not necessitate that they determine the breathing patterns associated with these emotions.

STUDY 1

Study 1 was designed to investigate whether different, more precise and accurate breathing instructions than those used by Bloch et al. (1991) could be established. It consisted in explicitly asking participants to generate emotional states and to identify and report the corresponding breathing patterns. These subjective reports were to be compared with the results of Boiten et al.'s (1994) review of the studies that investigated objective respiratory parameters. Our expectations were that (a) the information obtained from subjective reports would offer more details and a greater differentiation among emotions than the information issued from Boiten et al.'s review, and (b) the subjective reports would be concordant with the breathing patterns derived from Boiten et al., the latter thus validating to some extent the former. The rationale was that if, and only if, predictions (a) and (b) were met, Study 1's results could provide breathing patterns potentially able to induce specific emotions. However, this possibility would be void if either of the two predictions were not met.

Participants were invited to produce four emotional feeling states (of joy, anger, fear, and sadness), following a procedure adapted from the one described by Hess et al. (1992). When participants felt that they had reached the desired state, they were invited to describe their breathing in a questionnaire investigating several respiratory parameters.

Method

Participants and procedure

A total of 11 female and 12 male students volunteered to take part in the study. They were aged between 18 and 29 years (mean age = 23.8) and they participated individually in the experiment. The experimenter told them that the purpose of the study was to investigate how emotions could be expressed via respiratory patterns. They were simply instructed to produce an emotion—either joy, anger, fear, or sadness, in a random order—by modifying their respiration. They were also encouraged to maximise the intensity of their emotions and they were told that they could help themselves with personal memories or fantasies. Participants performed the experimental trials standing up alone in a laboratory room. The experimenter was in an adjacent room and contact was maintained with an interphone system. When participants judged themselves to have reached their best production of the target feeling state, participants reported in a questionnaire the characteristics of the specific respiratory pattern they had performed to express the emotion and, on a 7-point scale, the degree to which they felt they were successful in producing a breathing pattern corresponding to that emotion.

As a manipulation check, participants were also asked to report on the French version of the Differential Emotion Scale (Philippot, 1993) the intensity of the emotion feeling states they had experienced during the trial (from 0: no emotion at all to 6: the most intense emotion possible). This scale included the following items: concentrated, joyful, sad, angry, afraid, anxious, disgusted, scornful, surprised, ashamed, guilty, and happy. Only the six relevant items were retained for the data analysis (joyful, sad, angry, afraid, anxious, and happy).

Respiration questionnaire

Based on a pre-test study, a questionnaire investigating several respiratory parameters was constructed. Participants were asked to describe their inspiration and their expiration separately on five items: Was their respiration diaphragmatic, thoracic or both? Did they breath through their nose, their mouth or both? Did the frequency change (from ''−3'' = much slower to ''3'' = much faster), did the amplitude change (from ''−3'' = much more shallow to ''3'' = much deeper), and did they pause (from ''0'' = not at all to ''4'' = a lot)? Additional questions were asked for the whole respiratory pattern: Were there sighs, tremors, or tensions in the thorax (from ''0'' = not at all to ''4'' = a lot), and did the regularity of the respiration change (from ''−3'' = much more irregular to ''3'' = much more regular)?

Results

Manipulation check

On average, participants reported that they felt successful in producing emotional breathing patterns (mean success = 3.74 with ''0'' = unsuccessful trial, ''3'' = rather successful trial, and ''6'' = perfect trial). However, a MANOVA with emotion condition as a within-subject factor revealed that reported success varied according to emotion, $F(3, 20) = 4.99$, $p < .01$. *Post-hoc* analyses indicated that the joy respiratory pattern (mean = 4.48) was easier to produce than patterns of sadness, fear, and anger (respective means = 3.61, 3.56, 3.30).

Not only did participants indicate that they were successful in producing breathing patterns subjectively related to the target emotion, but they also reported feeling the corresponding subjective state. Indeed, a 4 × 6 MANOVA with emotion condition and emotion item of the DES as within-subject factors and sex as a between-subjects factor revealed main effects of emotion and emotion item, respectively, $F(3,63) = 3.99$, $p < .02$, $F(5,105) = 6.93$, $p < .0001$, that were qualified by an emotion × emotion item interaction, $F(15,315) = 34.01$, $p < .0001$. The pattern of the results and the *post-hoc* analyses represented in Table 1 clearly demonstrate that the manipulation induced specific emotional feeling states of a significant intensity.

Respiratory patterns

The central question of the present study was whether people can report respiratory patterns that differentiate among each basic emotional feeling state. Thus, to investigate the effect of emotion condition on the different parameters of inspiration and expiration, 2 × 4 MANOVAs were computed with inspiration-expiration and emotion as within-subjects factors. For the frequency and amplitude parameters, only the effect of emotion was significant, $F(3,20) = 29.22$, $p < .0001$, and $F(3,20) = 16.54$, $p < .0001$, respectively. For the pause

TABLE 1
Emotional feeling state as a function of emotion condition

		Emotion condition			
Feeling state		*Joy*	*Anger*	*Fear*	*Sadness*
Joyful	Mean	3.09_b	1.48_c	1.34_d	1.17_c
	(SD)	(1.62)	(0.89)	(0.71)	(0.49)
Sad	Mean	1.09_c	1.61_c	1.69_{cd}	4.13_a
	(SD)	(0.28)	(1.15)	(1.18)	(2.09)
Angry	Mean	1.04_c	4.39_a	1.91_{cd}	2.13_b
	(SD)	(0.20)	(1.97)	(1.44)	(1.68)
Afraid	Mean	1.00_c	1.52_c	4.08_b	1.43_c
	(SD)	(0.00)	(0.89)	(2.25)	(0.78)
Anxious	Mean	1.13_c	3.04_b	3.91_b	2.43_b
	(SD)	(0.34)	(1.96)	(1.95)	(1.99)
Happy	Mean	4.30_a	1.17_c	1.34_d	1.13_c
	(SD)	(1.79)	(0.49)	(0.77)	(0.45)

Note: Means with different subscripts differ at least at the 0.05 level of significance according to *t*-tests using Bonferroni's correction. (Only emotional feeling states items relevant to the emotion conditions are presented in this table.)

parameters, only the interaction between inspiration-expiration and emotion reached significance, $F(3, 20) = 3.70$, $p < .03$. *Post-hoc* analyses detailed these effects. As shown in Table 2, respiratory frequency increased for anger and fear, decreased for joy and did not change from baseline level for sadness. Respiratory amplitude increased dramatically in joy and, although to a lesser extent, in anger. For fear and sadness, amplitude remained at baseline levels. For pauses, *post-hoc* analyses revealed that the interaction was accounted for by the fact that although people reported more pauses after expiration in joy, $F(1, 22) = 4.80$, $p < .04$, they reported fewer pauses after inspiration in fear, $F(1, 22) = 3.61$, $p < .07$.

The effects of emotion on regularity, sighs, tremors, and thoracic tension were examined with a single factor (emotion) MANOVA. It appeared that all these parameters were significantly modulated by the type of emotion produced, $F(3, 20) = 4.09$, $p < .02$, for sighs; $F(3, 20) = 25.30$, $p < .0001$, for tremors; $F(3, 20) = 13.06$, $p < .0001$, for regularity; and $F(3, 20) = 45.89$, $p < .0001$, for thoracic tension. *Post-hoc* analyses specified these effects. As indicated in Table 2, sighing is specifically associated with sadness. In joy, respiration is more regular and presents much less thoracic tension than in anger and fear. Sadness falls in between this pattern and is characterised by tremors, which are totally absent in joy and moderately present in anger and fear.

Finally, the impact of emotion on whether the respiration was oral or nasal, and whether it was diaphragmatic or thoracic was examined using separate χ^2 for inspiration and expiration in each breathing condition. As displayed in Table 2, a

TABLE 2
Respiration parameters means values and (standard deviations) as a function of emotion

		Emotion			
Respiration parameter		*Joy*	*Anger*	*Fear*	*Sadness*
Frequency	Mean	-1.85_c	1.04_a	1.45_a	-0.35_b
	(SD)	(1.25)	(1.22)	(1.36)	(1.61)
Amplitude	Mean	2.07_a	0.91_b	-0.22_c	0.22_{bc}
	(SD)	(0.82)	(1.27)	(1.91)	(1.95)
Regularity	Mean	1.69_a	-0.83_c	-0.91_c	-0.61_b
	(SD)	(1.26)	(1.59)	(1.93)	(1.56)
Sighs	Mean	1.26_b	0.96_b	0.87_b	2.39_a
	(SD)	(1.35)	(1.43)	(1.46)	(1.53)
Tremors	Mean	0.04_c	1.39_b	1.48_b	2.65_a
	(SD)	(0.21)	(1.23)	(1.40)	(1.59)
Thoraxic tension	Mean	0.13_c	2.43_a	2.65_a	1.52_b
	(SD)	(0.34)	(1.44)	(1.03)	(1.53)

Note: Means with different subscripts differ at least at the 0.01 level of significance according to *t*-tests using Bonferroni's correction.

majority of participants judged the respiration to be nasal for joy and sadness, respectively, $\chi^2 = 40.29$, $p < .001$, $\chi^2 = 29.82$, $p < .001$, for inspiration and expiration in joy, and $\chi^2 = 34.77$, $p < .001$, $\chi^2 = 25.39$, $p < .001$, for inspiration and expiration in sadness. Respiration also tended to be nasal in anger, although to a lesser extent, $\chi^2 = 5.82$, $p < .10$, for inspiration and $\chi^2 = 10.76$, $p < .01$, for expiration. No significant trend appeared for fear. As regards the diaphragmatic or thoracic quality of the respiration, participants reported that expiration was predominantly diaphragmatic in anger and thoracic in fear, $\chi^2 = 6.61$, $p < .05$.

Discussion

Study 1 yielded three important findings. First, respiratory patterns that are differentiated among basic emotions were established on the basis of subjective reports. Second, these subjective patterns are congruent with the objective patterns reviewed by Boiten et al. (1994). Third, the explicit manipulation of respiration combined with imagery induced significant and specific emotional feeling states.

Regarding the first finding, the consistency of naive participants in their association between type of breathing pattern and specific emotion is remarkable. Previous research has already shown that people report experiencing different body sensation profiles for different emotions (Lyman & Waters, 1986; Philippot & Rimé, 1997; Rimé et al., 1990). Yet these studies had all considered a rather global perception of body changes (e.g. respiratory changes were measured on a single ‘‘respiratory change’’ item) and no precise body changes had been explored as specifically as in the present study. Thus, previous findings can be extended to note that people experience a very fine differentiation of body state during emotion, not only for the body as a whole but also for very specific changes, at least including breathing changes. In addition, these body sensations are quite homogenous across individuals and differentiated across emotions. These observations are contradictory to the undifferentiated arousal model notion of diffused perception of undifferentiated arousal inherited from Schachter’s (1964) theory. They are congruent with cognitive appraisal models and central network models, such as the Somatovisceral Afference Model of Emotion (SAME), proposed by Cacioppo et al. (1992).

With respect to the second finding, Study 1 participants’ reports do not contradict the findings of Boiten et al. (1994). In the present study, joy is associated with regular, moderately deep and slow breathing through the nose and with minimal thoracic tension, tremors, and sighs. The breathing tends to be diaphragmatic or both thoracic and diaphragmatic. This pattern is parallel to the slow and deep breathing Boiten et al. (1994) observed in a relaxed resting state. Yet, these authors report that calm happiness (as well as depression) is associated with slow but shallow breathing, whereas excited joy (as well as anger or fear) is associated with fast and deep breathing. Bloch et al.’s (1991) joy pattern (quick and deep nasal inspiration, followed by oral expiration with small jolts) is different from the pattern associated with joy by the participants of the present study as well as from the three patterns associated with positive states by Boiten et al. As mentioned above, Bloch et al.'s joy breathing pattern attempts to imitate laughter and might not be typical of joy.

For anger, participants in the present study reported rather fast, irregular, and deep nasal breathing with marked thoracic tension, minimal sighs, and some tremors. The expiration was diaphragmatic. This pattern corresponds to the fast and deep breathing Boiten et al. (1994) associated with excitement, including angry excitation. It also parallels to some degree Bloch et al.'s anger pattern (regular, quick, and deep nasal breathing), except that our participants reported irregular rather than regular breathing.

With respect to fear, our participants reported fast, irregular, rather shallow breathing, with much thoracic tension, some tremors, and minimal sighs. More thoracic breathing was reported for fear than for any other emotions. This pattern corresponds very well to the rapid, shallow breathing associated with tense anticipation by Boiten et al. It has also basic features in common with Bloch et al.'s fear pattern. However, the latter has additional specifications not reported by our participants: For Bloch et al. the respiration has to be oral and there must sometimes be a long expiration.

Finally, for sadness, our participants reported nasal breathing with average amplitude and frequency, marked with sighs and tremors as well as some thoracic tension and irregularity. Of the four types of breathing proposed by Boiten et al., the present pattern is closest to the slow and shallow breathing associated with state of withdrawal and passiveness. It shares some similarities with Bloch et al.'s sadness pattern (inspiration with brief jolts through the nose and expiration at one time through the mouth), specifically, normal frequency and amplitude, but also marked dissimilarities, including oral expiration, jolts in the inspiration and expiration in one time through the mouth for Bloch et al. As mentioned above, Bloch et al.'s sadness pattern attempts to imitate crying and might not be specific to sadness.

In summary, as predicted, the emotional breathing patterns reported by the participants of the present study are characterised by a clear and detailed differentiation among emotions. Moreover, they are congruent with the results of Boiten et al.'s (1994) meta-analysis. This suggests that, in their attempts to produce emotional states by manipulating their respiration, our participants have relied on breathing patterns that are similar to observations of psychophysiological studies investigating respiratory changes during emotion induction. As the conditions of clear differentiation among the four emotions investigated and congruence with Boiten et al.'s meta-analysis are met, the data of the present study can provide a valid basis for the construction of different sets of breathing instructions that would be specific to the discrete emotions of joy, anger, fear, and sadness.

The third finding of the present study is precisely related to emotion induction. Indeed, the analysis of the emotional feeling state questionnaire revealed that specific and rather intense emotions have resulted from the explicit instruction to produce emotion by manipulating respiration. This observation is in line with the report of Hess et al. (1992) that people have the ability to produce rather intense and specific emotions ''on demand''. Future research should examine whether the instruction to alter one's breathing adds a specific contribution to voluntary production of emotion. Of course, effects of experimenter demand can certainly not be completely discounted, although, during debriefing, participants reported that they had experienced genuine emotions. Similarly, the relative influence of other strategies, such as relying on personal memories, cannot be assessed in the present experiment.

Still, the present findings suggest that an explicit manipulation of respiration might be sufficient to induce a specific emotional feeling state. However, to test this assertion, the effects on feeling states resulting from the manipulation of respiration needs to be observed in a context free of experimental demand and in which other facets of emotion responses are kept constant.

STUDY 2

Study 2 examined whether specific emotional states could be induced by manipulating participants' breathing patterns with instructions based on Study 1's results. In addition, Study 2 investigated whether this effect could occur implicitly (i.e., without participants explicitly using breathing changes to infer their emotional feeling state). Participants were told that they were participating in a health psychology experiment aimed at examining the impact of breathing style on cardiovascular characteristics. After a training session, they performed the four breathing patterns that, unknown to them, were characteristic of joy, anger, fear, and sadness. Their feeling state was recorded by disguised items hidden in a questionnaire supposedly addressing the body symptoms induced by the breathing patterns.

Method

Participants and procedure

A total of 21 female and 5 male students aged between 17 and 23 years (mean age: 19.2) volunteered for the study. They participated individually in the experiment which consisted of two sessions of 45 minutes separated by a minimum of one night and a maximum of 48 hours. Participants were trained to perform the procedure during the first session and the actual data collection took place during the second session.

During the first session, the experimenter explained the cover story. Participants were told that the study had been designed to investigate the effects of breathing on cardiovascular changes and on physical feelings. Participants were told how respiration could influence the cardiovascular system at a functional and at a mechanical level. They were told that the hypothesis was that these effects could also influence subjective physical sensations. Then, the experimenter explained the procedure. The experiment consisted of four trials. Each trial was preceded by a short relaxation period during which participants had to close their eyes, breathe smoothly, relax every muscle, and visualise an imaginary circle inflating and deflating at the rhythm of their respiration. After relaxation, participants were to perform a respiratory pattern for two minutes and, immediately after, to complete a questionnaire on physical sensations. The experimenter explained that various respiratory and cardiovascular measurements would be taken during the breathing exercises. He showed the transducers (a respiratory belt and the FinaPress sensor of the Ohmeda 2300 blood pressure monitor[2]) and explained how this equipment operated.

Once the procedure was explained, the experimenter gave the breathing instructions, showed how to perform them and gave feedback to the participant about his/her performance. After having ascertained that the participant understood the breathing instructions, the experimenter affixed the transducers and went to the adjacent technical room. Communication with the participant was maintained throughout the experiment via an intercom system. After calibration of the physiological measurements, the rehearsal of the procedure began. The experimenter gave the relaxation instructions, then reminded the participant of the breathing instructions, had the participant perform them for two minutes, and asked to the participant to fill in the questionnaire. During the breathing trial, the experimenter could monitor on a computer screen the respiratory movements of the participant and check whether the instructions were correctly followed.

When they arrived for the second session, participants were reminded of the procedure. Then the experimenter affixed the respiratory belt and the FinaPress sensor and went to the technical room. The four trials were performed in a random order. Respiration was recorded during relaxation and trial periods. Finally, participants were debriefed and the actual purpose of the experiment was explained. They were specifically asked whether they suspected that the experimenter attempted to modify their emotional state by manipulating their respiration. No participants reported any suspicion about the real purpose of the experiment, about the fact that it concerned emotion induction, or about the fact that the questionnaire measured their emotional feeling state. Thus, if an effect on feeling state is observed, it can be considered as occurring outside of the participants' awareness of the process (i.e., the awareness of a relationship between breathing and feeling state).

[2]This apparatus only served to convince participants of the cover story. Cardiovascular data were thus not recorded. Given the strong impact of breathing on cardiovascular parameters, such data would have been useless in the present context.

Questionnaire

The questionnaire consisted of 22 items comprising different sensations. Items were ''vertigo'', ''nausea'', ''paraesthesia'', ''lump in the throat'', ''headache'', ''impression of unreality'', ''stomach sensations'', ''feeling cold, shivering'', ''feeling hot'', ''racing heart'', ''muscular tension'', ''perspiration'', ''goose flesh'', ''blushing'', ''weak knees'', and ''general activation''. Mixed among these items, four scales indexed emotional feeling states: ''feelings of fear, anxiety'', for fear; ''feelings of sadness, depression'', for sadness; ''positive feelings, good spirit'', for happiness; and ''feelings of aggressivity, aggravation'', for anger. Each item had to be rated by marking a check on a 10 centimetre line, anchored 0% to 100%. Participants were instructed that 0% reflected no such sensation at all, whereas 100% was the strongest sensation they could imagine feeling for this item. The dependent measures consisted of millimetres from the zero point on each scale.

Physiological measures

Respiration was recorded by an elastic tube strapped around the participant's chest. A sound of 575 Hz emitted at one end of the tube is received at the other end. The phase of the sound received varies according to the length of the tube which is itself determined by the respiratory movements of the ribcage. A coupler monitors these phase changes and outputs a signal varying in tension as a function of tube length (1.2 cm/V). Technical aspects of this system are described in van Rossum (1988). The signal of the coupler was sampled at a frequency of 10 Hz by a Computer-based Oscillograph and Data Acquisition System (CODAS) of Dataq Instruments. Codas, which consists of a combination of hardware and software, allows continuous data throughput to hard disk while maintaining a real-time display directly on the host computer's monitor. In addition, after the acquisition, data can be displayed on the monitor for artifacts inspection.

Respiration indices were derived from the raw signal of the strain-gauge (Boiten, 1994). The computer program used to that effect (Philippot & Philippot, 1991) outputs for each respiratory cycle: its length, amplitude, ratio of inspiration and expiration times, number of pauses and their length, and number of hampers.

Breathing instructions

The breathing instructions were derived from the results of Study 1:

Joy: ''Breathe and exhale slowly and deeply through the nose; your breathing is very regular and your ribcage relaxed.''

Anger: ''Breathe and exhale quickly through the nose; slightly deeper than regular breathing amplitude. Your breathing is slightly irregular with some tremors and your ribcage is very tense.''

Fear: ''Breathe and exhale quickly from the top of your ribcage; with a normal amplitude. Your breathing is slightly irregular with some tremors and your ribcage very tense.''

Sadness: ''Breathe and exhale through the nose with a normal amplitude and pace. Your ribcage is slightly tense, and there are some sighs in your expiration.''

Results and discussion

First, analyses were conducted to ascertain that participants' actual breathing patterns differed across conditions. MANOVAs with breathing condition as a within subject factor were computed on the differences scores (mean during the trial minus mean during relaxation) for the indices of frequency, amplitude, and ratio of inspiration and expiration times. As can be seen in Table 3, the effect of breathing condition was clearly significant for each index. *Post-hoc* analyses using the Bonferroni procedure revealed that participants followed the instructions (see subscripts in Table 3). Respiration time was longest during the joy condition, slightly shorter for the sadness condition, and much shorter in the anger and fear conditions, with fear respiration being slightly faster than anger respiration. The amplitude increased in the joy condition, remained at baseline levels for the anger and sadness conditions, and was shorter during fear. Finally, the ratio of inspiration and expiration times increased for anger, fear, and sadness but stayed at baseline level in joy.

Second, the impact of breathing condition on emotional feeling state was examined. A MANOVA with breathing condition and feeling scale as within-

TABLE 3
Respiratory parameters as a function of breathing condition

		Breathing condition					
Respiratory parameter		*Joy*	*Anger*	*Fear*	*Sadness*	$F(3, 23)$	p
Time	Mean	4.13_a	-6.41_c	-7.26_d	-1.26_b	84.14	.0001
	(SD)	(4.85)	(2.48)	(2.50)	(2.70)		
Amplitude	Mean	0.50_a	0.04_b	-0.20_c	0.15_b	20.98	.0001
	(SD)	(0.45)	(0.34)	(0.26)	(0.29)		
Ti/Te	Mean	0.05_b	0.14_a	0.32_a	0.17_a	6.90	.002
	(SD)	(0.17)	(0.24)	(0.38)	(0.14)		
Pause length	Mean	-0.44_a	-1.20_b	-1.39_b	0.25_a	6.22	.002
	(SD)	(1.55)	(1.75)	(1.69)	(2.35)		
Pause number	Mean	-0.15	0.52	0.22	0.67	1.12	.35
	(SD)	(0.99)	(2.15)	(1.67)	(1.84)		

Note: Means with different subscripts differ at least at the 0.01 level of significance according to *t*-tests using Bonferroni's correction.

subject factors was computed on the measures of the four feelings. A significant effect of breathing condition indicated that, overall, some breathing patterns induced more intense feeling state than others, $F(3, 23) = 9.02$, $p < .0004$. Similarly, some feeling states tended to be reported as more intense than others, as indicated by a significant effect of feeling scale, $F(3, 23) = 5.89$, $p < .004$. Of direct interest for our hypothesis, a significant interaction indicated that feeling state varied according to breathing conditions, $F(9, 17) = 8.73$, $p < .0001$: This effect accounts for 40% of the variance.

Post-hoc analyses specified the impact of breathing condition on feeling state (see Table 4). MANOVAs with feeling scale as within-subject factor were computed for each breathing condition. The effect of feeling scale was significant for each condition, indicating that each breathing condition induced a differentiated feeling state, $F(3, 22) = 13.32$, $p < .0001$, for joy; $F(3, 22) = 7.20$, $p < .001$, for anger; $F(3, 22) = 5.71$, $p < .004$, for fear; and $F(3, 22) = 4.10$, $p < .02$, for sadness, respectively. These effects were specified with paired *t*-test using the Bonferroni procedure. As can be seen in Table 4, the joy breathing condition induced significantly more positive feeling than any other condition and more than any other feeling within this condition. The same is true for the feeling of anger in the anger breathing condition. It should be noted that this breathing pattern also induced feelings of fear and anxiety, although to a lesser degree than anger feelings. The fear breathing condition induced feelings of anger and of fear/anxiety at a similar intensity level. Yet, the feelings of fear/anxiety induced in this condition are not more intense than those induced by any other conditions. Finally, the sad-

TABLE 4
Emotion feeling states as a function of breathing condition

		Breathing condition			
Emotion feeling state		*Joy*	*Anger*	*Fear*	*Sadness*
Positive state	Mean	54_{aI}	5_{cIII}	6_{cII}	23_{bI}
	(SD)	(33)	(8)	(12)	(25)
Anger	Mean	1_{cII}	55_{aI}	47_{bI}	7_{cII}
	(SD)	(2)	(37)	(32)	(12)
Anxiety, Fear	Mean	1_{bII}	40_{aII}	39_{aI}	8_{bII}
	(SD)	(2)	(35)	(34)	(13)
Sadness	Means	6_{bII}	12_{bIII}	13_{bII}	21_{aI}
	(SD)	(13)	(16)	(26)	(27)

Note: Means with different subscripts differ at least at the 0.01 level of significance according to *t*-tests using Bonferroni's correction. Alphabetic subscripts indicate a comparison between breathing conditions for a given feeling state; Roman number subscripts indicate a comparison between feeling state for a given breathing condition.

ness breathing condition induced to a comparable extent positive feelings and feeling of sadness. It should be noted that it is in this condition that feelings of sadness were the most intensely reported, as the three other breathing conditions induced no feeling of sadness at all.

In sum, it appears that the joy and anger breathing conditions successfully induced the target feeling state. The fear and sadness breathing conditions induced a mixed pattern of fear/anxiety and anger for the former and of positive state and sadness for the latter. These blends in pattern could be explained in two different ways. One possibility is that these breathing conditions indeed induced a blended emotional feeling state. Another possibility is that some individuals responded to these manipulations with a given feeling state, while others responded with another feeling state. For instance, some participants may have felt joy while performing the sadness breathing task, while other participants may have felt sad.

To decide between these alternatives, correlations were computed between feeling scales. In the fear condition, anger and fear were positively correlated, $r(27) = .58$, $p < .002$, indicating that the fear breathing pattern did indeed induce a blended emotional feeling state. In contrast, in the sadness condition, positive state and sadness were negatively correlated, $r(27) = -0.32$, $p < .10$. Thus, it seems that different individuals reacted with different feeling states to the sadness breathing pattern. A possibility is that, given the similarity in breathing instructions between the sadness and joy breathing conditions, some participants performed a breathing pattern closer to the joy breathing patterns, while others performed a ‘‘purer’’ sadness pattern. If this were true, based on data presented in Table 3, ‘‘happy responders’’ in the sadness breathing condition should evidence longer respiration time and amplitude, and smaller ratio of inspiration/expiration time than ‘‘sad responders’’. Pauses parameters, however, should not discriminate between these two groups. To test these hypotheses, respiratory parameters were compared with *t*-tests between ‘‘sad and happy responders’’. Participants who reported more happiness than sadness in the sadness breathing condition were classified as ‘‘happy responders’’. If the opposite was true, they were classified as ‘‘sad responders’’. Six participants who reported as much happiness as sadness were eliminated (generally, these participants reported no sadness together with no happiness at all). There were no differences between groups for the respiration time, amplitude, or pauses parameters. However, as predicted, ‘‘sad responders’’ were characterised by longer inspiration/expiration time ratio, $M = 0.23$, SD = 0.09, than happy responders, $M = 0.10$, SD = 0.16), $t(18) = 2.20$, $p < .03$. Thus, it seems that one objective respiratory parameter distinguishes between happy and sad responders. This finding suggests that the quality of the feeling state observed results directly from the breathing pattern performed rather than from any other factors. Future research might attempt to better control the breathing patterns performed by using a biofeedback procedure.

GENERAL DISCUSSION

Study 1 has indicated that people experience respiratory changes that are subjectively differentiated across different types of emotions. Study 2 has documented that differentiated emotional feeling states were induced by respiration manipulations without participants' awareness of the process. The intensity of the feeling states induced in Study 2 was not trivial: Mean ratings of joy, anger, and fear were 54, 55, and 47 on a scale in which 100 indicated the strongest intensity that participants could imagine feeling. The amount of variance accounted for by this effect (40%) is larger than the one accounted for by facial feedback (13%, in Matsumoto, 1987). To our knowledge, this is the first demonstration that the alteration of respiration is sufficient to induce emotion. It extends to visceral feedback the effects of body feedback on emotional states established for facial expression (e.g., Matsumoto, 1987) and posture (e.g. Stepper & Strack, 1993). These observations support the notion that body feedback plays a role in the determination of the quality of emotional feeling state and that this effect can occur without awareness of the process.

Taken together, the present results are totally congruent with the central network perspective described in the introduction. They are not congruent with the undifferentiated arousal model that postulates that emotion is characterised by a state of undifferentiated arousal that uniquely influences the intensity of feelings, provided that the individual is aware of the arousal and consciously attributes it to an emotional cause. Indeed, in Study 2, although individuals were aware of their body changes, they did not consciously relate them to an emotional state, as confirmed by a thorough debriefing on the matter. Thus, the present results indicate that body changes might influence feeling states independently of one's awareness of the process. Still, it is uncertain whether the awareness of the body state is necessary or not for peripheral feedback to occur. A convincing demonstration against this specific question would be to demonstrate the influence of respiratory changes on feeling states with participants who were neither aware of the process nor the respiratory changes. However, for practical reasons such a demonstration might be very difficult to realise.

Considering more specifically our results, it appears that joy, anger, and sadness—provided the execution of the proper breathing pattern—were successfully induced with instructions derived from the observations of Study 1. However, mixed results were observed for fear, which was not differentiated from anger. This observation raises the question of whether breathing manipulation affects feeling state by activating discrete emotions (e.g., Ekman, 1984; Levenson et al., 1990) or by moving it along dimensions of pleasantness and activation (e.g., Feldman Barrett & Russell, 1998). Indeed, of the four states induced, only fear and anger were in the same quadrant of unpleasant, high arousal state. Anger was successfully induced, though accompanied by some fear, whereas fear was not distinguished from anger.

There are at least four different interpretations that could account for this observation. The first interpretation is that respiratory feedback is capable of inducing discrete emotions and the fear breathing instructions derived from Study 1 were incomplete or inadequate. This possibility can only be examined by further psychophysiological research on respiration during emotion. A second interpretation is that, although body feedback as a whole is capable of inducing discrete emotions, breathing alone would not be sufficient to induce differentiated states of anger and fear because additional feedback from other body functions is necessary. According to the Somatovisceral Afference Model of Emotion (SAME) model proposed by Cacioppo et al. (1992), one source of peripheral feedback might not be enough to produce a discrete somatovisceral pattern that specifically refers to a specific emotion. A third possibility is that peripheral feedback is not capable of such fine distinctions, the latter requiring more cognitive appraisal processes. Finally, as suggested above, it may be that feeling states are organised dimensionally (Feldman Barrett, & Russell, 1998) and that Study 2 results simply reflect this reality. Future research is needed to decide among these possibilities. To test the second possibility, we are presently planning studies in which facial, postural, and respiratory feedback will be manipulated independently. By providing ambiguous and unambiguous somatovisceral patterns (emotionally incongruent or congruent feedback from face, posture or respiration), such manipulations allow for testing the SAME model (Cacioppo et al., 1992).

From a clinical perspective, our results suggest relations between anger-hostility and fear-anxiety, as induced by rapid breathing. Indeed, it is remarkable that the fast and deep breathing, normally expected to induce more hyperventilation (Beck & Scott, 1988; Huey & West, 1983)—and consequently, more anxiety—than the fast and shallow breathing actually induced more anger than anxiety. The fast and shallow breathing induced as much anger as anxiety. These observations suggest that hyperventilation might be as strongly related to anger and hostility as to fear and anxiety. This is congruent with the observation that people who panic, for whom hyperventilation is functional, score higher on hostility (Dadds et al., 1993). The anxiety produced by hyperventilation might thus originate in a hostile coping attitude in challenging situations.

A final comment concerns the regulation of emotion. Previous research has shown that attempts to regulate emotion by the suppression of its expression resulted in an increase in physiological responding (Gross, 1998; Manstead, 1991). Other researchers have observed just the opposite (Kappas, McHugo, & Lanzetta, 1989). Thus, attempts to regulate emotion in one physiological system (facial muscles) resulted in increased manifestation in other body channels (visceral arousal) in some studies and in decreased manifestation in other studies. Also relevant to this question, a wealth of clinical evidence has shown that feelings of anxiety can be alleviated by specific breathing exercises (Lum, 1981). It is therefore unclear whether the control of one body channel necessarily results in increased manifestations in other channels. It might be that the direction of the effect depends on the body channel and the type of control considered. The findings of the present studies encourage future research to examine the regulatory effects of specific breathing instructions in people exposed to emotional situations by independently manipulating breathing instructions and emotional situations.

In sum, the present studies have shown an implicit influence of respiratory feedback on the induction of emotional feeling state. They thus offer further support to those theories of emotion stating that the quality of emotional feelings are, at least in part, modulated by body feedback, without necessity of individual's awareness of the relationship between body changes and feeling state. It remains to be established whether respiratory feedback induces discrete emotions or whether it moves the feeling state along pleasantness and arousal dimensions. Finally, we propose that the respiratory feedback effect constitutes a rich avenue for future research in emotion regulation.

Manuscript received 3 May 1998
Revised manuscript 15 June 2001

REFERENCES

Beck, J.G., & Scott, S.K. (1988). Physiological and symptom responses to hyperventilation: A comparison of frequent and infrequent panickers. *Journal of Psychopathology and Behavioral Assessment*, *10*, 117–127.

Bloch, S., Lemeignan, M., & Aguilera, N. (1991). Specific respiratory patterns distinguish among human basic emotion. International *Journal of Psychophysiology*, *11*, 141–154.

Bloch, S., & Santibanez, H.G. (1972). Simposio Latino-Americano de psicobiologia del aprentizaje (pp. 170–184). In S. Bloch & R. Anerios (Eds.), *Psicobiologia del aprentizaje*. Santiago, Chile: Universidad de Chile.

Boiten, F.A. (1994). Component analysis of task-related respiratory patterns. *International Journal of Psychophysiology*, *15*, 91–104.

Boiten, F.A. (1996). Autonomic response patterns during voluntary facial action. *Psychophysiology*, *33*, 123–131.

Boiten, F.A., Frijda, N.H., & Wientjes, C.J.E. (1994). Emotions and respiratory patterns: review and critical analysis. *International Journal of Psychophysiology*, *17*, 103–128.

Buck, R. (1985). Prime theory: An integrated view of motivation and emotion. *Psychological Review*, *92*, 389–413.

Cacioppo, J.T., Berntson, G.G., & Klein, D.J. (1992). What is an emotion? The role of somatovisceral afference, with special emphasis on somatovisceral ''illusions''. In M.S. Clark (Ed.), *Review of Personality and Social Psychology*, *14*, 68–98.

Cannon, W.B. (1927). The James–Lange theory of emotions: A critical examination and an alternative theory. *American Journal of Psychology*, *39*, 106–124.

Dadds, M.R., Rosenthal-Gaffney, L., Kenardy, J., Oei, T.P.S., et al. (1993). An exploration of the relationship between expression of hostility and the anxiety disorders. *Journal of Psychiatric Research*, *27*, 17–26.

Damasio, A.R. (1994). *Descartes' error: emotion, reason and the human brain*. New York: Grosset/Putnam.

Duclos, S.D., Laird, J.D., Schneider, E., Sexter, M., Stern, L., & VanLighten, O. (1989). Emotion-specific effects of facial expressions and postures on emotional experience. *Journal of Personality and Social Psychology*, *57*, 100–108.

Ekman, P. (1984). Expression and the nature of emotion. In K. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 319–343). Hillsdale, NJ: Erlbaum.

Ekman, P. (1999). Basic emotions. In T. Dalgleish & M.J. Power (Eds), *Handbook of cognition and emotion* (pp. 45–60). Chichester, UK: Wiley.

Feldman Barrett, L., & Russell, J.A. (1998). Independance and bipolarity in the structure of affect. *Journal of Personality and Social Psychology*, *74*, 967–984.

Frijda, N.H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Gross J.J. (1998) Antecedent- and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology*, *74*, 224–237.

Hess, U., Kappas, A., McHugo, G.J., Lanzetta, J.T., & Kleck, R.E. (1992). The facilitative effect of facial expression on the self-generation of emotion. *International Journal of Psychophysiology*, *12*, 251–265.

Huey, S.R., & West, S.G. (1983). Hyperventilation: its relation to symptom experience and to anxiety. *Journal of Abnormal Psychology*, *92*, 422–432.

Izard, C.E. (1979). *Emotion in personality and psychopathology*. New York: Plenum.

Izard, C.E. (1990). Facial expressions and the regulation of emotions. *Journal of Personality and Social Psychology*, *58*, 487–498.

James, W. (1884). What is an emotion? *Mind*, *9*, 188–205.

James, W. (1890). *Principles of psychology* (2 Vols.). New York: Holt.

Kappas, A. (1989). *Control of emotion*. Unpublished Ph.D. dissertation, Darmouth College, USA.

Kappas, A., McHugo, & G.J., Lanzetta, J.T. (1989, October). *Componential control and the modulation of emotional experience*. Paper presented at the 29th Annual Meeting of the Society for Psychophysiological Research, New Orleans.

Kirouac, G. (1995). *Les émotions*. Québec: Presses de l'Université du Québec.

Laird, J. (1984). The real role of facial response in the experience of emotion: a reply to Tourangeau and Ellsworth, and others. *Journal of Personality and Social Psychology*, *47*, 909–917.

Lang, P.J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, *16*, 495–512.

Lang, P.J. (1984). Cognition in emotion: Concept and action. In C. Izard, J. Kagan, & R. Zajonc (Eds.), *Emotion, cognition, and behavior*. New York: Cambridge University Press.

Lazarus, R.S. (1991). Progress on a cognitive-motivational-relational theory of emotion. *American Psychologist*, *46*, 819–834.

Levenson, R.W. (1992). Autonomic nervous system differences among emotions. *Psychological Science*, *3*, 23–27.

Levenson, R.W., Carstensen, L.L., Friesen, W.V., & Ekman, P. (1991). Emotion, physiology, and expression in old age. *Psychology and Aging*, *6*, 28–35.

Levenson, R.W., Ekman, P., & Friesen, W.V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology*, *27*, 363–384.

Lum, L.C. (1981). Hyperventilation and anxiety state. *Journal of the Royal Society of Medicine*, *74*, 1–4.

Lyman, B. & Waters, J.C.E. (1986). The experiential loci and sensory qualities of various emotions. *Motivation and Emotion*, *10*, 25–37.

Manstead, A.S.R. (1988). The role of facial movement in emotion. In H.L. Wagner (Ed.), *Social psychophysiology and emotion: Theory and clinical application*. Chichester, UK: Wiley.

Manstead, A.S.R. (1991). Expressiveness as an individual difference. In R.S. Feldman & B. Rimé (Eds.), *Fundamentals of nonverbal behavior* (pp. 285–328). Cambridge, UK: Cambridge University Press.

Matsumoto, D. (1987). The role of facial responses in the experience of emotion: More methodological problems and a meta-analysis. *Journal of Personality and Social Psychology*, *52*, 769–774.

McIntosh, D.N. (1996). Facial feedback hypotheses: evidence, implications, and directions. *Motivation and Emotion*, *20*, 121–147.

Pecchinenda, A. & Smith, C.A. (1996). The affective significance of skin conductance activity during a difficult problem-solving task. *Cognition and Emotion*, *10*, 481–503.

Personality and Social Psychology Bulletin (1990). Special issue: Centennial celebration of the Principles of Psychology of William James. *Personality and Social Psychology Bulletin*, *16*, 597–783.

Philippot, P. (1993). Inducing and assessing differentiated emotion-feeling states in the laboratory. *Cognition and Emotion*, *7*, 171–193.

Philippot, M., & Philippot, P. (1991). *Thorax: A program of respiratory signal analysis* [computer program]. Louvain-la-Neuve, Belgium: University of Louvain, Experimental and Social Psychology Unit.

Philippot, P., & Rimé, B. (1997). The perception of bodily sensation during emotion: A cross-cultural perspective. *Polish Bulletin of Psychology*, *28*, 175–188.

Philippot, P., & Schaefer, A. (2001). Emotion and memory. In T.J. Mayne & G.A. Bonano (Eds.), *Emotion: current issues and future directions*. New York: Guilford Press.

Reisenzein, R. (1983). The Schachter theory of emotion: Two decades later. *Psychological Bulletin*, *94*, 239–264.

Rimé, B., Philippot, P., & Cisamolo, D. (1990). Social schemata of peripheral changes in emotion. *Journal of Personality and Social Psychology*, *59*, 38–49.

Russell, J. (1991). In defence of a prototype approach to emotion concepts. *Journal of Personality and Social Psychology*, *60*, 37–47.

Schachter, S. (1964). The interaction of cognitive and physiological determinants of emotional state. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 1, pp. 49–79). New York: Academic Press.

Scherer, K.R. (1984). On the nature and function of emotion: A component process approach. In K. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 293–317). Hillsdale, NJ: Erlbaum.

Smith, C.A., & Kirby, L.D. (2000). Consequences require antecedents: Toward a process model of emotion elicitation. In J.P. Forgas (Ed.), *Feeling and thinking: The role of affect in social cognition*. New York: Cambridge University Press.

Stemmler, G. (1989). Autonomic differentiation of emotion revisited: Convergent and discriminant validation. *Psychophysiology*, *26*, 617–632.

Stemmler, G. (1992). The vagueness of specificity: Models of peripheral physiological emotion specificity in emotion theories and their experimental discriminability. *Journal of Psychophysiology*, *6*, 17–28.

Stepper, S., & Strack, F. (1993). Proprioceptive determinants of affective and nonaffective feelings. *Journal of Personality and Social Psychology*, *64*, 211–220.

Teasdale, J.D. (1996). Clinical relevant theory: Integrating clinical insight with cognitive science. In P. Salkovskis (Ed.), *Frontiers of cognitive therapy*. New York: Guilford Press.

Tomkins, S.S. (1980). Affect as amplification: some modification in theory. In R. Plutchik & H. Kellerman (Eds.), *Theories of emotion* (pp. 141–164). New York: Academic Press.

van Rossum, E. (1988). *Ademhalingsmeetsystee* (Report No. 5). Amsterdam: Vrij Universiteit, Subfakulteit Psychologie, Electronische Werkplaats.

Zajonc, R.B., & McIntosh, D.N. (1992). Emotions research—Some promising questions and some questionable promises. *Psychological Science*, *3*, 70–74.

Zillmann, D. (1979). Excitation transfer in hostility and aggression. In D. Zillman (Ed.), *Hostility and aggression*. Hillsdale, NJ: Erlbaum.

Zillmann, D. (1983). Transfer of excitation in emotion behavior. In J.T. Cacioppo & R.E. Petty (Eds.), *Social psychophysiology* (pp. 215–240). New York: Guilford Press.