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Emotion response coherence: A dual-process perspective☆

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ABSTRACT

Emotions are widely thought to involve coordinated responses across multiple responses (e.g., experiential, behavioral, and physiological). However, empirical support for this general "response coherence" postulate is inconsistent. The present research takes a dual-process perspective, suggesting that response coherence might be conditional upon response system (i.e., automatic versus reflective). In particular, we tested the hypothesis that response coherence should be maximal *within* each system and minimal *across* the two systems. To test this prediction, 36 participants underwent an anger provocation while two relatively automatic (anger accessibility and physiology) and two relatively reflective (anger experience and instrumental behavior) responses were measured. As predicted, coherence was found within the automatic and reflective systems, but not across them. Implications for emotion response coherence, dual-process frameworks, and the functions of emotions are discussed.

1. Introduction

A central postulate of many emotion theories is that emotions involve coordinated changes across experiential, behavioral, and physiological responses (e.g., Averill, 1980; Ekman, 1992; Frijda, Ortony, Sonnemans, & Clore, 1992; Lazarus, 1991; Levenson, 1994; Scherer, 1984; Tomkins, 1962). This general *response coherence* postulate is often associated with an evolutionary perspective on the function of emotions. By imposing coherence across the various components of an emotional response, emotions are thought to prepare the organism for the actions required to respond optimally to environmental demands (e.g., Ekman, 1992; Levenson, 1994; Plutchik, 1980).

Despite the centrality of this postulate, empirical evidence for response system coherence is surprisingly inconsistent, with some research providing support in favor of response coherence and other research failing to support it. To reconcile these inconsistent findings, the present study proposes and tests a dual-process framework of emotion response coherence, suggesting two largely independent systems: an automatic (relatively unconscious, fast, and efficient) and a reflective (relatively conscious, deliberate, and effortful) system. According to this account, response coherence should be maximal *within* each system and minimal *across* the two systems.

1.1. Response coherence

Studies investigating the degree of coherence among emotion components are not only relatively rare, they "provide for the greater part at best limited support" (Reisenzein, 2000, p. 2) for the assumption of response coherence. Associations among the different emotion components are often weaker than expected (e.g., Bonanno & Keltner, 2004; Mauss, Wilhelm, & Gross, 2004; Reisenzein, 2000; Ruch, 1995), non-existent (e.g., Jakobs, Fischer, & Manstead, 2001; Mauss et al., 2004; Reisenzein, Bördgen, Holtbernd, & Matz, 2006), or even negative (e.g., Buck, 1977). These inconsistencies across studies have led some psychologists to argue that the coherence postulate may be overstated or even completely unfounded (Barrett, 2006; Bradley & Lang, 2000; Fridlund, 1994; Lang, 1988; Reisenzein, 2000).

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At the same time, discarding the coherence postulate entirely is not consistent with the research that has identified at least some degree of coherence among responses (e.g., Bonanno & Keltner, 2004; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005; Sze, Gyurak, Yuan, & Levenson, 2010). One solution to this tension is that coherence may not be an all-or-none feature of emotions. Rather, different degrees of coherence might be found for different types of responses. Indeed, when differentiating among different types of responses, some systematic differences in coherence emerge.

The strongest associations are typically found between experience and behavior (e.g., Fischer and Roseman, 2007; Zeelenberg & Pieters, 2004). In contrast, associations between physiological responses, on the one hand, and experience and behavior, on the other, are more modest or non-existent (e.g., Borkovec, Stone, O'Brien, & Kaloupek, 1974; Grossman, Wilhelm, Kawachi, & Sparrow, 2001; Mauss, Wilhelm, & Gross, 2003; Mauss et al., 2004, 2005; Weinstein, Averill, Opton, & Lazarus, 1968). Thus, coherence has been typically found between experience and behavior, whereas lesser or no coherence has been found between physiological responses and other responses. What principle could account for these response-specific patterns of coherence? In the next section, we propose that dual-process frameworks might explain systematic differences in coherence across different responses.

1.2. Dual-process frameworks and response coherence

Dual-process frameworks assume that psychological responses are a joint function of two largely independent systems, one automatic and the other reflective. Automatic responses are relatively unconscious, fast, and efficient, while reflective responses are relatively conscious, deliberate, and effortful. Both systems are thought to play in concert to promote adaptive behavior, including emotions (Bargh & Ferguson, 2000; Baumeister, Vohs, DeWall, & Zhang, 2007; Kahneman & Frederick, 2002; Lieberman, 2007; Smith & DeCoster, 2000; Smith & Neumann, 2005; Strack & Deutsch, 2004). More specifically, dual-process frameworks assume that the automatic system activates behavioral schemata through spreading activation, which originates mainly from perceptual input. One of the greatest advantages of the automatic system is that it is not only fast but also requires little or no cognitive effort and has a low threshold for processing incoming information. The reflective system, in contrast, generates declarative knowledge by assigning perceptual input to a semantic category (e.g., Evans and Stanovich, 2013; Strack & Deutsch, 2004). It is thought to operate relatively slowly and to involve relatively greater effort.

Research – mainly from the field of social cognition – supports the idea of two independent systems. For example, there is (a) psychometric evidence that automatic and reflective aspects of the same construct are distinct (e.g., Cunningham, Preacher, & Banaji, 2001; Greenwald & Farnham, 2000; Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005; Nosek & Smith, 2007; Payne, Burkley, & Stokes, 2008); (b) neurological evidence that implicit and explicit measures correspond to distinct cognitive processes and do not simply constitute different measurement modes (Cunningham, Johnson, Gatenby, Gore & Banaji, 2003; Cunningham et al., 2004; Phelps et al., 2000); and (c) empirical evidence showing that implicit and explicit measures both have different domains of predictive potency (Dijksterhuis & Nordgren, 2006; Greenwald, Poehlman, Uhlmann, & Banaji, 2009). Taken together, evidence supports two independent systems: an automatic and a reflective system.

We propose that one can apply this dual-process framework to understand emotion response coherence. This idea leads to the prediction that coherence should not be an all-or-none feature of emotions. Rather, coherence should be conditional on the system of the involved emotional response. Relatively automatic responses should cohere with one another and relatively reflective responses should cohere with one another. However, responses across the two systems should cohere to a lesser degree with one another.

Although existing research, as noted above, appears to be generally consistent with the notion of two independent systems of coherence, very little research to date has directly tested this idea utilizing multiple measures from within the automatic and multiple measures from within the reflective system. That is, although previous research on response coherence has typically examined several indicators of the reflective system (usually self-reported emotional experience and behavior), it has typically only examined physiological responding as the sole indicator of the automatic system. In addition, for some emotional responses it is not entirely clear to what extent they are relatively more automatic or reflective (Smith & Neumann, 2005). For example, in most studies testing the coherence postulate, facial expressive behavior was measured (e.g., Bonanno & Keltner, 2004; Fernández-Dols & Crivelli, 2013; Mauss et al., 2005; Reisenzein, 2000; Reisenzein et al., 2006; Reisenzein, Studtmann, & Horstmann, 2013). Facial behavior can occur in a relatively automatic or reflective mode (e.g., Baumeister et al., 2007; Ekman, 1972). Therefore, and in light of the goal of the present study, we included behavior that is evidently more at the reflective end of the continuum (hostile evaluations of the experimenter; see also below). To test the idea that coherence is conditional upon response system (automatic versus reflective), multiple measures from each system are necessary. The present research provided such data.

1.3. The present study

The present study tested the hypothesis that response coherence should be maximal *within* each system and minimal *across* the two systems. We examined emotional responses in the context of anger because anger involves pronounced responses in all emotional components (Mauss, Cook, & Gross, 2007; Reisenzein, 2000). To induce anger, we used a well-validated anger provocation procedure (Mauss, Cook, & Gross, 2007; Stemmler, Heldmann, Pauls, & Scherer, 2001). We assessed two automatic (anger accessibility and physiological responses) and two reflective (self-reported experience and instrumental behavior) anger responses.

First, concerning the automatic system, we assessed anger accessibility by means of a lexical decision task (cf. Bargh & Ferguson, 2000; Niedenthal & Setterlund, 1994). In this task participants have to decide as fast as possible whether a given letter string is or is not a word, with some words being anger-related. These lexical decisions occur relatively fast and do not depend on the individual having the intention or awareness to evaluate the content of the words, and thus constitute relative automatic responses. Additionally, we assessed physiological responses by measuring mean arterial blood pressure, a key response in the context of anger (Stemmler et al., 2001). People are generally relatively unaware of these bodily responses, and they are relatively difficult to control (Edelmann & Baker, 2002; Katkin, 1985; Pennebaker, 1982). Physiological responses thus constitute relatively automatic responses.

Second, concerning the reflective system, we assessed subjective experience of an emotion, which was measured with participants' self-reported anger experience. These emotion experiences were considered to be reflective responses, as they are controllable (e.g., Mauss, Cook, Cheng, & Gross, 2007) and by definition subject to introspection. Our second measure of the reflective emotional system was instrumental anger behavior, which was measured by obtaining participants' anonymous evaluations of the person who angered them. Participants were led to believe that their evaluations could have disadvantageous effects for the career of their object of anger. This behavior was therefore

Table 1
Means, standard deviations, and intercorrelations of study variables ($N = 36$).

	M	*SD*	1	2	3	4	5	6	7	8
1. Sex[a]	1.45	.51	–							
2. Age	21.03	1.52	−.09	–						
3. Anger accessibility control	−.01	.06	−.17	.07	–					
4. Anger accessibility provocation	−.04	.05	.22	−.01	−.15	–				
5. Blood pressure baseline	93.74	17.04	−.18	.34	.15	.25	–			
6. Blood pressure provocation	112.75	22.44	−.26	.31	.04	.43*	.93**	–		
7. Self-reported anger baseline	1.05	1.45	−.16	−.20	.00	.05	−.19	−.15	–	
8. Self-reported anger provocation	4.21	2.81	.31	−.19	−.27	−.07	−.19	−.15	.42*	–
9. Anger behavior	5.95	1.24	.51**	−.22	−.27	−.01	−.24	−.15	.19	.39*

[a] 1, male; 2, female.
* Significant at $\alpha < .05$ (two-tailed).
** Significant at $\alpha < .01$ (two-tailed).

relatively controllable and slower, open to introspection, and thus constituted a relatively reflective response. In sum, we obtained measures of experience and behavioral responses as indices of the reflective emotional system. While the two automatic responses may arguably have some reflective characteristics, and vice versa, the important point is that the two automatic responses are more automatic than the reflective ones on an "automatic–reflective" continuum.

2. Method

2.1. Participants

Forty-three undergraduate students (23 males and 20 females) participated in the study, for which they received $12. Data from seven participants who did not become angry because they became aware of the goal of the anger provocation (as determined during debriefing) were not included in the analyses. The final sample consisted of 36 participants (19 males, 17 females). Their mean age was 21.0 years ($SD = 1.5$). Sixty-one percent of the participants identified themselves as Caucasian American, 14% as Asian American, 6% as African American, 6% as Latino, and 11% as 'other'.

2.2. Procedure

On arrival at the laboratory, participants were told that they would be participating in a study on cognitive performance and mood. After physiological sensors were attached, participants watched a neutral 5-min film while baseline responses were collected, and then reported their frustration, annoyance, and anger experience (along with 13 distractor terms).

Following Stemmler and colleagues (e.g., 2001), participants then performed tedious counting tasks designed to induce anger. These tasks required them to count backwards for 1 min in steps of 7 or 13 from large numbers, e.g. 18,652. The experimenter interrupted the participants several times via intercom with scripted and pre-recorded remarks on their performance and cooperation, delivered in an increasingly unfriendly and impatient tone of voice. They were blamed for "producing artifacts" by "moving their hand;" in fact, such movement was hardly possible. Additionally, there was an unexplained delay for 30 s after which participants were blamed for the fact that the experimenter "could not use the data they were producing like this." At the end of the anger provocation, the experimenter said, "Let's just stop here. Just fill out the next section in your questionnaire packet," in an irritated tone that implied that the session had not gone smoothly (see Mauss, Evers, Wilhelm, & Gross, 2006 for a similar induction).

After the anger provocation, participants reported on their anger, after which the next "cognitive performance task" was administered on a laptop computer. Participants had to decide as quickly as possible whether word-like stimuli presented on the screen were words or non-words. This lexical-decision task was designed to provide a measure of *anger accessibility* (see Section 2.3 for more detail).

After completing this task, participants were told that the Department of Psychology wished to evaluate experimenters to ensure that all experiments were conducted in a professional manner. Participants were assured that all their answers would be completely confidential and anonymous and were instructed to seal the completed surveys in envelopes provided. On the survey-form it was stated that the survey was meant to gain insight into the functioning of new experimenters and that their responses would give valuable insights for evaluating the experimenter and help in determining whether this person was fitting to conduct further experiments in future. In fact, this survey was meant to be an assessment of instrumental *anger behavior*, in that it provided participants with an opportunity to express anger in a resentful/vengeful/consequential way toward their object of anger (the experimenter). Next, participants were probed about any suspicions they had about the anger provocation and debriefed.

One week later, on average, participants returned for a second session and, together with questionnaires not relevant to the present study, completed the lexical decision task to obtain measurements of anger accessibility when they were not angered.[1] Finally, participants were thanked, debriefed, and paid.

2.3. Measures

2.3.1. Automatic measures

In the lexical decision task reaction times were measured to assess how quickly participants recognized anger words relative to neutral words. The task consisted of 30 anger (e.g., *angry*, *furious*) and 30 neutral words (e.g., *margin*, *total*), as well as filler words. All words were matched for length and frequency and were presented for a maximum of 3 s. A 1300-ms fixation point (*XXX*) preceded every word. The task was programmed in PsyScope 1.1 and was presented on an Apple computer. The words were presented in four fixed random orders. Half the participants used the right hand for words (key L) and the left hand for non-words (key A); the other half used the reversed key-hand assignments. For the assessment of anger accessibility all words with an error rate higher than 20% ($N = 5$) and all latencies lower than 300 ms and higher than 3000 ms were excluded. Reaction times for incorrect responses were set to missing, and the data were then log transformed (Fazio, 1990). All latencies for anger and neutral words were combined into means for anger and neutral words. In line with previous research (e.g., Loney, Frick, Clements, Ellis, & Kerlin, 2003), we created difference scores subtracting each participant's average response time to neutral words from his/her average response time to anger words. We refer to anger accessibility assessed after the provocation as the provocation measurement. We refer to anger accessibility assessed one week later as the control measurement. This control measurement was deemed necessary in order to show that the anger provocation resulted in higher anger accessibility (as reflected in shorter response latencies) compared to the control measurement. For the final index of anger accessibility we subtracted difference scores obtained at the control measurement from difference scores obtained at the provocation measurement.

Physiological responding was assessed during baseline and anger provocation by measuring mean arterial blood pressure (MAP) that was sampled at 400 Hz using laboratory software. This cardiovascular measure was chosen because it is a key physiological indicator of anger (Stemmler et al., 2001). Customized analysis software (Wilhelm, Grossman, & Roth, 1999) was applied offline for physiological data reduction, artifact control, and computation of average mean arterial blood pressure scores for each participant. MAP (mmHg) was obtained from the third finger of the non-dominant hand by means of the Finapres™ 2300 (Ohmeda, Madison, WI) system. From this signal, beat-to-beat stroke volume was measured using Wesseling's pulse-contour analysis method (BEATFAST, TNO-Biomedical Instrumentation, Amsterdam). Averages were obtained across the baseline and across the anger provocation period. For analyzing blood pressure, change scores (anger provocation minus baseline) were used to control for individual differences at baseline.

2.3.2. Reflective measures

Participants rated their experience of anger, frustration, and annoyance on 11-point scales (see also Mauss et al., 2006), ranging from 0 (*none at all*) to 10 (*extremely*). The three items were combined into a single self-reported anger scale (before versus

[1] We obtained this measure after (rather than before) the provocation in order to minimize insight into the goal of this study. The possibility that participants would still be angry after one week seemed to be minimal. To additionally rule out this possibility, self-reported anger experience was assessed in the follow-up session. A paired *t*-test showed that participants reported less anger in the follow-up session ($M = 1.62$, $SD = 1.47$) than after the anger provocation ($M = 4.07$, $SD = 2.83$), $t(32) = 5.05$, $p < .001$.

after anger provocation: $\alpha = .92$ versus $\alpha = .94$). For analyzing self-reported anger, change scores (after minus before anger provocation) were used to control for individual differences at baseline. Instrumental anger behavior was assessed by participants' evaluations of the experimenter in the "anonymous survey" (for example, 'I think it is inappropriate for the experimenter to conduct further experiments in the future'). The survey contained 16 items, ranging from 0 (*strongly disagree*) to 7 (*strongly agree*). Higher scores indicate a more negative evaluation. All 16 items were combined to form an anger behavior index ($\alpha = .88$).

3. Results

Means, standard deviations and intercorrelations of study variables are displayed in Table 1.

3.1. Manipulation check: effects of the anger provocation

A paired *t*-test showed a marginally significant main effect indicating higher anger accessibility after the anger provocation ($M = -.04$, $SD = .05$) than one week later ($M = -.01$, $SD = .06$), $t(31) = 1.80$, $p = .082$. Participants exhibited greater blood pressure during the anger provocation ($M = 113.36$, $SD = 21.28$) than during the baseline ($M = 94.00$, $SD = 17.26$), $t(30) = 12.94$, $p < .001$. A paired *t*-test further indicated that participants reported experiencing more anger after the anger provocation ($M = 4.21$, $SD = 2.81$) than at baseline ($M = 1.05$, $SD = 1.45$), $t(35) = 7.43$, $p < .001$. Additionally, participants behaved angrily by evaluating the experimenter negatively (on a scale from 0 to 7: $M = 5.95$, $SD = 1.24$, with the M being significantly higher than the midpoint of the scale, $t(35) = 11.89$, $p < .001$). Overall, these findings suggest that the anger provocation was successful.

3.2. Response coherence

To test our predictions, simultaneous regression analyses, predicting each emotional response by the three other emotional responses, were used. For example, for predicting blood pressure, automatic anger evaluation, self-reported anger, and anger behavior were entered as predictors. Before entering the variables into the regression equations, all predictor variables were mean-centered to minimize multicollinearity (Aiken & West, 1991). These regression analyses provided tests of the unique relationship of each predictor with the dependent variable, controlling for the effects of the other predictors.

For *anger accessibility* the regression analysis revealed that it was significantly predicted by blood pressure, $\beta = .39$, $t = 2.12$, $p = .044$, but not by self-reported anger, $\beta = -.01$, $t = -.03$, $p = .974$, or anger behavior, $\beta = .13$, $t = .63$, $p = .534$. Likewise, *blood pressure* was predicted by anger accessibility, $\beta = .39$, $t = 2.12$, $p = .044$, but not by self-reported anger, $\beta < .01$, $t = .02$, $p = .987$, or anger behavior, $\beta = .09$, $t = .43$, $p = .670$. Next, *self-reported anger* was significantly predicted by anger behavior, $\beta = .47$, $t = 2.57$, $p = .016$, but not by anger accessibility, $\beta = -.01$, $t = -.03$, $p = .974$, or blood pressure, $\beta = .47$, $t = .02$, $p = .987$. Likewise, *anger behavior* was predicted by self-reported anger, $\beta = .47$, $t = 2.57$, $p = .016$, but not by anger accessibility, $\beta = .12$, $t = .63$, $p = .534$, or blood pressure, $\beta = .08$, $t = .43$, $p = .670$.

Taken together, and as illustrated in Fig. 1 (depicting change scores of anger provocation minus baseline), only the components within the automatic and reflective systems were significantly interrelated. Thus, the present results suggest that there are two largely independent systems of emotional responding, one automatic, and the other reflective.

4. Discussion

Empirical support for the response coherence postulate is inconsistent. To reconcile inconsistent results, we proposed a dual-process framework of emotion response coherence, suggesting two largely independent systems. We tested the hypothesis that coherence is relatively strong within the automatic and reflective response systems, but relatively weak or non-existent across them. As predicted, we found support for (a) coherence between automatic responses, i.e., anger accessibility and blood pressure, (b) coherence between reflective responses, i.e., self-reported anger and instrumental anger behavior, and (c) no coherence between automatic and reflective responses. These results have implications for our understanding of emotion response coherence and for dual-process frameworks.

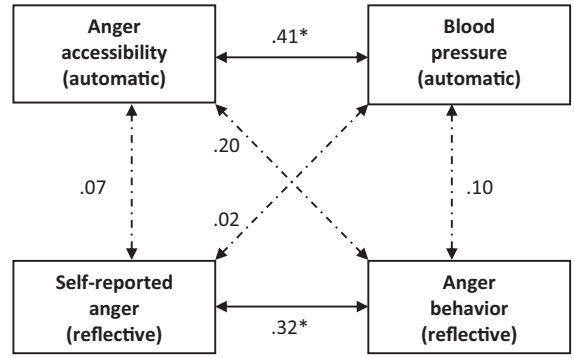

Fig. 1. Intercorrelations of the different indices of the automatic and reflective systems. All correlations are based on change scores (provocation minus baseline), except for anger behavior, which measured only during the provocation. Solid lines indicate significant correlations ($p < .05$); dashed lines indicate non-significant associations ($p > .29$).

4.1. Implications for emotion response coherence

The present findings shed new light on the question of whether emotion response systems cohere. They suggest that coherence is not an all-or-none feature of emotions. Rather, coherence appears to depend on the type of response involved, with more automatic responses showing coherence with one another and more reflective responses showing coherence with one another, while responses that cross these two types of responding fail to show reliable coherence. Empirically, this helps reconcile inconsistent results in the emotion response coherence literature, which has tended to find greater coherence for experience–behavior pairings and lower or no coherence for pairings involving physiological responses.

From the perspective of a dual-process framework these results make sense, as according to this perspective the automatic and reflective systems are indeed seen as relatively independent and operating in parallel (Strack & Deutsch, 2004). While the automatic system elicits behavior through associative links and motivational orientations, the reflective system generates behavioral decisions that are based on knowledge about facts and values. The lack of coherence between the emotional indices of the automatic and reflective systems is consistent with the perspective that the two systems operate relatively independently of one another. The fact that the present study found coherence within the automatic and within the reflective system also makes sense in the context of a dual-process framework, given that according to this framework automatic responses and reflective responses share important features with one another.

The present findings also have some implications for our understanding of the function of coherence. Some theories have conceptualized coherence as an evolutionarily evolved adaptive pattern with primarily biological functions (Ekman, 1992; Levenson, 1994). Others have conceptualized coherence as socially evolved with primarily social functions (Cacioppo, Berntson, & Klein, 1992; Campos & Barrett, 1984). The present findings suggest

that both explanations might apply. Coherence within automatic emotional responses may have a primarily biological function, such as immediate action preparation, whereas coherence within reflective emotional responses may have primarily social functions, such as communicating one's subjective experiences to others. Coherence within each system might be adaptive. In line with this idea, research has shown that coherence between emotion experience and emotion behavior is linked to psychological functioning (Mauss et al., 2011). However, coherence across the two systems may not necessarily be adaptive. In some cases, anger might be a particularly good example, it might even be advantageous to uncouple relatively reflective from relatively automatic responses. Thus, coherence may or may not be functional, depending on which system is considered.

One apparent inconsistency bears noting: Despite presumably being part of the automatic system, different physiological responses often show relatively little coherence with one another (e.g., Cacioppo et al., 1992; Lacey, 1967). Similarly, despite being part of the same system, one can imagine situations in which two measures of the reflective system do not cohere with one another (e.g., when feeling an emotion but deciding not to act on it). Two considerations resolve this inconsistency. First, the present framework does not imply that all measures of the automatic system and all measures of the reflective system should always cohere with one another. Rather, we argue that on average coherence within the automatic system and coherence within the reflective system are relatively greater than coherence across the two systems. Second, different physiological responses (e.g., cardiac versus vascular; e.g., Tomaka, Blascovich, Kelsey, & Leitten, 1993) serve different functions and are activated to different degrees in different emotional contexts. Thus, in addition to the shared feature of being automatic they differ in important ways, and should thus not be expected to always cohere tightly. For these reasons, low degrees of coherence among different responses within one system do not necessarily conflict with the present account.

4.2. Implications for dual-process frameworks

Our findings support the idea that distinguishing between automatic and reflective processes is important. These findings also may have implications for the nature and relationship of these two types of response systems. Generally, dual-process frameworks offer two interpretations of the relationship between automatic and reflective measures. One perspective considers them to be assessing distinct systems (e.g., Greenwald & Banaji, 1995; Wilson, Lindsey, & Schooler, 2000). A second perspective hypothesizes a single system and suggests that the automatic–reflective distinction more meaningfully refers to the method of measurement rather than to dissociable constructs (e.g., Fazio & Olson, 2003).

In this study, the automatic components of emotion were associated even though they were measured using different methods (for example, physiological responses were measured continuously during the anger provocation while anger accessibility was measured by means of a lexical decision task after the anger provocation). This supports the argument that automatic and reflective responses represent distinct systems rather than a single system in which dissociations are due to methodological artifacts. This also supports the idea that differences in measurement alone cannot account for the automatic–reflective distinction (e.g., Cunningham et al., 2001; Greenwald & Farnham, 2000; Hofmann et al., 2005; Nosek & Smith, 2007; Payne et al., 2008; Schultheiss, Yankova, Dirlikov, & Schad, 2009). Rather, the automatic–reflective distinction is a substantive one that can help us understand crucial aspects of human behavior, including emotions.

4.3. Limitations and future directions

This study makes a theoretical advance by articulating and testing a new perspective on emotion response coherence in the context of a powerful negative emotion. At the same time, however, it is important to acknowledge several limitations of the present study.

One limitation relates to the emotional context considered in this study. Here we focused only on anger. Previous research on surprise, sadness, and amusement suggests that the present findings may generalize to other emotions (Mauss et al., 2005; Reisenzein, 2000). However, future studies should investigate coherence in additional emotions. It may be prudent to consider the intensity of these additional emotions as well, as response coherence may increase as the intensity of the emotion increases, which has been shown for amusement, but not for sadness (Mauss et al., 2005). As the present study focused on a relatively intense emotional context, we did not manipulate emotional intensity. We assume though, that as emotional intensity increases, only coherence within the automatic and within the reflective system increases, but that the relative lack of coherence across both systems would remain. As this speculation is not corroborated by empirical evidence, future studies that manipulate emotion intensity would provide important additional evidence.

Second, differences in the timing of our measures might have decreased our estimates of coherence (see e.g., Mauss et al., 2005; Stemmler, 1992). Physiological responding was measured online and continuously during the anger provocation, whereas the remaining measures were taken at a single point in time after the anger provocation. While this feature may have lowered the association between physiological responses, on the one hand, and anger accessibility, experience, and behavior, on the other, this attenuation would have applied to all three associations. The main contribution of the present data – showing relatively greater coherence between physiology and an automatic response versus physiology and the two reflective responses – therefore cannot be explained by this design feature.

Third, in the present study, we sampled two measures from within each of the two systems we considered. As previous research on response coherence has primarily focused on physiological responding as the sole indicator of the automatic system, adding a second measure of automatic responding constituted an advance. Nonetheless, future research on emotion response coherence should incorporate a broader variety of automatic as well as reflective responses (e.g., multiple measures of physiological responding).

Fourth, coherence within the automatic system and within the reflective system was relatively modest ($rs = .41$ and .32, respectively). This may be related to the between-subjects design of the current study; within-subjects correlations may have resulted in greater correlations (cf. Mauss et al., 2005). It should be noted, as well, that the main contribution of the present findings is the relative magnitude of within- versus across-system coherence and not their absolute magnitude.

Finally, the present study included a relatively small sample (19 males, 17 females). Consequently, there was not enough power to reliably examine potential moderators. Sex is a particularly interesting variable to consider. Sex differences in emotion are related to socialization processes, such as culturally acquired display rules and social norms (Brody & Hall, 2000; Kring, 2000). Given that reflective measures are more sensitive to influences of socialization (Keltner & Haidt, 2001), it might be that sex influences coherence of reflective measures more than coherence of automatic ones. To assess if there are indeed sex differences in coherence, and to examine other potential moderators, future studies should include larger samples of men and women.

5. Concluding comment

While many theories propose that emotions involve coherence across responses, the empirical support for this claim has been quite mixed. In this paper, we have argued that coherence might not be an all-or-none feature of emotions. Rather, coherence might be conditional upon the type of emotion responses under consideration, with the automatic versus reflective distinction serving as a key organizing principle. In support of this perspective, we found coherence within the automatic and within the reflective system, but not across them. These results support a modified coherence view, whereby whether or not coherence is observed depends on the types of response system involved.

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