
On the Social Nature of Personality: Effects of Extraversion, Agreeableness, and Feedback About Collective Resource Use on Cooperation in a Resource Dilemma

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The present research investigated how individual differences in Extraversion and Agreeableness affect cooperation in an experimental resource dilemma. Manipulated feedback indicated either that the common resource was being used at a sustainable rate or that it was being rapidly depleted. As predicted, Extraversion was generally negatively related to cooperation, whereas Agreeableness was generally positively related to cooperation. Whereas individuals high in Extraversion and individuals low in Agreeableness were unresponsive to feedback regarding collective resource use, individuals low in Extraversion and individuals high in Agreeableness exercised more self-restraint when the common resource was severely threatened. Exploratory analyses revealed neither interactive effects of Extraversion and Agreeableness nor effects of individual differences in Conscientiousness, Emotional Stability, and Intellect. Together, these results highlight the importance of individual differences in Extraversion and Agreeableness in social dilemma settings.

Overcoming one's personal limitations often can be accomplished by cooperating with others. Through coordinated efforts, a group may outdo even the most spectacularly talented individual acting alone. The social group can thus provide a powerful buffer against the demands of the physical environment (Brewer, in press; Buss, 1991b; Leaky, 1978; Simon, 1990). However, to

reap the rewards of interindividual cooperation, individual group members frequently have to make personal sacrifices. A classic example is Hardin's (1968) tragedy of the commons, in which each herdsman profits from keeping as many cattle as possible on a common pasture but all herdsmen face ruin from overgrazing if they add too many animals to the common land. In such cases, individual group members are faced with the social dilemma of choosing between their personal interests and the collective interests of their social group (Dawes, 1980; Komorita & Parks, 1995; Messick & Brewer, 1983; Van Lange, Liebrand, Messick, & Wilke, 1993).

The capacity for cooperation is probably present within every human being. Nonetheless, the strength of that capacity may vary across situations and persons. The social dilemma literature has successfully identified a number of situational variables that may elicit or undermine cooperative behavior (for reviews, see Komorita &

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Parks, 1995; Messick & Brewer, 1983; Van Lange et al., 1993). One important situational variable is the behavior of other group members. Although the influence of others' behavior may be moderated by many other variables, one consistent finding is that people often reciprocate the level of cooperativeness displayed by others (e.g., Kelley & Stahelski, 1970; McClintock & Liebrand, 1988; Rubin & Brown, 1975; Wyer, 1969). Unfortunately, research has remained inconclusive regarding the role of personality in social dilemmas (for reviews, see Rubin & Brown, 1975; Terhune, 1970; Thompson, 1990). The failure to find consistent personality effects has led some researchers in the field to question the importance of personality characteristics as determinants of social conflict behavior (e.g., Davis-Blake & Pfeffer, 1989; Lewicki, Litterer, Minton, & Saunders, 1994; Worchel, 1986).

However, it seems premature to conclude that personality plays no significant role in social dilemmas. On a theoretical level, psychoevolutionary models suggest that environmental pressures may give rise to individual differences in levels of cooperativeness (Buss, 1997; Graziano & Eisenberg, 1997; Hogan, 1982; Tooby & Cosmides, 1990). In particular, different individuals may be confronted with environments that differ in the adaptiveness of cooperative behavior. For example, individuals raised in large families as opposed to individuals raised in small families may more frequently encounter situations in which resources have to be shared (Van Lange, Otten, De Bruin, & Joireman, 1997). As a result of such recurrently different environmental pressures, stable individual differences may develop in preferred behavioral strategies in interdependent situations (Buss, 1997; Tooby & Cosmides, 1990). Empirically, critics have pointed out numerous shortcomings in previous research into the influence of personality characteristics in social dilemmas, such as unresolved trait measurement issues, insufficiently rich and complex social dilemma simulations, and a neglect of situational moderators (e.g., Nemeth, 1972; Terhune, 1970; Thompson, 1990).

THE SEARCH FOR A GENERAL TAXONOMY OF INTERPERSONAL PERSONALITY TRAITS

One of the most important obstacles in the study of personality in social interaction has been a lack of consensus on how personality should be defined and measured. Some researchers have attempted to circumvent this problem by inferring the dispositional variable of cooperativeness from different patterns of behavioral choices (e.g., Kuhlman & Marshello, 1975; Liebrand & Van Run, 1985; Messick & McClintock, 1968; Van Lange & Kuhlman, 1994). Although such a behavioral approach avoids many problematic issues relating to measurement and definition that have plagued conventional personal-

ity constructs, it also has important limitations. First, the behavioral approach does not provide a common conceptual language that specifies the relations between behavioral measures of interpersonal dispositions and other personality constructs. This language barrier makes it difficult to integrate findings from different areas, impeding the accumulation of scientific findings. Second, it remains unclear to what extent behavioral measures are able to gauge cross-situational dispositions. Some studies indicate that the predictive validity of behavioral measures can vary considerably depending on their particular format (Parks, 1994). Moreover, behavioral decisions may be influenced by even very subtle situational cues (Hertel & Fiedler, 1998; Neuberg, 1988), which may further undermine the ability of behavioral measures to tap into cross-situational dispositions. In light of these considerations, it seems desirable to arrive at a generic conceptual framework of interpersonal dispositions that encompasses both behavioral and conventional personality approaches.

Fortunately, researchers have recently made important advances toward establishing such a general framework of interpersonal dispositions. Over the last two decades, personality researchers have reached a consensus that the domain of interpersonal traits can be adequately described by two dimensions¹ (e.g., De Raad, 1995; McCrae & Costa, 1989; Trapnell & Wiggins, 1990). Evidence for this taxonomic framework stems from two independent lines of research. The first originates in social-clinical psychology (Freedman, Leary, Ossorio, & Coffey, 1951; see Trapnell & Wiggins, 1990), in which the two dimensions have been labeled Dominance and Nurturance (e.g., Wiggins, 1979, 1980). The second line of research originates in the lexical/factor-analytic tradition (e.g., De Raad, 1995; McCrae & Costa, 1989), in which the two dimensions have been labeled Extraversion and Agreeableness. The different labels reflect somewhat differing locations of the two defining axes in the interpersonal trait domain: The Dominance-Nurturance axes were located on theoretical grounds, whereas the Extraversion-Agreeableness dimensions were located by means of factor-analytic procedures (see De Raad, 1995; Hofstee, De Raad, & Goldberg, 1992; McCrae & Costa, 1989; Trapnell & Wiggins, 1990). The Extraversion-Agreeableness framework is part of a five-factor taxonomy that has gained considerable support in the field of personality (Hofstee et al., 1992; John, Angleitner, & Ostendorf, 1988; McCrae & John, 1992). Moreover, the Extraversion-Agreeableness framework is increasingly used in the social psychological research (e.g., Barry & Friedman, 1998; Buss, 1991a, 1992; Caldwell & Burger, 1997; David & Suls, 1999; Graziano, Hair, & Finch, 1997; Graziano, Jensen-Campbell, & Hair, 1996; Suls, Martin, & David, 1998). We therefore use the labels of

Extraversion, which is associated with being sociable, talkative, and active, and Agreeableness, which is associated with being trusting, cooperative, and tolerant. It may be noted that, empirically, Extraversion-Dominance and Agreeableness-Nurturance correlations are often in the .60s and higher (e.g., De Raad, 1995; Trapnell & Wiggins, 1990).

As a taxonomy of interpersonal personality characteristics, the Extraversion-Agreeableness framework offers important advantages to the study of personality in social interaction. First, the taxonomy may serve as an integrative framework for previous work in the field because every personality trait that is intrinsically interpersonal can be expected to fall within the two-dimensional trait domain that comprises Extraversion and Agreeableness (De Raad, 1995; McCrae & Costa, 1989; Trapnell & Wiggins, 1990). Thus, the framework permits researchers to go beyond isolated traits to examine empirical regularities across a broad range of personality constructs. Second, Extraversion and Agreeableness refer to relatively decontextualized dimensions of personality. Consequently, individual differences in Extraversion and Agreeableness can be expected to relate to behavioral tendencies across a wide range of interpersonal settings. Third, factor-analytic evidence indicates that Extraversion and Agreeableness are among the most reliable personality dimensions to emerge across different cultures and language domains (e.g., Digman & Takemoto-Chock, 1981; Hofstee et al., 1992; John et al., 1988; McCrae & Costa, 1987; Trapnell & Wiggins, 1990). This enables researchers to examine empirical regularities that exist across different cultures. In sum, the Extraversion-Agreeableness framework promises to be a suitable starting point for the analysis of the role of personality in interpersonal interaction, particularly in social dilemmas.

EFFECTS OF EXTRAVERSION AND AGREEABLENESS ON COOPERATION

Few studies have systematically examined the role of Extraversion and Agreeableness in interpersonal conflict. Moreover, Extraversion and Agreeableness have mostly been studied separately. In one study involving hypothetical scenarios of conflict situations, Norman and Watson (1976) found that individuals low on Extraversion rated interpersonal conflicts as more aversive than did individuals high on Extraversion. These results were replicated by Graziano, Bernstein-Feldesman, and Rahe (1985), who speculated that introverts may be more motivated to avoid the arousal associated with competitive situations. Thus, it appears that individuals low on Extraversion are more inclined toward cooperation than are individuals high on Extraversion, because people who cooperate are more

likely to avoid interpersonal conflict (e.g., Kelley & Stahelski, 1970). Consistent with this notion, Bem and Lord (1979) found that individuals classified as cooperators were described by their roommates as introverted, whereas individuals classified as noncooperators were consistently described as extraverted. In sum, the available evidence suggests that individuals low on Extraversion are more inclined to behave cooperatively than are individuals high on Extraversion. This may seem at odds with the popular meaning of the trait "extraverted," which has "friendly" connotations as well (Hofstee et al., 1992). Within the Extraversion-Agreeableness framework, however, friendly connotations of Extraversion are entirely subsumed under the Agreeableness dimension; therefore, this contradiction is more apparent than real.

Theoretically, Agreeableness has been related to a motivation to maintain positive relations with others. Some authors have linked this motivation to an evolved willingness to suspend one's individual interests for the good of one's social group (Buss, 1991b; Digman & Takemoto-Chock, 1981; Graziano & Eisenberg, 1997). A set of recent studies has subjected the supposed link between Agreeableness and cooperative behavior to empirical testing. In a study of manipulation tactics in intimate relationships, Buss (1992) found that individuals high on Agreeableness used more constructive conflict resolution strategies, such as pleasure induction and reason, than did individuals low on Agreeableness. Moreover, individuals high on Agreeableness were less likely to use coercive conflict resolution strategies than were individuals low on Agreeableness. In another study, individuals low on Agreeableness were found to be less considerate to their marriage partners than were individuals high on Agreeableness (Buss, 1991a). In a related vein, Graziano et al. (1996) reported two studies in which individuals high on Agreeableness displayed stronger preferences for constructive conflict resolution strategies over power assertion tactics compared to individuals low on Agreeableness. Graziano et al. (1997) replicated and extended these findings by showing that individuals high on Agreeableness behaved less competitively during a group task compared with individuals low on Agreeableness. Overall, the available evidence suggests that individuals high on Agreeableness are generally more inclined to behave cooperatively than are individuals low on Agreeableness.

THE PRESENT RESEARCH AND HYPOTHESES

The present research investigated how individual differences in Extraversion and Agreeableness affect cooperation in a social dilemma setting. Our earlier discussion suggested that individuals low on Extraversion are more averse to competitive situations than are individu-

als high on Extraversion. Because cooperation often is reciprocated by others (e.g., Kelley & Stahelski, 1970), one way to avoid interpersonal conflict is to display highly cooperative behavior. Accordingly, we expected individuals low on Extraversion to be generally more cooperative than individuals high on Extraversion (Bem & Lord, 1979; Graziano et al., 1985; Norman & Watson, 1976). The foregoing discussion also indicated that individuals high on Agreeableness are more inclined to care about the collective interests of their social group. Consequently, we expected individuals high on Agreeableness to be generally more cooperative than individuals low on Agreeableness (Buss, 1991a, 1992; Graziano et al., 1996, 1997).

Previous work on the role of personality in social interaction has been criticized for an underemphasis of the role of situations (Buss, 1987; Rubin & Brown, 1975; Terhune, 1970; Thompson, 1990). To overcome this limitation, the present research employed a resource dilemma paradigm in which individuals made consecutive decisions as to how much to take from a collective resource that was replenished at a fixed rate (e.g., Brewer & Kramer, 1986; Liebrand, 1984). Thus, we could examine the influence of Extraversion and Agreeableness during repeated interactions. During these interactions, we supplied participants with manipulated feedback about collective resource use so that we could study how personality characteristics interacted with perceived level of threat to the collective resource.

Primarily self-interested individuals tend to believe that noncooperation is the strongest and most intelligent strategy in social dilemmas (Van Lange & Kuhlman, 1994). In addition, self-interested individuals typically display low levels of cooperative behavior, showing a tendency to exploit other group members' cooperative behavior whenever it occurs (Kelley & Stahelski, 1970; McClintock & Liebrand, 1988). Consequently, individuals high on Extraversion and individuals low on Agreeableness were expected to display low levels of cooperation (i.e., high resource use) independent of feedback about other group members' behavior. In contrast, cooperatively oriented individuals are known to be responsive to the level of cooperation by other group members. Although cooperatively oriented individuals are concerned with outcomes associated with mutual cooperation, they often react to exploitation by behaving noncooperatively (e.g., Kelley & Stahelski, 1970; Kramer, McClintock, & Messick, 1986). Consequently, individuals low on Extraversion and individuals high on Agreeableness were expected to reciprocate the level of cooperation by other group members. In response to cooperative group members, individuals low on Extraversion and individuals high on Agreeableness were expected to behave more cooperatively, whereas in

response to noncooperative group members they were expected to behave less cooperatively.

In the resource dilemma under study, preservation of the collective resource was partly determined by the consumption patterns of the individual group members. As long as the collective resource was not under risk of being depleted, there was little pressure on individuals to reduce their consumption to preserve the collective resource. This low-threat situation occurred when collective consumption took place at a sustainable rate or at the early stages of collective overconsumption. However, when the collective resource continued to be overused, the risk of its extinction would become more and more apparent. We suspected that this would increase the concerns to preserve the collective resource among cooperatively oriented individuals (see Kramer et al., 1986, for a similar argument). Thus, individuals low on Extraversion and individuals high on Agreeableness were expected to reciprocate collective overuse but only as long as the collective resource was not under risk of depletion. When collective overuse continued to the point of imminent depletion, individuals low on Extraversion and individuals high on Agreeableness might switch to lower levels of resource use to avert depletion of the collective resource.

Consistent with psychometric evidence (e.g., Trapnell & Wiggins, 1990), and experimental evidence regarding the differential motivational underpinnings of Extraversion and Agreeableness (e.g., Graziano et al., 1985, 1997), we regard Extraversion and Agreeableness as two orthogonal determinants of interpersonal behavior. Consequently, we expected to find negligible correlations between these two constructs. In addition, the predicted effects of each dimension should remain reliable after controlling for each other's influence. The conceptual independence of Extraversion and Agreeableness further opens up the possibility that these personality dimensions interact with each other to predict cooperative behavior. For instance, individuals low on Extraversion and high on Agreeableness might be especially prone to being cooperative. Although it is unclear whether this would occur over and above the additive effects of Extraversion and Agreeableness, this possibility seemed of sufficient interest to merit further exploration in the present research.

Finally, the present research explored the influence of three other broad personality dimensions: Conscientiousness, Emotional Stability, and Intellect. These three broad personality dimensions were considered potentially important because they, together with Extraversion and Agreeableness, are among the five most robust personality dimensions to have surfaced in a large number of factor-analytic studies (see Digman, 1990; John et al., 1988; Ozer & Reise, 1994). Although these three personality dimensions are not intrinsically interpersonal,

some authors have speculated that they may still have important interpersonal consequences (cf. McCrae & Costa, 1989). Thus, it seemed worthwhile to see whether individual differences in Conscientiousness, Emotional Stability, and Intellect can account for variance in cooperative behavior that cannot be explained by individual differences in Extraversion and Agreeableness.

METHOD

Overview and Design

The present study employed a computerized resource dilemma paradigm (e.g., Brewer & Kramer, 1986; Kramer et al., 1986; Liebrand, 1984; Parks, 1994). Each participant shared access to a common pool of resources with seven (simulated) others. Experimental feedback indicated either that the common resource was being collectively sustained or that it was being collectively overused. Each simulation was interrupted after participants had made 12 consecutive resource use decisions. The primary independent variables were participants' Extraversion and Agreeableness scores and feedback about resource use (sustained use vs. rapid depletion). The main dependent variable was each participant's resource use throughout the resource dilemma simulation.

Participants

A total of 72 first-year psychology students at the University of Groningen (in the Netherlands) participated in the experiment. Participants were informed that the investigation comprised a computerized decision game and that each participant would have a chance of winning a compact disc (CD) player (or its monetary equivalent) or a CD voucher worth 50 guilders (about U.S.\$30).

Personality Measurement

As part of a personality research program, 1st-year students of psychology received a mailing in which they were invited to participate in a personality study. All questionnaires were mailed. In an accompanying letter, participants were asked not to discuss their ratings with others. In return for their participation, targets received feedback about their personality profiles. The feedback was given after the experimental data had been collected.²

Participants completed a list of 225 personality-descriptive adjectives that were selected to represent the entire domain of Dutch trait descriptors (cf. Hendriks, 1997). Ratings on the trait-adjective rating list were made on scales ranging from 1 (*much less than others*) to 5 (*much more than others*). Scores on Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Intellect were calculated by multiplying each participant's item

ratings by the factor weights of each item for the respective personality dimensions. These factor weights were determined by factor analyzing item ratings from a larger pool of participants ($N = 790$; this pool included the sample that participated in the present study). This factor analysis yielded five interpretable factors corresponding to the Dutch Big Five personality dimensions (Hofstee et al., 1992). The first two factors were labeled Extraversion and Agreeableness, the remaining three were labeled Conscientiousness, Emotional Stability, and Intellect (see Hendriks, 1997, for a more detailed description).

Procedure

The experiment was conducted in a laboratory containing eight Apple Macintosh computers located in separate cubicles and a central computer. After arriving at the laboratory, participants were met by an experimenter who led them to their separate cubicles. The remainder of the experiment was administered via a computer program.

Resource Dilemma Simulation

After being familiarized with the computer, participants proceeded with the resource dilemma simulation. Participants were told that the research involved a decision-making game. This game was to be played with 7 other participants who were in the adjacent cubicles and were ostensibly linked together via the central computer. Each participant was told that she or he, together with the others, shared access to a common resource pool. The common pool initially contained 400 points, visualized by means of a bar chart on the computer screen. On each game trial, participants could take between 0 and 10 points for themselves. After each participant had indicated the number of points she or he wanted to take, the common resources would be replenished with 10% of the number of points that remained in the common pool after the total number of points had been subtracted.

During the next trial, participants could again withdraw points from the common pool. Participants were told that they could continue to accumulate points for as long as the common pool was not empty. The total number of points that participants accumulated for themselves would determine their odds in the lottery that would take place after the experiment. To maximize their chances of winning a CD player or a CD voucher (or their monetary equivalent), each participant should try to accumulate as many points as possible. It was pointed out that the number of points that each participant could collect depended on both the number of points he or she would take per trial and the number of rounds that the game would be played. No indication

was given as to the best strategy or the number of trials that the game would be played.

At the end of each trial, participants received feedback regarding the choices made by the players and a bar chart representing the current level of the common resource. Because each player was referred to by a color code, each player remained anonymous. Feedback about the other players' choices and the level of the common resource was manipulated. Feedback about participants' own choices was genuine and was supplied to strengthen the impression that the feedback was truthful. The resource dilemma simulation continued for 12 trials and was subsequently interrupted by a series of postexperimental questions. Next, participants were debriefed and thanked for their participation. Two weeks after the experiment, it was announced which participants could collect their prizes at the psychology department.

Feedback About Resource Use

In the sustained use condition, feedback indicated that the group was using the resource at a rate that allowed the common resource to sustain itself through replenishment after each round. During the 12 trials of the simulation, graphical feedback indicated that the level of the common resource fluctuated between 400 and 375 points. Feedback about individual resource use indicated that one player (the high user) withdrew relatively many points per trial ($M = 8.5$ per trial). Another player (the low user) withdrew relatively few points for himself or herself per trial ($M = 3.4$ per trial). The other players withdrew intermediate amounts ($M = 4.5$ per trial).

In the rapid depletion condition, feedback indicated that the group was using the resource at a rate that did not allow the common resource to sustain itself through replenishment. During the 12 rounds, graphical feedback indicated that the level of the common resource dropped from 400 to about 40 points (the common pool was not completely depleted at the last trial). Feedback about individual resource use indicated that the high user withdrew on average 9.3 points per trial, the low user withdrew on average 4.7 points per trial, and the intermediate users withdrew on average 6.0 points per trial.

RESULTS

Manipulation Check

As a manipulation check, participants were asked to estimate the average number of points the other players harvested during the 12 trials. Estimated average resource use by the other players was significantly higher in the rapid depletion than in the sustainable use condi-

tion ($M = 5.24$ vs. $M = 4.24$, $p < .001$). Thus, the feedback manipulation appeared to have been successful in influencing perceptions of collective resource use.

Relationship Between Extraversion and Agreeableness

The correlation between Extraversion and Agreeableness was small and unreliable ($r = -.14$, *ns*). Thus, our factor analysis procedures appear to have succeeded in orthogonalizing the personality dimensions relating to Extraversion and Agreeableness. The statistical independence of Extraversion and Agreeableness is desirable because it allows the current research to test whether Extraversion and Agreeableness independently contribute to predicting resource use behavior.

Resource Use

Participants' resource use decisions have a multilevel structure because each resource use decision can be considered a lower level observation nested under the upper level unit, persons. Taking this data structure into account, we analyzed the data using multilevel analysis (MLwiN) (Goldstein et al., 1998), which treats both lower and upper level units as sampling units so that inferences can be made to both observations and persons (Bryk & Raudenbusch, 1992; see David & Suls, 1999; Suls et al., 1998, for applications in personality research). Following this approach, patterns of resource use across the different stages of the resource dilemma simulation were calculated separately for each participant. In subsequent steps, the variability of the estimated parameters (i.e., slopes and intercepts) of the individual coefficients was modeled with between-group variables (feedback condition), individual attributes (e.g., Extraversion and Agreeableness), and their interaction terms.

Within-Person Model

We began by setting up a model at the within-subject level. This can be formulated as fitting a model for a population of curves (Snijders, in press). As a first step, we fit the mean curve in resource use decisions exactly. Because there are 12 resource use decisions, this can be done by using an 11th-degree polynomial. This fully saturated model is comparable with a conventional MANOVA with repeated measures. Formally, the model can be characterized by the population mean curve, given by

$$\text{Resource Use}_{ij} = a_{0j} + a_{1j}\text{Trial}_{ij} + a_{2j}\text{Trial}_{ij}^2 + \dots + a_{11j}\text{Trial}_{ij}^{11} \quad (1)$$

where Resource Use_{ij} represents resource use at Trial t by individuals j , a_{0j} is the intercept, and a_{1j} to a_{11j} represent

the slopes of the curves. Note that there is no random residual in the within-person model because the model is fully saturated.

An equivalent approach is to use dummy variables. We chose the latter option because the MLwiN software does not allow for computation of an orthogonalized set of polynomials. It should be kept in mind that whether one uses 11 dummy variables or an 11th-degree polynomial is just a matter of parametrization and not a difference between two statistical models (cf. Snijders, in press). Resource use during the first trial of the resource dilemma was used as the reference level of resource use, and separate dummy variables were used in the random part of the model. Formally, the model can be characterized as follows:

$$\text{Resource Use}_{ij} = u_{1j}\text{Constant}_{ij} + u_{2j}\text{Trial}^2_{ij} + \dots + u_{12j}\text{Trial}^{12}_{ij} \quad (2)$$

where Resource Use_i represents resource use at Trial t by individuals j, u_{1j} is average resource use at Trial 1, and u_{2j} to u_{12j} represent average resource use at Trials 2 to 12. Again, there is no random residual in the within-person model because the model is fully saturated.

The goodness of fit of this model was indicated by a deviance of 2851.35. Average resource use per trial fluctuated between 5.51 and 6.23. Estimated variances in resource use per trial were significant (ranging from 2.88 to 4.33). In addition, estimated variances in resource use per trial tended to increase as the simulation progressed (from 3.34 in the first trial to 4.33 in the last trial). Significant covariances among resource use during the different trials indicated that there was considerable consistency in levels of resource use within individuals (interested readers may contact the first author for more details regarding this analysis). Because the main variables of interest were between-person effects, the remainder of this section will concentrate on the between-person model.

Between-Person Model

The second, between-subject level of the model describes the degree to which manipulated feedback regarding collective resource use and personality characteristics can account for variability in the temporal patterns of participants' resource use. Our modeling was restricted to linear and quadratic patterns in resource use because mathematically more complex trends were not considered theoretically meaningful. Consequently, the between-subject model has three parts, referring to the effects of manipulated feedback and personality characteristics on intercept differences in resource use, linear trends in resource use, and quadratic trends in

resource use. The model of intercept differences in resource use was as follows:

$$a_{0j} = \beta_0 + \beta_1\text{FB}_j + \beta_2\text{E}_j + \beta_3\text{A}_j + \beta_4\text{FB}*\text{E}_j + \beta_5\text{FB}*\text{A}_j + s_{0j} \quad (3)$$

where a_{0j} represents overall between-subject differences in resource use, the intercept β₀ represents the expected level of average resource use in the sustained use condition for a person whose Extraversion and Agreeableness are average, the slope β₁ indicates whether differential feedback (FB_j) regarding the level of collective resource use caused significant variation in resource use (0 = sustained use, 1 = rapid depletion), the slope β₂ indicates whether individual differences in Extraversion (E_j) accounted for significant variation in resource use, the slope β₃ indicates whether individual differences in Agreeableness (A_j) accounted for significant variation in resource use, the slope β₄ indicates whether the interaction between feedback and Extraversion (FB*E_j) accounted for significant variation in resource use, the slope β₅ indicates whether the interaction between feedback and Agreeableness (FB*A_j) accounted for significant variation in resource use, and s_{0j} is random residual variance in between-subject differences in resource use. The second and third parts of the between-subject model are similar except that feedback and individual differences in Extraversion and Agreeableness are used as potential predictors of variations in the linear (a_{1j}) and quadratic (a_{2j}) trends in resource use:

$$a_{1j} = \beta_6 + \beta_7\text{FB}_j + \beta_8\text{E}_j + \beta_9\text{A}_j + \beta_{10}\text{FB}*\text{E}_j + \beta_{11}\text{FB}*\text{A}_j + s_{1j} \quad (4)$$

$$a_{2j} = \beta_{12} + \beta_{13}\text{FB}_j + \beta_{14}\text{E}_j + \beta_{15}\text{A}_j + \beta_{16}\text{FB}*\text{E}_j + \beta_{17}\text{FB}*\text{A}_j + s_{2j} \quad (5)$$

Complete Model

Recall that dummy variables were used for each trial in the within-person model but not in the between-person model. The complete model thus formed a hybrid of the within-person model described in Formula 2 and the between-person model described in Formulas 3-5. Stated formally,

$$\begin{aligned} \text{Resource Use}_{ij} = & \beta_0 + \beta_1\text{FB}_j + \beta_2\text{E}_j + \beta_3\text{A}_j + \beta_4\text{FBE}_j + \beta_5\text{FBA}_j + \beta_6\text{Trial}_{ij} \\ & + \beta_7\text{Trial}*\text{FB}_{ij} + \beta_8\text{Trial}*\text{E}_{ij} + \beta_9\text{Trial}*\text{A}_{ij} + \beta_{10}\text{Trial}*\text{FB}*\text{E}_{ij} \\ & + \beta_{11}\text{Trial}*\text{FB}*\text{A}_{ij} + \beta_{12}\text{Trial}^2_{ij} + \beta_{13}\text{Trial}^2*\text{FB}_{ij} + \beta_{14}\text{Trial}^2*\text{E}_{ij} \\ & + \beta_{15}\text{Trial}^2*\text{A}_{ij} + \beta_{16}\text{Trial}^2*\text{FB}*\text{E}_{ij} + \beta_{17}\text{Trial}^2*\text{FB}*\text{A}_{ij} \\ & + u_{1j}\text{Constant}_{ij} + u_{2j}\text{Trial}^2_{ij} + \dots + u_{12j}\text{Trial}^{12}_{ij} \end{aligned} \quad (6)$$

where β₀ indicates the expected level of average resource use in the sustained use condition for a person whose Extraversion and Agreeableness are average and β₁ to β₁₇ represent the slopes of the main effects of feedback, the

linear and quadratic trends in resource use, individual differences in Extraversion and Agreeableness, and their interactions. These effects together constituted the fixed part of the model. The remainder of the model consisted of the random effects for trial, represented by a constant and 11 dummy variables.

To facilitate comparison of effect sizes, all predictor variables were standardized by multiplying regression coefficients with $SD(x)/SD(y)$. Univariate effects (fixed and random) can be tested by dividing them by their standard error. The resulting quantity is approximately normally distributed. Multivariate effects of predictors can be tested by computing the increase in goodness of fit after including a set of predictors, represented by a decrease in deviance. The resulting quantity follows a chi-square distribution, with the number of added predictors as degrees of freedom. The decrease in model deviance also provides an indication of the variance explained by the added predictors.

Overall Variations in Resource Use

First, linear and quadratic trends in resource use were estimated. The resulting decrease in model deviance was significant, $\chi^2(2) = 8.73, p < .02$. Univariate tests revealed that there was a small but reliable linear trend across trials, $\beta = .05, z = 1.85, p < .05$, indicating that there was a slight increase in resource use with each trial. In addition, there was a significant quadratic trend, $\beta = -.19, z = 1.85, p < .05$, indicating that resource use tended to increase during the first trials of the simulation and tended to decrease during the final trials of the simulation.

Effects of Feedback About Collective Resource Use

Next, the main effect of feedback and the Feedback \times Trial interactions were added to the model. The resulting decrease in model deviance was marginally significant, $\chi^2(3) = 6.28, p < .10$. The univariate interaction between feedback and the quadratic trend in resource use was significant, $\beta = -.21, z = 2.12, p < .05$, indicating that the quadratic trend in resource use only occurred in the rapid depletion condition. Thus, the decrease in resource use during the final trials of the simulation was only present when the common resource was being collectively overused.

Effects of Extraversion and Agreeableness

After this, effects of Extraversion and Agreeableness and their interactions with trial block and feedback were estimated and tested in a hierarchical fashion. During the first step, main effects of Extraversion and Agreeableness were added to the model. After this, two-way

interaction effects of Extraversion and Agreeableness with trial and feedback were added. The final step involved adding the three-way interactions between Extraversion and Agreeableness and trial and feedback. The resulting model deviance was 2804.14, which represented a highly significant decrease compared to the model without Extraversion and Agreeableness predictors, $\chi^2(12) = 32.20, p < .002$.

As expected, participants high on Extraversion harvested more from the common resource than did participants low in Extraversion, $\beta = .13, z = 1.71, p < .05$. This main effect, however, was qualified by the predicted three-way interaction between Extraversion, feedback, and the quadratic trend, $\beta = .35, z = 3.54, p < .001$. This interaction is graphically displayed in Figure 1. Further tests revealed that, in the sustained-use condition, participants high on Extraversion harvested more from the common resource than did participants low on Extraversion, $\beta = .23, z = 2.29, p < .05$. In the rapid depletion condition, there was a significant interaction between Extraversion and the quadratic trend, $\beta = .51, z = 3.75, p < .001$. Under rapid depletion, participants high on Extraversion remained fairly constant in their resource use. In contrast, participants low in Extraversion tended to raise their resource use to the level of participants low on Extraversion during the first half of the simulation. During the second half of the simulation, however, participants low on Extraversion showed a strong decrease in their resource use.

As expected, participants high in Agreeableness harvested less from the common resource than did participants low on Agreeableness, $\beta = -.25, z = 3.22, p < .001$. This main effect, however, was qualified by the predicted three-way interaction between Agreeableness, feedback, and the linear trend, $\beta = -.11, z = 1.87, p < .05$. This interaction is graphically displayed in Figure 2. In the sustained-use condition, participants high on Agreeableness harvested less from the common resource than did participants low on Agreeableness, $\beta = -.32, z = 3.61, p < .001$. In the rapid-depletion condition, there was a significant interaction between Agreeableness and trial, indicating that participants high on Agreeableness harvested less with each trial, whereas harvesting by participants low on Agreeableness remained high throughout the simulation. A marginally significant three-way interaction between Agreeableness, feedback, and the quadratic trend indicated that this effect was most apparent during the later trials of the simulation, $\beta = -.13, z = 1.40, p < .10$.

Exploratory Analyses

After testing the primary hypotheses concerning Extraversion and Agreeableness, a series of exploratory analyses was conducted to examine whether the interaction between Extraversion and Agreeableness pre-

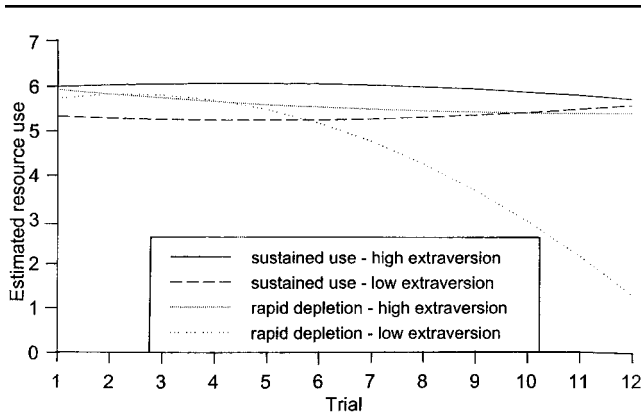


Figure 1 Estimated resource use per trial as a function of Extraversion and feedback about resource use.

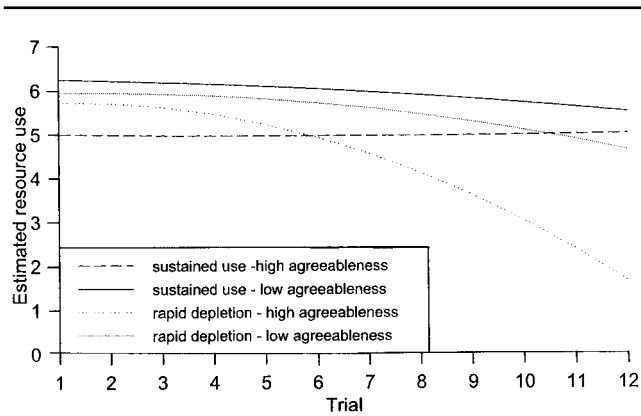


Figure 2 Estimated resource use per trial as a function of Agreeableness and feedback about resource use.

dicted variance in resource use over and above the additive effects of Extraversion and Agreeableness. In these analyses, estimations were made of the two-way interaction between Extraversion and Agreeableness and the three-way interactions between Extraversion, Agreeableness, and trial and Extraversion, Agreeableness, and feedback. These analyses revealed no significant multivariate or univariate effects.

A second set of exploratory analyses was run to see whether individual differences in Conscientiousness, Emotional Stability, and Intellect were able to account for additional variance in resource use. In these analyses, the model including all effects involving trial, feedback, Extraversion, and Agreeableness acted as a baseline. Only main effects of Conscientiousness, Emotional Stability, and Intellect and their respective two-way interactions with trial and feedback were tested. The results of these analyses revealed no statistically reliable multivariate effects of the three personal-

ity dimensions. In addition, a series of univariate analyses testing the main effects of Emotional Stability and Intellect and their two-way interactions involving trial and feedback revealed no more significant effects than would be expected to occur by chance (only 1 out of 18 tests was significant at the .05 level).

DISCUSSION

The present findings highlight the interpersonal nature of individual differences in Extraversion and Agreeableness. It was found that (a) global personality differences in Extraversion and Agreeableness were linked to cooperation in a resource dilemma; (b) the link between Extraversion and Agreeableness and cooperation was moderated by situational variables, that is, level of collective cooperation and severity of threat to the collective resource; and (c) Conscientiousness, Emotional Stability, and Intellect, three personality dimensions hypothesized to be not intrinsically interpersonal (McCrae & Costa, 1987), did not affect cooperative behavior. Taken together, these findings contribute to the accumulating support for the validity of the Extraversion-Agreeableness dimensions as an integrative framework for the study of interpersonal personality traits (e.g., Barry & Friedman, 1998; De Raad, 1995; Graziano et al., 1985; Graziano & Eisenberg, 1997; Graziano et al., 1997; McCrae & Costa, 1989; Trapnell & Wiggins, 1990).

The present findings demonstrate that global, decontextualized ratings of Extraversion and Agreeableness can predict specific behavioral choices in a social dilemma context. This is important because most of the work on interpersonal dispositions has either focused on highly contextualized behavioral measures (e.g., Messick & McClintock, 1968) or on the structure of interpersonal personality traits (e.g., McCrae & Costa, 1989). By relating individual differences in Extraversion and Agreeableness to interpersonal behavior, the present research enhances the nomological network surrounding the structural model of Extraversion-Agreeableness. Moreover, the link between Extraversion-Agreeableness and cooperative behavior suggests that general structural representations in personality can be related to behavioral adaptations to the social environment. This bolsters theorizing about global personality differences as evolved strategies for solving adaptive problems associated with social exchange (Buss, 1997; Graziano & Eisenberg, 1997; Hogan, 1982). In so doing, the present research counters previous criticisms that the Extraversion-Agreeableness framework is a purely psychometric invention (Eysenck, 1992) or no more than an artifact of everyday discourse about persons (Semin & Chassein, 1985).

Individuals high on Extraversion and individuals low on Agreeableness appeared mainly interested in harvesting as much as they could from the collective resource. By contrast, individuals low on Extraversion and individuals high on Agreeableness seemed to use a behavioral strategy that was considerably more complex. The latter individuals reciprocated other group members' level of cooperation when the threat to collective resource was low, showing high levels of cooperation in response to a cooperative group and low levels of cooperation in response to a noncooperative group. However, when the collective resource became severely threatened, individuals low on Extraversion and individuals high on Agreeableness dropped their resource dramatically. Thus, individuals low on Extraversion and individuals high on Agreeableness appeared highly responsive to both other group members' behavior and the degree to which the collective resource was threatened. Overall, this pattern is consistent with previous observations that cooperatively oriented individuals are more sensitive to situational contingencies than are noncooperatively oriented individuals (Kelley & Stahelski, 1970; Kramer et al., 1986; McClintock & Liebrand, 1988). We may speculate that context sensitivity possesses greater adaptive value among cooperatively oriented individuals. Cooperators may have developed a greater sensitivity to cues relating to interdependent others' intentions to reduce their own exploitability. In agreement with this, there is evidence that cooperators are more strongly affected by information about a partner's honesty (Van Lange & Kuhlman, 1994).

At a more general level, the obtained Person \times Situation interactions confirm that "humans are strategic problem-solvers, whose evolved psychological mechanisms are at least somewhat domain-specific and whose behavioral products are highly dependent on eliciting context" (Buss, 1997, p. 326). More simply put, it appears that a social dilemma setting may trigger different reactions under different circumstances among different individuals. The situated nature of the influence of personality on cooperation fits well with conceptions of personality differences as strategic psychological mechanisms (Buss, 1997; Tooby & Cosmides, 1990; see also Bargh, 1990). This conception may be contrasted with alternative views of traits as fixed, nonconditional patterns of personality (see McAdams, 1995). The current perspective moves beyond previous person/situation dichotomies by posing that although personality is stable, people's behavior may vary. As Hogan (1982) put it, "In order to be consistent, people must change their actions when they deal with other people" (p. 85).

It is noteworthy that the dimensions of Extraversion and Agreeableness emerged as two independent predictors of cooperative behavior. First, Extraversion and

Agreeableness were successfully orthogonalized through factor-analytic procedures. In addition, we analyzed the influence of each dimension while statistically controlling for the influence of the other dimension. Nevertheless, the current findings showed the effects of these dimensions to be almost each other's mirror image. Consequently, one might wonder whether the two dimensions are really driven by a single psychological process. The available literature seems to suggest otherwise. Individual differences in Extraversion have been related to a motivation to avoid interpersonal competition (Graziano et al., 1985; Norman & Watson, 1976). For instance, Graziano et al. (1985) has suggested that introverts display an aversion toward competitive situations because such encounters create aversive arousal for them. In contrast, individual differences in Agreeableness have been related to a motivation to approach interpersonal cooperation (Buss, 1991b; Digman & Takemoto-Chock, 1981; Graziano & Eisenberg, 1997). For instance, Graziano et al. (1996) proposed that "agreeable people may be more highly motivated to maintain positive relations with other people" (p. 821). Thus, although more work is needed in this area, the available evidence suggests that Extraversion and Agreeableness are distinct psychological systems in the regulation of interpersonal behavior.

LIMITATIONS AND FUTURE DIRECTIONS

Although the present research was successful in demonstrating the influence of Extraversion and Agreeableness on cooperative behavior, the processes that mediate this relationship are still not completely understood. As mentioned earlier, some investigators have suggested that individuals low in Extraversion may be averse to interpersonal competition because they are more sensitive to the arousal and threat of punishment that accompany interpersonal competition than are individuals high in Extraversion (Graziano et al., 1985; Norman & Watson, 1976; see also Eysenck, 1967; Gray, 1972). Thus, individuals low in Extraversion's avoidance of arousal may lead to behavioral avoidance of conflict, leading in turn to more cooperation in interdependent situations. Future research may explore the mediational role of arousal by obtaining measurements of arousal during a social dilemma simulation and relating these to Extraversion and cooperative behavior. In addition, threat of punishment may be manipulated in alternative ways. For instance, framing a social dilemma in terms of losses (e.g., Brewer & Kramer, 1986; McCusker & Carnevale, 1995) may decrease the level of cooperation by individuals low in Extraversion if their cooperativeness is indeed motivated by a need to avoid negative outcomes.

Agreeableness differences have been related to motives to interact harmoniously with other persons (Buss, 1991b; Digman & Takemoto-Chock, 1981; Graziano & Eisenberg, 1997; Graziano et al., 1997). For example, Graziano and Eisenberg (1997) have suggested that individuals high on Agreeableness may be more disposed toward cooperation because they possess a greater capacity for empathic emotion than do individuals low on Agreeableness. In addition, Graziano et al. (1997) proposed that Agreeableness differences may affect behavior by affecting the individual's choices for specific strategies in interpersonal situations. General measures of Agreeableness may thus be combined with more specific personality variables to obtain both a general understanding of the relationship between personality and interpersonal behavior and a more fine-grained understanding of the influence of personality in specific situations (McAdams, 1995; for illustrations of this approach, see Caldwell & Burger, 1997; Graziano et al., 1997).

Another important issue concerns the question of how personality traits that lie outside of the Extraversion-Agreeableness framework may affect cooperation. As mentioned earlier, factor-analytic studies have yielded evidence for at least three other universal personality dimensions: Conscientiousness, Emotional Stability, and Intellect. The present research failed to uncover any systematic relations between cooperative behavior and these three dimensions, but the conclusion is not warranted that Conscientiousness, Emotional Stability, and Intellect may never affect interpersonal cooperation. Indeed, it remains possible that Conscientiousness, Emotional Stability, and Intellect affect interpersonal behavior through different mechanisms than the ones studied in the present research. For instance, Conscientiousness, Emotional Stability, and Intellect may influence cooperative behavior indirectly by affecting the selection (e.g., Buss, 1987; Emmons & Diener, 1986) or the manipulation of the interaction context (e.g., Buss, 1987, 1992; Caldwell & Burger, 1997).

Finally, the social dilemma paradigm used in this research may offer a useful tool for addressing a classic issue in personality research: that of comparing self- and peer-ratings of personality (Funder, 1995; Funder & Colvin, 1997; Hofstee, 1994; John & Robins, 1993; Moskowitz, 1990). From a psychoevolutionary perspective, it seems probable that people have developed cognitive mechanisms to detect stable individual differences in cooperative tendencies (Borkenau, 1990; Buss, 1997; Graziano & Eisenberg, 1997; Hogan, 1982). Consistent with this, the present research found that the effects of self-rated Extraversion and Agreeableness on cooperative behavior were largely replicated in peer-ratings of Extraversion and Agreeableness (see Note 2). By system-

atically comparing the predictive validity of self- and peer-ratings of personality in social dilemmas, researchers may attain greater insight into the factors that underlie personality judgments in interdependent settings.

CONCLUDING REMARKS

Social groups offer many advantages to their individual members, including the possibility of joining resources to achieve higher outcomes. However, the collective interests of a social group are sometimes at odds with the interests of its individual members. Previous research on social dilemmas has illuminated the processes that determine whether people choose to serve their own immediate self-interests or make personal sacrifices for the common good (Komorita & Parks, 1995; Messick & Brewer, 1983; Van Lange et al., 1993). The present research adds to these findings that individual differences in Extraversion and Agreeableness are able to explain substantial variations in cooperative behavior, especially when conflict between individual and collective interests is high. In this way, personality and social behavior were shown to be inextricably linked.

NOTES

1. This is not to say, of course, that this taxonomic approach has remained without its critics. However, most critiques have centered on the five-factor model of personality (Block, 1995; Eysenck, 1992; McAdams, 1992). Because the two-dimensional framework of Extraversion and Agreeableness is only based in part on the five-factor model, many of the objections raised against the five-factor model do not apply to the Extraversion-Agreeableness framework.

2. We also collected peer ratings of personality, which were provided by two to four judges per participant. These judges were persons who knew the participants well, were not students in psychology themselves, and were living at different addresses from the participants. As in previous research (e.g., John & Robins, 1993), there was substantial agreement between self and peers on ratings of Extraversion, $r(72) = .82$, $p < .0001$, and on ratings of Agreeableness, $r(72) = .66$, $p < .001$. When peer ratings of Extraversion and Agreeableness were substituted in supplementary analyses, results were comparable with those obtained for self-ratings. Interested readers may contact the first author for more details.

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