



## Response speed as an individual difference: Its role in moderating the agreeableness–anger relationship

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### ABSTRACT

Anger is an emotion that is precipitated by hostile attitudes and high arousal. The trait of agreeableness is a moderately inverse predictor of hostile attitudes and anger. Relations between agreeableness and anger are likely to be stronger to the extent that the person can be characterized as high in dispositional arousal. Arousal-related manipulations speed responses in cognitive tasks. Thus, individual differences in response speed may be informative concerning general tendencies toward aroused states. In three studies ( $N = 319$ ) individual differences in response speed in basic choice tasks interacted with agreeableness to predict state-related experiences of anger. Specifically, the highest levels of anger were observed among fast/disagreeable individuals. The utility of this probe in future studies is discussed.

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### 1. Introduction

Two dimensions are necessary to understand the emotions that individuals experience (Watson & Tellegen, 1985). A set of dimensions with a long history and excellent psychometric support (Russell, 1980, 2003) characterizes emotional experiences in terms of their combination of valence (negative versus positive) and arousal (high versus low). At least a moderate level of arousal, though, is necessary in capturing most of the experiences that we would term emotions such as fear, anger, and joy (Cannon, 1932; Ekman, Levenson, & Friesen, 1983; Panksepp, 1998; Schachter & Singer, 1962). Indeed, low arousal states – such as boredom or calmness – are characterized by a lack of emotion elicitors (Watson, 2000) and such states are not prototypical of emotion (Shaver, Schwartz, Kirson, & O'Connor, 1987). Arousal, then, is a central construct in emotion theory as well as a defining feature of most emotional reactions.

Personality traits are predictive of emotional states, but such relations are fairly general across levels of arousal. For example, the trait of extraversion seems to predict low- and high-arousal positive emotional states somewhat equally (Lucas & Fujita, 2000). Similarly, the trait of neuroticism predicts a wide variety of negative emotional states, including low arousal states such as boredom, and medium arousal states such as sadness, and high arousal states such as anxiety (Suls & Martin, 2005). Further, trait approaches to capturing the emotional arousal dimension have not proven particularly successful. Surprise, a high arousal emotion that is neutral with respect to valence, does not exhibit trait-like

properties (Watson, 2000). Affect intensity purports to capture personality variations in emotional arousal independent of emotional valence (Larsen & Diener, 1987), but subsequent analyses of this measure (and construct) found it to be a heterogeneous one (Bachorowski & Braaten, 1994; McConville & Cooper, 1995). In addition, affect intensity is a better predictor of emotional variability over time than a general tendency toward high arousal emotional states (Kardum, 1999).

Admittedly, the arousal construct is a tricky one. It might be defined in terms of sensitivity of the fight–flight motivational system, though suggestions of this type are mostly theoretical in the context of human personality (Pickering & Gray, 1999). It might be operationalized in terms of measures of peripheral physiology such as skin conductance or heart rate, but these measures serve multiple masters and are quite variable across situations (Cacioppo, Berntson, & Crites, 1996). Eysenck (1991) suggested that extraversion might be understood in terms of lower levels of baseline cortical arousal, but there are multiple findings problematic for this claim (Matthews & Gilliland, 1999). We suggest a different approach. One of the principle effects of arousal should be to facilitate response speed. If so, individual differences in response speed should possess predictive validity concerning the likelihood that the person would experience high arousal states like anger. We make this case before outlining our predictions.

#### 1.1. Response speed as an indicator of arousal

One of arousal's central functions should be to speed responding (Duffy, 1957), especially in simple tasks (Hindmarch, Aufdembrinke, & Ott, 1988). This idea has been validated in a number of

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experimental studies. The administration of stimulants (e.g., amphetamine) induces higher levels of subjective and cortical arousal (Hutchison, Wood, & Swift, 1999; Leyton et al., 2007). Such drugs also result in faster responses in simple cognitive tasks (Kim, Ko, Na, Park, & Kim, 2006; Riccio, Waldrop, Reynolds, & Lowe, 2001). Moderate physical exercise increases the extent to which the individual is subjectively aroused (Shields, Larson, Swartz, & Smith, 2011; Thayer, 1987) and also results in faster responses in cognitive tasks (Etnier et al., 1997; Tomporowski, 2003). Anti-anxiety drugs – especially those targeting the central nervous system – reduce subjective anxiety and also reduce response speed in cognitive tasks (Bourin, du Tertre, & Payeur, 1993; Hindmarch, 1994). Finally, both subjective arousal and response speed follow the same circadian rhythm (Bratzke, Rolke, Ulrich, & Peters, 2007; Reinberg, Ashkenazi, & Smolensky, 2007; Silva, Wang, Ronda, Wyatt, & Duffy, 2010). In sum, arousal-related manipulations systematically affect response speed.

We now consider individual differences. A number of theories of depression suggest that it is associated with low arousal and a passive mode of interacting with the environment (Gotlib & Hammen, 1992; Ingram, Scott, & Siegle, 1999; Kuhl & Helle, 1986; Mogg & Bradley, 1998). Reaction time probes of depression have proven their worth in this literature. Depressed (relative to non-depressed) individuals exhibit slower response speeds in a number of cognitive and behavioral tasks (Hoffmann, Gonze, & Mendlewicz, 1985; Sobin & Sackeim, 1997; Weckowicz, Tam, Mason, & Bay, 1978). Importantly so, such effects are episodic in that successful treatment for depression mitigates such slowed response tendencies (Ghozlan & Widlocher, 1989; Sobin & Sackeim, 1997). Whether individual differences in response speed might serve as a more general marker of arousal, in contexts other than depression, remains to be seen. Yet, there is enough research to suggest that it might. In the present studies, we suggest that faster response speed may be predictor of anger, but particularly so among disagreeable individuals.

### 1.2. Response speed as a potential predictor of anger

The activation of hostile thoughts – by manipulations such as the weapon effect or violent media exposure – often results in higher levels of subsequent aggression (Anderson & Bushman, 2002). However, such effects tend to be much more pronounced in high arousal circumstances than low arousal circumstances (Berkowitz, 1993). In related terms, Schachter and Singer (1962) showed that an irritated confederate irritated the self to a greater extent following epinephrine injections. Further, the excitation-transfer literature has shown that prior manipulations of arousal – such as by vigorous exercise – exacerbate the subsequent experience of anger and the display of aggressive behaviors to provocation and in hostile situations (Zillmann, 1996; Zillmann & Bryant, 1974). Such findings make sense in that anger – and the closely linked construct of reactive aggression (Wilkowski & Robinson, 2010) – involves some interactive combination of hostile thoughts and arousal.

Similar principles may operate in the realm of individual differences. Low levels of agreeableness predict high levels of anger (Watson, 2000). Such relations are likely attitudinal in nature as disagreeable individuals have hostile thoughts, are cynical concerning others, and are cold in their interpersonal functioning (Graziano & Eisenberg, 1997; Paulhus & Williams, 2002; Smith, Glazer, Ruiz, & Gallo, 2004). There is no evidence to suggest, however, that disagreeable individuals are typically more aroused, at least that we know of. For this reason, we suggest that an implicit indicator of arousal should be important in understanding the extent to which low levels of agreeableness predict high levels of anger. In three studies, we hypothesized that the trait of agreeableness would interact with response speed to predict state-related variations in

anger. We further hypothesized that the highest levels of anger would be observed among disagreeable individuals exhibiting fast responding in reaction time tasks.

## 2. Study 1

Study 1 constituted an initial examination of our interactive predictions. Agreeableness was assessed in self-reported trait terms. Response speed, on the other hand, was assessed across several choice reaction time tasks. Individual differences in anger were assessed in relation to recent experiences – i.e., those occurring during the previous week. We predicted that agreeableness should be a better predictor of anger among fast responders than slow responders.

### 2.2. Method

#### 2.2.1. Participants and procedures

Ninety-four (62 female) undergraduates from the University of Illinois-Champaign received course credit by their participation. All sessions involved groups of seven or less, who completed the categorization task first and the self-report measures subsequently. The order of measures is consistent with recommendations to assess more implicit processes and state-related experiences before trait measurement, given the relative malleability of the former measures relative to the latter (Robinson & Neighbors, 2006).

#### 2.2.2. Agreeableness

Individual differences in agreeableness were assessed using Goldberg's (1999) broad-bandwidth scale, shown to be reliable and valid in many previous studies (e.g., Meier & Robinson, 2004; Wilkowski, Robinson, & Meier, 2006). Participants reported on the extent (1 = *very inaccurate*; 5 = *very accurate*) to which they could generally be characterized as disagreeable (e.g., insult people) versus agreeable (e.g., have a soft heart) in relation to 10 items, the former of which were reverse-scored. Alpha for this scale was .79.

#### 2.2.3. Response speed

Individual differences in response speed can be assessed quite reliably by using basic choice reaction time (RT) tasks. To assess individual differences in speed independent of task-related considerations (Robinson & Oishi, 2006), four distinct semantic tasks were administered. In Study 1, tasks involved categorizing stimulus words as me-related (e.g., self) versus not me-related (e.g., other), feminine (e.g., emotional) versus masculine (e.g., rational), as a vegetable (e.g., carrot) or a fruit (e.g., peach), and in terms of whether they were pleasant (e.g., candy) or unpleasant (e.g., coffin) in affective connotation. There were a total of 224 trials. The particular tasks do not matter; rather, multiple tasks were administered to ensure that average RT scores reflect general tendencies rather than task-specific ones.

Instructions were presented prior to each of the separate tasks. Subsequently, participants were to press the 1 or 9 keys at the top of the keyboard as quickly as possible if the specific stimulus better matched one category (e.g., a vegetable) than the other (e.g., a fruit). Response mappings (e.g., vegetable & fruit) were presented to the left and right of the computer screen during the task. Blocks were ordered in the same sequence across participants to facilitate individual difference comparisons. To preclude response-expectancy processes, stimuli were randomly selected and assigned to individual trials. Words remained on the screen until categorized. A brief 150 ms blank delay occurred subsequent to each categorization. Error feedback was provided to encourage a high degree of accurate responding.

Individual differences in response speed were quantified as follows. Incorrect responses were somewhat rare (8.99%), but such trials were deleted as response speed is better and more unambiguously quantified in relation to correct responses (Ratcliff, 1993). The remaining RTs were log-transformed to reduce positive skew. Subsequently, very fast or slow log speed scores (2.5 SDs below or above average) were replaced with these 2.5 SD values (Robinson, 2007). Finally, average response speed scores for each individual were computed. Response speed was quite reliable: Cronbach's alpha across blocks was .91.

#### 2.2.4. State anger

We assessed individual differences in anger in terms of the well-validated subscale of Watson and Clark (1994), which asks individuals to rate the extent to which (1 = *not at all*; 5 = *extremely*) they have felt five markers of anger (angry, hostile, irritable, scornful, disgusted, & loathing). To focus on recent experiences of anger (Robinson & Clore, 2002), the time frame for reporting was the "last week". Alpha for this scale was .85.

### 3. Results

#### 3.1. Relations among the variables

Correlations among the variables, for all studies, are reported in Table 1. Although there was some tendency for disagreeable individuals to be faster in responding, this tendency was not significant. As would be expected on the basis of previous research (Martin, Watson, & Wan, 2000), agreeableness and anger were inversely correlated, though moderately so. Finally, individual differences in response speed did not predict anger arousal in zero-order terms, though there was some slight but non-significant association of this type.

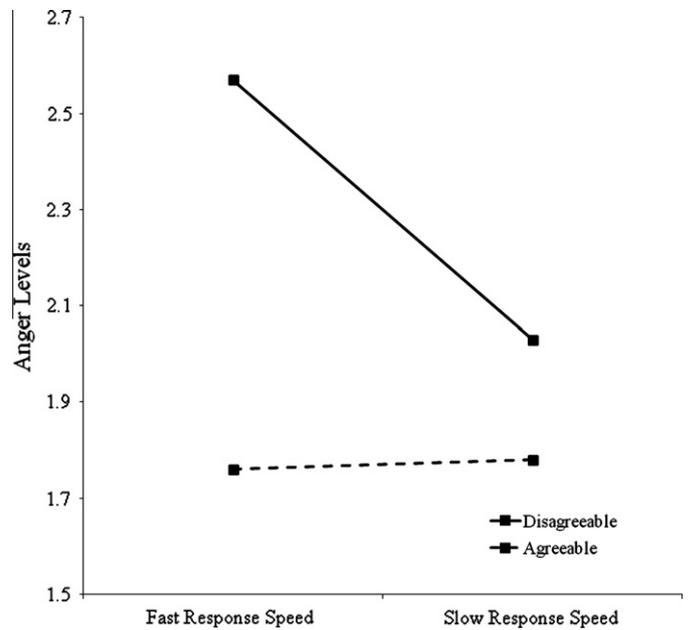
#### 3.2. Interactive hypotheses

We hypothesized that anger would interactively vary by agreeableness and response speed, such that the highest levels of it would be observed among disagreeable/fast individuals. A multiple regression was conducted to assess such predictions. First, the two predictors (agreeableness & response speed) were standardized. Second, such standardized scores were multiplied to create an interaction term. Finally, anger was predicted on the basis of both

**Table 1**  
Zero-order correlations, Studies 1–3.

	Study 1		
	1	2	
1. Agreeableness	—		
2. Response speed	-.19	—	
3. Anger levels	-.33*	-.16	
	Study 2		
	1	2	
1. Agreeableness	—		
2. Response speed	-.12	—	
3. Anger levels	-.20*	-.01	
	Study 3		
	1	2	3
1. Agreeableness	—		
2. Response speed	-.09	—	
3. Lab anger	-.27*	-.04	—
4. Daily anger	-.18	-.09	.56*

\*  $p < .05$ .



**Fig. 1.** Anger as a function of agreeableness and response speed, Study 1.

standardized main effects and the relevant interactive term (Aiken & West, 1991).

Agreeableness predicted anger in this multiple regression,  $\beta = -.38$ ,  $t = -4.08$ ,  $p < .01$ , as did response speed,  $\beta = -.19$ ,  $t = -2.06$ ,  $p < .05$ . Both disagreeable and fast individuals, then, reported higher levels of anger in their daily lives. Of more importance, there was a significant agreeableness by response speed interaction,  $\beta = .24$ ,  $t = 2.59$ ,  $p < .05$ . To interpret the interaction, we used the regression equation to estimate anger means for individuals low ( $-1$  SD) versus high ( $+1$  SD) in agreeableness who were comparatively fast ( $-1$  SD) versus slow ( $+1$  SD) in the reaction time task (Aiken & West, 1991).

These estimated means are displayed in Fig. 1 and they suggest that low levels of agreeableness predicted higher levels of anger only among fast (presumably more aroused) individuals. This interpretation of the interaction was statistically supported in terms of simple slopes analyses (Aiken & West, 1991). Among fast ( $-1$  SD) individuals, agreeableness was a strong inverse predictor of anger,  $\beta = -.59$ ,  $t = -4.70$ ,  $p < .01$ . Among slow ( $+1$  SD) individuals, there was no such relationship,  $\beta = -.18$ ,  $t = -1.49$ ,  $p > .10$ .

#### 3.3. Follow-up analysis

In Study 1, there was a significant correlation between response speed and accuracy such that slower individuals tended to be more accurate,  $r = .33$ ,  $p < .05$ . We therefore re-ran the multiple regression reported above while simultaneously controlling for response accuracy. The agreeableness by response speed interaction remained significant in this follow-up analysis,  $\beta = .26$ ,  $t = 2.68$ ,  $p < .01$ , thus mitigating potential concerns related to speed-accuracy tradeoffs.

### 4. Discussion and Study 2

Disagreeable, relative to agreeable, individuals endorse more hostile thoughts concerning others and the interpersonal world more generally (Paulhus & Williams, 2002). For such thoughts to predict anger, though, a certain propensity toward arousal would seem to be necessary as anger is a high arousal state (Watson, 2000). Our literature review led us to posit that individual differ-

ences in response speed might serve as an indicator of such a propensity. On the basis of these ideas, we hypothesized that agreeableness would interact with response speed to predict state-related experiences of anger. Just such an interaction was found and the highest levels of anger were observed among disagreeable/fast individuals. Although predicted, the interactive results of Study 1 were novel and therefore required replication. In addition, one limitation of the Study 1 design was that it was strictly cross-sectional in nature in that all variables were assessed at the same time. In Study 2, instead, we instituted a temporal lag between assessments of the predictor variables and anger experiences.

## 5. Method

### 5.1. Participants and procedures

The Study 2 sample consisted of 129 (77 female) undergraduates from the University of Illinois-Champaign who received extra credit. In an initial assessment session, individual differences in response speed were assessed and then levels of personality agreeableness were assessed afterwards. Tendencies to experience anger in daily life were quantified two weeks later, upon returning to the laboratory.

### 5.2. Measures

The personality trait of agreeableness was assessed in relation to the same Goldberg (1999) scale used in Study 1 ( $\alpha = .83$ ). The other predictor was response speed. For the sake of generalizability, we used different choice blocks in Study 2 than in Study 1. Participants were asked to classify words as: pleasant (e.g., candy) versus unpleasant (e.g., dirt), animal words (e.g., mouse) versus not animal words (e.g., mop), threatening (e.g., knife) versus not (e.g., mildew), neutral (e.g., apple) versus pleasant (e.g., kiss), neutral (e.g., coffee) versus unpleasant (e.g., coffin), and wealth-related (e.g., money) versus not (e.g., sunset) in six consecutive blocks. There were a total of 322 trials. This battery has been validated in previous studies in terms of high accuracy rates (Robinson, Meier, & Solberg, 2005).

Choice blocks were ordered as mentioned above so that the assessment was constant across individuals. Stimuli were chosen at random, however, to preclude expectancy effects. As in Study 1, screens introduced each task, responses were made with the 1 and 9 keys at the top of the keyboard, and mappings were provided to the left and right of the computer screen. Timing factors were practically identical to Study 1, except for a 2000 ms error message in the case of inaccurate responding. Individual differences in response speed were scored exactly as in Study 1. Errors were infrequent (5.11%) and individual differences in response speed were quite reliable as assessed across tasks ( $\alpha = .91$ ).

Two weeks subsequent to assessing response speed and then agreeableness, participants returned to the lab and completed a state anger measure. The measure was the same as in Study 1 (Watson & Clark, 1994) with the same “last week” time frame ( $\alpha = .85$ ). Because of the temporal lag instituted in Study 2, though, reports of state anger would necessarily encompass a time frame different from that in which the predictors were assessed.

## 6. Results

### 6.1. Relations among the variables

As shown in the second panel of Table 1, agreeableness was a negative predictor of anger, though this relation was not particularly strong. Agreeableness did not predict response speed in zero-order

terms, nor was this relationship expected. Finally, response speed was not a significant predictor of anger in “main effect” terms.

### 6.2. Interactive hypotheses

Agreeableness and response speed were hypothesized to interactively predict anger. A multiple regression, parallel to Study 1, was performed to test this proposed interactive relationship. The main effect for agreeableness was significant in the multiple regression,  $\beta = -.25$ ,  $t = -2.81$ ,  $p < .01$ . The main effect for response speed was not significant,  $\beta = -.01$ ,  $t = -.14$ ,  $p > .85$ . More importantly, agreeableness and response speed were again found to interactively predict state-related experiences of anger,  $\beta = .18$ ,  $t = 2.05$ ,  $p < .05$ .

Estimated means for the interaction are displayed in Fig. 2. Simple slopes analyses were then performed. Among fast individuals ( $-1$  SD on the response speed measure), agreeableness was a robust predictor of anger,  $\beta = -.40$ ,  $t = -3.11$ ,  $p < .01$ . Among slow individuals ( $+1$  SD), on the other hand, agreeableness was not a significant predictor of experiences of anger,  $\beta = -.09$ ,  $t = -.95$ ,  $p > .85$ . These results again indicate that it is a combination of low agreeableness and fast responding that predicts the highest levels of anger arousal. In Study 2, there was no relationship between response speed and response accuracy,  $r = .05$ ,  $p = .50$ , and we therefore omitted follow-up testing of the sort reported in Study 1.

## 7. Discussion and Study 3

The most important goal of Study 2 was to replicate the interactive pattern observed in Study 1, which was a novel one. We were able to replicate this interactive pattern using a different sample and a different set of categorization blocks. Furthermore, the replicated interactive findings cannot be ascribed to order effects among the measures or same-session interpretations of the relations observed. Truly so, it appears that faster response speeds potentiate the anger of disagreeable individuals.

A significant limitation of Studies 1 and 2, however, is that anger experiences were assessed by one report only. Potentially stronger conclusions could be made to the extent that the same interactive relationship predicts anger aggregated across multiple

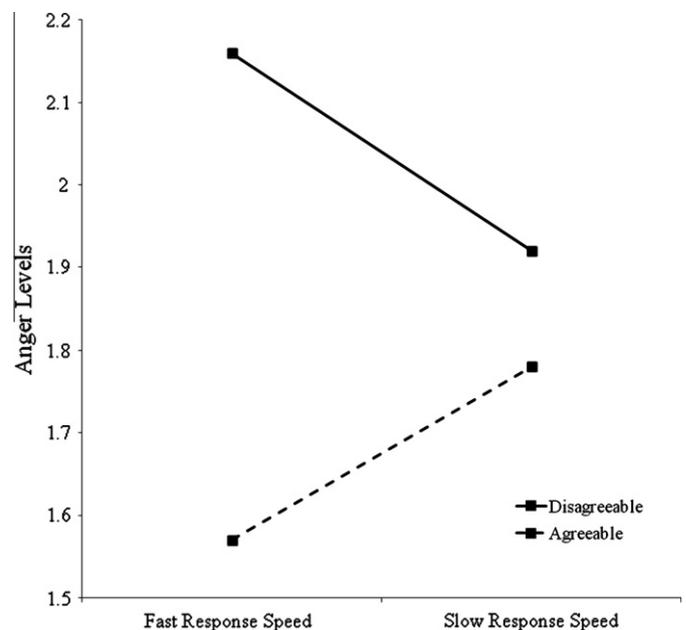


Fig. 2. Anger as a function of agreeableness and response speed, Study 2.

assessments (Epstein, 1983) and potentially so in relation to more momentary experiences of anger, as can be assessed in experience-sampling protocols (Bolger, Davis, & Rafaeli, 2003). In addition, it would be of value to show that the interactions observed in Studies 1 and 2 also characterize the percentage of waking time that anger is experienced, termed a duration-based emotion assessment by Schimmack, Oishi, Diener, and Suh (2000).

## 8. Method

### 8.1. Participants and procedures

Ninety-six (69 female) undergraduate students from a University of Illinois-Champaign personality psychology class received course credit by their participation. In the middle of the semester, they came to a computer lab and completed categorization tasks in groups of 10 or less. Subsequent to the computer task, they reported on their levels of agreeableness. The dependent measures – see below for further details – spanned the rest of the semester.

### 8.2. Predictors

In addition to the conceptual replication efforts mentioned above, the personality trait of agreeableness was assessed in a different manner than in Studies 1 and 2. Goldberg (1992) suggests that trait-related adjectives rather than statements may better assess agreeableness from a lexical perspective. Following this suggestion, Study 3 assessed agreeableness using the 20 unipolar markers reported in Goldberg's paper. Participants reported on the extent (1 = *very inaccurate of me*; 5 = *very accurate of me*) to which they could generally be described in terms of high agreeable (e.g., cooperative) versus low agreeable (e.g., demanding) markers. Low agreeable markers were reverse-scored and the scale was reliable ( $\alpha = .86$ ).

Individual differences in response speed were assessed in a more comprehensive manner than in Study 1. Procedures for the task – including instruction screens, the provision of response-mappings, and the duration of error feedback – were identical to Study 2. However, more choice tasks were administered. Participants categorized stimuli as animal (e.g., mouse) versus not animal (e.g., mop), neutral (e.g., shoe) versus unpleasant (e.g., dirt), neutral (e.g., coffee) versus pleasant (e.g., kiss), threatening (e.g., cancer) versus not (e.g., mildew), intense (e.g., loud) versus not intense (e.g., quiet), and masculine (e.g., forceful) versus feminine (e.g., sympathetic). There were 276 trials in all. Errors were infrequent (6.31%). Individual differences in response speed were scored as in prior studies ( $\alpha = .92$ ).

### 8.3. Anger outcomes

Because the sample completed multiple assessments as part of a personality class, we could assess anger over time and across days. The first measure was completed four times spanning the semester and none of these assessments occurred during the week that the predictors were measured. Following Schimmack et al. (2000), individuals were asked to report on the percentage of time that they had recently experienced five markers of anger (items = angry, annoyed, disgusted, hostile, & irritable) along an 8-point scale (e.g., 4 = 25–50% of their waking lives). Cronbach's alpha was .76 for this scale across the four occasions.

Anger experiences were also assessed in a daily-reporting protocol conducted toward the end of the semester. For each of 14 days in a row, participants were to reflect on their daily experiences and indicate the percentage of waking time for that day

that they experienced several markers of anger. The items rated, as well as the response scale, were identical to those of the previous paragraph. Each daily report was completed after 8 p.m. and returned to the department the next day. Compliance rates were excellent as the average participant deposited 94.4% of the daily reports. Cronbach's alpha for the anger scale was .80 across days, indicating robust individual differences in the duration of anger experiences.

## 9. Results

### 9.1. Relations among the variables

For the sake of parsimony, we refer to the two outcome measures in terms of lab and daily assessments of anger duration. Levels of personality agreeableness were inversely predictive of lab reports of anger duration, but marginally predictive of daily reports of anger duration. The two anger outcome measures were positively correlated with each other, indicating general tendencies toward anger. Agreeableness and response speed were not correlated. Finally, response speed did not, by itself, predict lab or daily levels of anger. These correlational findings are broadly consistent with those of Studies 1 and 2.

### 9.2. Interactive hypotheses

We again hypothesized that agreeableness and response speed would interact to predict anger experiences, here of a duration-based type. Because multiple assessments of anger were obtained, we first examined whether the data were best modeled in a simple fashion – in which anger experiences were averaged across assessments – or were better modeled in multi-level terms (i.e., observations nested within individuals). Results were the same in either case. Further, a comparison of multi-level models and least squared models revealed no significant differences between parameter estimates for the two types of models. Accordingly, the simpler least squared estimates are reported, following the recommendations of Tabachnick and Fidell (2007).

In the multiple regression predicting lab-based reports of anger, there was a main effect for agreeableness,  $\beta = -.30$ ,  $t = -3.26$ ,  $p < .01$ , but not response speed,  $\beta = -.08$ ,  $t = -0.91$ ,  $p > .35$ . Of more importance, these predictors significantly interacted with each other,  $\beta = .29$ ,  $t = 3.13$ ,  $p < .01$ . Estimated means for the interaction are reported in the top panel of Fig. 3 and they suggest findings quite parallel to the prior studies. Simple slopes analyses (Aiken & West, 1991) confirmed this point. For fast individuals ( $-1$  SD levels of response speed), agreeableness was a significant predictor of anger,  $\beta = -.60$ ,  $t = -4.27$ ,  $p < .01$ . For slow individuals ( $+1$  SD), there was no relationship between agreeableness and anger,  $\beta = -.00$ ,  $t = .05$ ,  $p > .95$ .

In the multiple regression predicting daily reports of anger, parallel results were obtained. The multiple regression revealed that agreeableness was an inverse predictor of anger,  $\beta = -.20$ ,  $t = -2.08$ ,  $p < .05$ . Faster responding marginally predicted higher levels of daily anger,  $\beta = -.16$ ,  $t = 1.64$ ,  $p = .10$ . These effects were qualified by a significant agreeableness by response speed interaction,  $\beta = .19$ ,  $t = 2.01$ ,  $p < .05$ , estimated means for which are displayed in the bottom panel of Fig. 3. Follow-up simple slopes analyses revealed that agreeableness was a significant predictor of daily anger among fast ( $-1$  SD) responders,  $\beta = -.40$ ,  $t = -2.81$ ,  $p < .01$ , but was a non-significant predictor among slow ( $+1$  SD) responders,  $\beta = -.00$ ,  $t = -.07$ ,  $p > .90$ . As in Study 2, accuracy was not correlated with speed,  $r = .06$ ,  $p = .52$ .

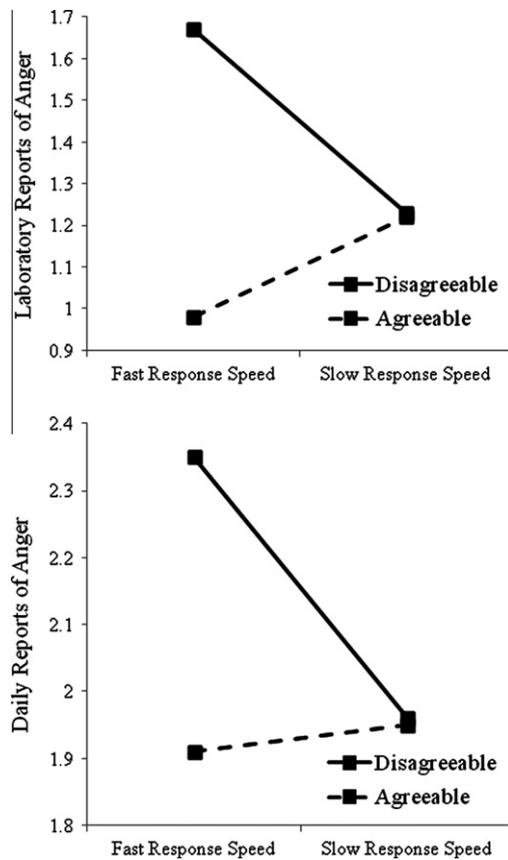


Fig. 3. Interactions between agreeableness and response speed in predicting laboratory reports of anger (top panel) and daily reports of anger (bottom panel), Study 3.

## 10. Discussion

Unlike the prior studies, Study 3 assessed anger experiences throughout the course of an entire semester and also in terms of daily experiences. Additionally, the focus was on the percentage of time that individuals experienced anger. Regardless, results were substantially the same: Anger experiences varied jointly by agreeableness and response speed and the most problematic levels of anger were particular to hostile (i.e., disagreeable) individuals who were also fast in their response speed.

## 11. General discussion

Response speed in the absence of manipulations may serve as an indicator of the individual's general or dispositional propensity toward high arousal states. This idea was examined in the context of understanding the agreeableness–anger relationship. In three studies, it was found that response speed interacted with the trait of agreeableness to predict anger, a high-arousal emotional state. Agreeableness–anger relations were pronounced among fast responders, but absent among slow responders and the highest levels of anger were observed among disagreeable/fast responders. In this section, we consider our cognitive probe in more depth, revisit the basis of our interactive predictions, and present directions of future research in a manner informed by the present findings.

### 11.1. Response speed as an index of arousal

Response speed is sensitive to manipulations of arousal, whether drug-induced (Riccio et al., 2001), based on circadian

rhythms (Silva et al., 2010), or physiological activity (Etnier et al., 1997). In addition, response speed tracks depression levels, which are often viewed in terms of low levels of arousal and/or activation (Sobin & Sackeim, 1997). In the present studies, we did not manipulate arousal levels, but rather assessed response speed as an individual difference variable. Such individual differences, we suggest and our results corroborate, are a consequential predictor of proneness toward high arousal states, at least in the realm of state-related anger. Nonetheless, our probe of individual differences in arousal is largely novel to the personality literature and requires further discussion.

In some cognitive tasks, faster responding predicts less accurate responding (Sanders, 1998). There is sometimes, then, what is termed a speed–accuracy tradeoff such that fast responders trade speed for accuracy and exhibit many errors as a result (Wickelgren, 1977). Such tradeoffs are deemed problematic to the cognitive literature, but they were generally not observed in the present studies, likely so because a substantial penalty for errors was administered (Pashler, 1998). Study 1 was the only one in which faster responders were more error-prone and controlling for accuracy rates still resulted in a significant agreeableness by response speed interaction. On the basis of the present procedures, then, response speed cannot be interpreted in terms of this speed–accuracy tradeoff or potential extensions to the personality literature such as impulsive responding.

There are various indices of arousal and most of them assess peripheral physiology (e.g., skin conductance, heart rate). Response speed, we doubt, predicts such peripheral measures of physiology. Rather, it assesses arousal in a more central cortical manner. Given the role that the neurotransmitter norepinephrine plays in mediating levels of alertness and readiness to respond, this neurotransmitter system and its frontal projections likely underlie at least a proportion of variance in response speed (Arnsten & Robbins, 2002). In any case, behavioral measures such as response speed are valuable precisely because they reflect outputs of multiple brain mechanisms and processes in an integrative, easy-to-assess manner.

Even so, response speed itself is likely reflective of several factors. Certainly, there is some relation between response speed and the *g* factor of intelligence (Jensen, 1998). On the other hand, simple tasks like ours are likely to be *g*-loaded to a lesser extent than are more complex tasks – e.g., those in which a stimulus must be classified in terms of one of eight (rather than two) response options or those imposing a working memory load (Jensen, 2006). This is especially the case among relatively well-functioning and similarly-aged adults such as those constituting our samples. In any case, the fact that circadian rhythms (Silva et al., 2010) and central stimulants (Riccio et al., 2001) influence response speed suggests that response speed is sensitive to arousal-based variables and manipulations. Thus, individual differences in response speed should have significant implications for understanding individual differences in arousal-related outcomes. Our view is that slow response speed, in particular, is incompatible with an aroused mode of interacting with the environment and it was for this reason that low levels of anger were generally observed among slow responders in the present studies.

### 11.2. Discussion of the interactive findings

Our interactive results were robust across studies and outcome assessments. The particular interactive pattern merits further discussion. Agreeableness was a non-significant predictor of anger among slow responders. We suggest that this was so because anger is a high arousal emotional state and slow response speed is incompatible with aroused states like anger. Response speed predicted higher levels of anger among disagreeable individuals, but

was generally not predictive of anger among agreeable individuals (see Figs. 1–3). Such findings also make sense because anger is precipitated by hostile thoughts (Anderson & Bushman, 2002), agreeable individuals do not harbor such hostile thoughts (Martin et al., 2000), and – therefore – agreeable individuals should not be prone to anger regardless of their arousal levels (Wilkowski & Robinson, 2008). Quite the contrary, agreeable/fast responders might instead experience greater levels emotional empathy, a prosocial emotion that is both agreeable and has some basis in higher levels of arousal (Graziano & Eisenberg, 1997).

We focused on anger in the present studies, but the interaction observed should be relevant in the prediction of other outcomes as well. Perhaps first and foremost, similar interactions should be observed in relation to what is termed emotional or reactive aggression (Wilkowski & Robinson, 2010). Additionally, the interaction should be found in predicting provocation-induced aggression in the laboratory (Bettencourt, Talley, Benjamin, & Valentine, 2006). The interaction might also characterize responses to violent media exposure (Anderson & Bushman, 2002) and perhaps excitation-transfer effects of the sort highlighted by Zillmann (1996). From a broader perspective, some of the problematic outcomes predicted by low levels of agreeableness – such as quarrelsomeness (Moskowitz, 2010), relationship conflicts (Smith et al., 2004), and vindictive interpersonal strategies (Buss, 1992) – should similarly vary as a function of both levels of agreeableness and individual differences in response speed.

The interactions found may also have health-related implications. On the basis of clinical interviews, Friedman and Rosenman (1959) contrasted Type A and Type B personalities, the former personality type characteristic of patients exhibiting cardiovascular disease to a greater extent. The Type A personality was defined in terms of both hostile attitudes and some degree of impatience (among other indicators). The Type B personality was characterized in opposite terms (Davis & Cowles, 1985). Subsequent results linked Type A personality to greater increases in blood pressure in anticipation of a difficult task (Gastorf, 1981), coronary artery occlusions (Williams et al., 1980), angina symptoms (Haynes, Feinleib, Levine, Scotch, & Kannel, 1978), and the prospective prediction of cardiovascular disease development in epidemiological studies (Dembroski, MacDougall, Costa, & Grandits, 1989). Hostility, we suggest, is a feature of low levels of agreeableness (Paulhus & Williams, 2002). Impatience, on the other hand, might have some relationship to our cognitive probe of response speed. If so, the present results might have implications for understanding cardiovascular disease risk factors and outcomes, which should vary interactively by agreeableness and response speed according to our findings.

### 11.3. Additional considerations and conclusions

We view response speed as a non-specific indicator of arousal. Its effects should vary by the trait in question. From this perspective, response speed should interact with the trait of neuroticism to predict high arousal states such as anxiety and should interact with the trait of extraversion to predict high arousal states such as excitement (Watson, 2000). Investigations of this type have yet to be performed. Regardless, though, response speed was shown to moderate the agreeableness-anger relationship in several studies.

We do not wish to suggest that slow responders are un-traited (Baumeister & Tice, 1988). Rather, our findings suggest that high arousal emotional states, at least, can be best understood in interactive terms. We offer our cognitive probe of individual differences in arousal in this context. Perhaps most generally, we have shown that a cognitive probe – and a very reliable one – has important implications for understanding the manner in which a self-reported

personality trait functions from an outcome-related perspective. We advocate further investigations of the present type, which can better reconcile trait-related and cognitive perspectives of the individual (e.g., McClelland, 1951; Robinson & Neighbors, 2006).

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