Personality facets and RIASEC interests: An integrated model

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A B S T R A C T

Research examining links between personality and interest have typically focused on links between measures of the five factor model and Holland's RIASEC types. However, the five factor model of personality can be divided in to a larger set of narrow domain personality scales measuring facets of the 'big five' traits. Research in a number of fields indicates that facet scales are effective for clarifying the relationship between personality and other broad constructs, including academic achievement, job performance, stress and coping, and achievement motivation. In the present study links between personality facets and the RIASEC model were examined using property vector fitting. Obtained results are consistent with previous research suggesting that the use of facet-level personality measures can clarify relations between personality and other constructs, and provides new information linking personality facets and interests. The use of facet-level measures of personality expands the range of personality concepts that can be presented to individuals who are exploring career options.

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1. Introduction

In the research literature on individual differences, including personality and interests, there is an emerging consensus regarding the importance of developing integrated models to represent the inter-relations among constructs, producing a more complete understanding of how individuals adapt to their environments and make important educational and career-related decisions (Armstrong & Rounds, 2008; Dawis, 1992; Lubinski, 2000). One area of integrative research has focused on links between the five factor model of personality, which currently stands as a dominant model of personality assessment and research (Digman, 1990; Goldberg, 1993), and Holland's (1959, 1997) RIASEC model of interests, which occupies a similar position in the area of interest assessment and research (Campbell & Borgen, 1999; Rounds, 1995). However, a number of studies have demonstrated that additional predictive utility can be obtained from personality measures when the five factor model is split in to facet-level scales (Dudley, Orvis, Lebiecki, & Cortina, 2006). Therefore, identifying links between personality facets and the RIASEC model is a potentially useful extension of previous interest-personality research. In the present study, the structural methods developed for the *Atlas of Individual Differences* (Armstrong, Day, McVay, & Rounds, 2008) will be used to integrate personality facets with Holland's RIASEC model of interests.

2. Integration and trait complexes

Calls for integrating information across individual differences domains often hinge on the realization that models of how individuals function and adjust to their environments are enhanced by combining information from different areas of measurement and theoretical viewpoints (Lubinski, 2000). For example, Ackerman and Heggestad (1997) have identified

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a number of trait complexes that linked cognitive abilities with personality and interests, including a Social complex combining interest in working with people, extraversion, and subjective well being, a Clerical trait complex that includes interest in business operations, conscientiousness and traditionalism, and perceptual speed, a Science trait complex that includes interest in working with things, visual perception, and mathematical ability, and an Intellectual trait complex that combines scientific and creative interests, the personality trait of openness to experience, idea fluency and general mental ability. Lubinski (2000) proposed using the term trait constellation to describe theses relationships among individual differences domains, arguing that understanding the relationships and interactions among traits is critical to predicting person-environment fit. Armstrong et al. (2008) extended Ackerman and Heggestad's (1997) and Lubinski's (2000) work by using Holland's (1959, 1997) structural model of interests as a template for integrating individual differences measures, developing an Atlas of Individual Differences to facilitate the use of integrated models in applied settings.

The socio-analytic model of identity development (Hogan, 1983; Hogan & Roberts, 2000, 2004) hypothesizes that personality traits and abilities have an effect on the development of interests by influencing how individuals react to experiences and adapt to environments. The socio-analytic model also predicts that interests will have an effect on the development of personality and abilities because the self-selection of educational and work environments (Ickes, Snyder, & Garcia, 1997; Scarr, 1996) impacts the range of experiences an individual has, thus influencing which traits are developed and refined over time (Roberts, Caspi, & Moffitt, 2003; Schooler, 2001). These reciprocal influences contribute to contextual convergence, the finding that relations between individual differences constructs emerge in the context of work environments (Armstrong et al., 2008). One of the key mechanisms contributing to this contextual convergence is the gravitational hypothesis (McCormick, DeNisi, & Shaw, 1979; Wilk, Desmarais, & Sackett, 1995) which states that individuals are pulled towards occupations that are consistent with their level of cognitive ability. In addition to cognitive demands, the gravitational hypothesis may impact other dimensions of person-environment fit, including interests (Reeve & Heggestad, 2004).

3. Holland's model as an integrative framework

Holland (1959, 1997) proposed that a set of six interest-based categories, Realistic, Investigative, Artistic, Social, Enterprising, and Conventional, collectively referred to by the first-letters acronym RIASEC, can be used to classify individuals and occupations. The structural parallels between individuals and work environments in the Holland model facilitate the process of identifying career choices that will enhance person–environment fit (Rayman & Atanasoff, 1999). Holland (1997) justifies the use of a parallel individual and occupational structure for a number of reasons, including the notion that individuals are drawn towards choosing occupational choices that are a good match for their vocational identity, and also that individuals play an important role in defining the characteristics of the environments they work in. Armstrong et al. (2008) identified a number of characteristics of the Holland model that contribute to its utility as a template for developing an integrated model of individual differences, including its structural hypothesis and the range of constructs used by Holland to define the RIASEC types. Holland's model provides a parallel set of categories for individuals and work environments, thereby facilitating the process of linking individuals to career choices. Additionally, using an interest-based taxonomy of both individuals and work environments enhances the utility of integrated models in applied settings due to the central role of work in the identities and self-concepts of many individuals (Dini, 2000; Gottfredson, 1985).

In addition to specifying parallel categories for individual interests and occupational classification, Holland (1997) proposed that a spatial model could be used to represent the inter-relations among the six RIASEC categories using a hexagonal, or circumplex, structure where the distances between each type is inversely proportional to the degree of similarity. Research has generally supported the circular ordering of the six RIASEC interest types and work environments in the U.S. (Rounds & Tracey, 1993; Tracey & Rounds, 1993). Fig. 1 summarizes dimensional interpretations of Holland and the findings of Atlas model research. Holland's model, which classifies work environments on the basis of interests is an effective template for identifying trait complexes due to the nature of interests (i.e., preferences for environments that allow for engagement in preferred patterns of behavior). Holland's model provides a spatial representation of the degree of similarity across environments, making it possible to examine relationships based on a structural hypothesis instead of bivariate correlations. Therefore, Holland's model provides a set of empirically validated reference points for representing the circumplex structure of interests (Armstrong et al., 2008).

4. Interests and personality

Educational and work environments may be essential to understanding how personality traits are linked to interests, because it is environmental conditions that place demands on individuals, and these demands are clearly articulated in school and work settings (French, Caplan, & Harrison, 1982; Schooler, 2001). The primary focus of interest-personality research has been the examination of the relations between the five factor personality model and Holland's (1959, 1997) RIASEC Model. The results of meta-analyses of this research support a number of links between RIASEC interest measures and the five factor model of personality that are consistent with Holland's conceptualization of his interest types (Barrick, Mount, & Gupta, 2003; Larson, Rottinghaus, & Borgen, 2002). In particular, two of the most consistently identified interest-personality associations are between Extroversion and the S and E types, and between Openness to Experience and the A and I types (Ackerman & Heggestad, 1997; Hogan & Blake, 1999; Tokar, Fischer, & Subich, 1998). These links have been found in college
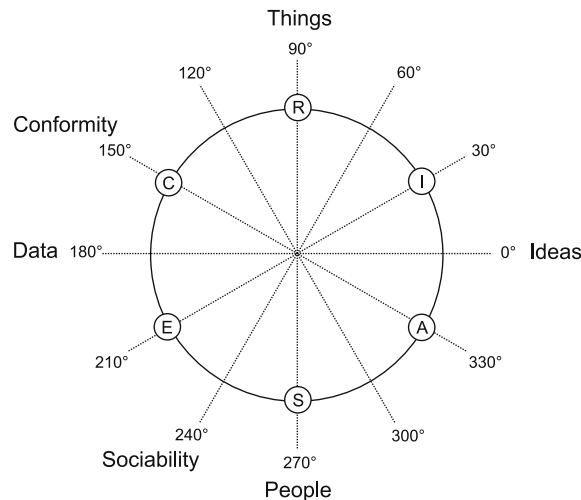
Fig. 1. Polar coordinates for Holland's (1997) RIASEC structure with labels indicating orientation of Prediger's (1982) Data-Ideas and Things-People, and Hogan's (1983) Sociability and Conformity dimensions. R = Realistic, I = Investigative, A = Artistic. S = Social, E = Enterprising, C = Conventional.

students (Tokar, Vaux, & Swanson, 1995), employed adults (Costa, McCrae, & Holland, 1984), and military trainees (Gottfredson, Jones, & Holland, 1993). Other RIASEC-five factor associations emerge less consistently in empirical studies, including links between Agreeableness and the S type (Tokar et al., 1998), Conscientiousness and the C type (Gottfredson et al., 1993), and a negative correlation between Neuroticism and the E type (De Fruyt & Mervielde, 1997).

The five factor model of personality can be conceptualized as a hierarchical model where each broad factor can be subdivided into a set of facet scales. For example, the NEO-PI-R (Costa and McCrae, 1992) includes six facet scales for each of the five broad factors it measures, and Goldberg (1999) has developed public domain measures of these facets. Although researchers examining links between personality measures with academic and work-related issues have typically focused on the broad traits measured by the five factor model, there has also been an increased use of facet scales. Dudley, Orvis, Leibcki, and Cortina (2006) have argued that personality facets may help further clarify our understanding how work-related behaviors are linked to personality traits, and may also uncover important individual differences in personality-work behavior links that are obscured when using broad measures. In their meta-analysis of Conscientiousness facets and job performance, Dudley et al. found that using facet-level measures provided incremental improvements in prediction of job performance over broad factor measures. Therefore, it is conceivable that personality facets may provide important insight into links between individual differences in personality and interests. Indeed, when Holland (1999) reviewed the work of De Fruyt and Mervielde (1997) examining correlations between NEO-PI-R facets and RIASEC interests, he noted that "the NEO facet scales appear to clarify some of the differences between adjacent [RIASEC] types" (p. 95).

In addition to the research by Dudley et al. (2006) demonstrating the effectiveness of personality facets to improve the prediction of workplace performance over broad personality traits, research supporting the utility of facet measures has emerged in a number of topics. For example, O'Connor and Paunonen (2007) found that specific personality measures at the facet level sub-domains of conscientiousness and openness to experience were more effective predictors of academic performance that the broad big-five measures. Facet level measures of personality are also more effective for predicting coping behaviors (Connor-Smith & Flachsbart, 2007). Bibb, Steinmayr, and Spinath (2008) reported that facets were more effective at accounting for the relationship between personality and goals. The relationship between fluid intelligence and openness to experience is stronger found when fitting a measurement model with personality facets (Beauducel, Leipmann, Felfe, & Nettelsnstroth, 2007). Also, a series of studies reported in Ekehammar and Akrami (2007) demonstrate that facets are more effective than big five for predicting prejudice and sexism. Personality facets were also found more effective predictors of behavior than a broad big-five measure, accounting for more variance in 40 behavioral outcomes measured by Paunonen and Ashton (2001).

5. The present study

Overall, previous research suggests that meaningful information related to the career choice process and vocational adjustment can be obtained from the joint assessment of personality and interests. Additionally, recent studies using personality facets suggests that these narrower measures of personality may be more effective than broad factors for accounting for individual differences in work-related behaviors. Despite the potential utility of personality facet measures, there are comparatively few investigations examining facet-level relations between RIASEC interests and personality. But although Holland (1999) has suggested that using personality facets can improve our understanding of the RIASEC model, previous

research linking personality facets with interests such as De Fruyt and Mervielde (1997) has not explicitly tested Holland's structural model. Therefore, the primary objective of the present study will be to evaluate links between personality facets and interests using the statistical methods outlined in Armstrong et al. (2008) to account for Holland's structural hypothesis.

The linear multiple regression-based technique of property vector fitting (Jones & Koehly, 1993; Kruskal & Wish, 1978) is put forward here as a strategy for integrating individual differences variables into Holland's model. This technique allows for the placement of a variable into a multidimensional space (i.e., the RIASEC interest structure) as a vector emerging from the origin of the dimensional coordinate system. The angle of the property vector is calculated from the regression coefficients obtained from an analysis of how well the RIASEC structural coordinates predict observed scores for the variable on each of the six types. Property vector fitting results illustrate the structural relations among interests and other individual differences characteristics by indicating the orientation of characteristics in the interest structure and by comparing the relative orientations of different characteristics. Instead of focusing on the magnitude of particular bivariate relationships, this analysis systematically models the relative strength of associations between characteristics and the RIASEC structure. Bootstrapping (Efron & Tibshirani, 1993) will be used to generate confidence intervals for the magnitude of effect (R^2) and direction (angle θ) of each property vector.

6. Methods

6.1. Participants

6.1.1. Sample 1

The first sample of data was obtained from a published source, the study of RIASEC interests and personality by De Fruyt and Mervielde (1997). This sample consisted of 934 (436 female, 498 male) Dutch-speaking students enrolled in their final year at either the University of Ghent or the Catholic Industrial School of Ghent who were recruited to participate in a longitudinal study of the transition from school to the labor market. These participants ranged in age from 20 to 43 years (M = 23.4, SD = 2.2) and represented the full range of academic programs offered at the two educational institutions. Additional information on the recruitment process is available in De Fruyt and Mervielde (pp. 89–90).

6.1.2. Sample 2

Participants in the second sample were undergraduate students recruited from psychology and educational psychology classes at two large Midwestern universities who agreed to complete the survey instruments used in this study in exchange for course credit. The sample included 1,186 participants with 749 (63%) being female and 437 (37%) being male. Participants ranged in age from 17 to 52 years (M = 19.5, SD = 2.7), with 51% of students enrolled as freshmen, 29% as sophomores, and 19.4% as juniors and seniors, with less than 1% not reporting their current academic standing. The majority of the participants self-identified their ethnic identity as White/Caucasian (85.3%), with 4.1% self-identifying as Asian American, 3.8% as African American, and 3.0% as Hispanic American, and the remaining 3.8% self-identifying as either Native American, biracial, multiethnic, or not responding to this demographic item.

6.2. Measures

6.2.1. Interests

Participants in the De Fruyt and Mervielde (1997) sample completed a Dutch translation of Holland's (1979) Self-Directed Search, the BZO95. The BZO95 reportedly includes four sets of 12-item RIASEC scales measuring interest in activities, interest in occupations, self-reported competencies, and self-descriptions of personality. As discussed in De Fruyt and Mervielde (pp. 90–91), only the activity, occupation, and competency items were used in their study in an attempt to minimize the potential for criterion contamination between the BZO95 RIASEC personality items and the NEO-PI-R facet scale items.

Participants in Sample 2 completed the Interest Profiler (Lewis & Rivkin, 1999). This measure consists of 180 items, originally designed for career exploration as an interest self-assessment to measure the six RIASEC Holland types. Respondents were asked to rate on a Likert-type scale from 1 (*strongly dislike*) to 5 (*strongly like*) how much they like a particular interest. Scores were computed based on the mean for each of the six Holland types. Lewis and Rivkin reported coefficient alphas ranging from .95 to .97 for each of the six scales. Evidence for convergent and discriminant validity was supported by comparing the Interest Profiler with the Interest-Finder, another O[*]NET interest assessment, with a median correlation of .82 for similar scales, and a median correlation of .46 for dissimilar scales (Lewis & Rivkin, 1999).

As illustrated in Fig. 2, when analyzing the RIASEC inter-correlations for the current samples, a violation of the order hypothesis was identified for the participants, with the E type being pulled into the center of the RIASEC structure. Based on this finding, it was decided to re-score the Interest Profiler using revised scoring instructions developed by Rounds (2007) to improve the structural validity of the measure. The revised scoring included subset of 60 of the 180 items was used, with 10 items endorsing each of the six Holland types. In a sample of 313 college students, the mean correlation between revised IP scales and the Strong Interest Inventory (Harmon, Hansen, Borgen, & Hammer, 1994) RIASEC scales was found to be .65, which was comparable to results for the full IP scales. As illustrated in Fig. 2, the revised short-form scoring
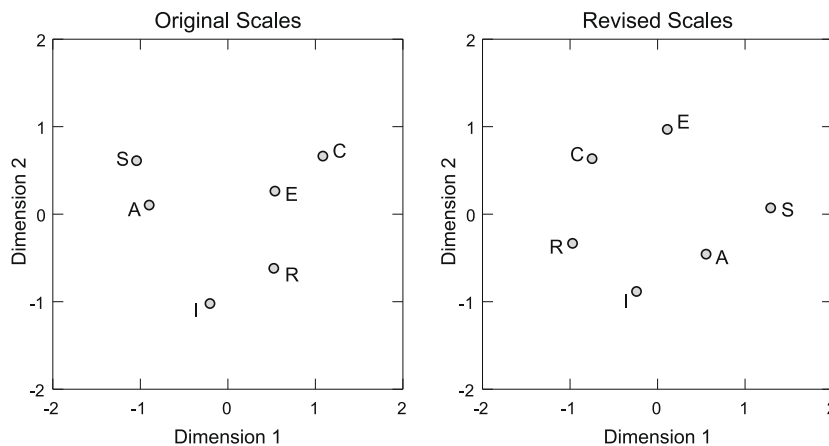
Fig. 2. Multidimensional scaling analysis of original and revised short form Interest Profiler. R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional.

improved the fit of the Interest Profiler to the Holland structure with the current sample of participants. In the current sample, the coefficient alpha reliability coefficients for the revised scales ranged from .84 to .90 with a mean of .88.

6.2.2. NEO-PI-R facet scales

As discussed in De Fruyt and Mervielde (1997), their sample completed the Dutch translation of Costa and McCrae's (1992) NEO-PI-R. De Fruyt and Mervielde describe this measure as "a faithful translation of the NEO-PI-R, with a factor structure and psychometric properties closely resembling the normative US inventory" (p. 90). However, for both the Dutch translation of the SDS and NEO-PI-R they do not provide specific psychometric data or reliability scores for the scales with their sample.

6.2.3. International Personality Item Pool

Participants in Sample 2 completed the five factor model facet scales developed for the International Personality Item Pool (Goldberg et al., 2006). In a sample of 501 adults, the mean coefficient alpha reliability for the IPIP facet scales was found to be .80, with a range from .71 to .88, and the mean correlation between corresponding IPIP and NEO-PI-R facet scales was found to be .73 (Goldberg, 1999). In the present sample, the coefficient alpha reliability coefficients for the IPIP facet scales ranged from .65 to .88 with a mean of .79.

6.3. Property vector fitting

The property vector fitting (Jones & Koehly, 1993; Kruskal & Wish, 1978) statistical technique was used to integrate personality facets into a RIASEC interest-based circumplex spatial map. Coordinates for the theoretical structure of Holland's model were specified based on previous research (Rounds & Tracey, 1993). Correlations between personality facets and the RIASEC types were then analyzed using regression to predict the observed correlations from the RIASEC model coordinates. Variance accounted for (R^2) indicates how well each facet fits the RIASEC circumplex structure, with higher values indicating a stronger relationship with the RIASEC structure. The location of the facet's vector in the circumplex was determined by calculating angles corresponding to the polar coordinate system (see Fig. 1) from the regression analysis beta weights, with the zero degree location set at the mid-point between I and A in the circumplex, with angles increasing in a counter-clockwise direction. Therefore, the links between personality facets and interests can be interpreted based on the orientation of vectors representing each facet that radiate from the center of the RIASEC circumplex with a corresponding strength (R^2) and direction (θ).

To empirically generate estimates of the R^2 and angle parameters for the IPIP facets a bootstrap procedure (Efron & Tibshirani, 1993) was used. By creating 1000 bootstrap samples ($n = 1186$) from the original data by random sampling with replacement for each property, 95% confidence intervals for R^2 and θ were computed using the percentile method (Mooney & Duval, 1993). In the present study, standard errors could not be calculated for the De Fruyt and Mervielde (1997) study, because this data was only published in summary form. Each facet was evaluated for its integrative potential on the basis of having at least one significant correlation with the RIASEC types. The results of the property vector fitting analyses were evaluated using a cutoff of $R^2 > .50$ for inclusion in the integrated model (Armstrong et al., 2008). Property vectors are interpreted as being consistent with Holland's theory (1997) to the extent that their location in the interest circumplex was in a direction consistent with Holland's predictions. Properties were considered to have a poor fit with the interest structure when the range of the 95% confidence interval for the angle is greater than 180 degrees, thus indicating possible range of locations that

contradict the order predictions in Holland's RIASEC model. Additionally, if a vector met the R^2 cutoff of .50, but pointed in a direction contrary to Holland's theory, the variable in question was viewed as a good fit to the interest circumplex, but inconsistent with Holland's type definitions and structural model.

7. Results

7.1. De Fruyt and Mervielde (1997) data

The correlations between RIASEC interests and NEO-PI-R facets published in De Fruyt and Mervielde (1997) indicates that in their sample of 934 students each personality facet had a statistically significant correlation ($p < .001$). Therefore, property vector fitting analyses were conducted for all 30 facet scales to evaluate their fit within the Holland RIASEC structure. R^2 values and angles obtained for the NEO-PI-R facet scales in the property vector fitting analysis are presented in Table 1, and the vectors for facets with R^2 values greater than .50 are illustrated in Fig. 3.

7.1.1. Agreeableness
For the Agreeableness facets two of the six reached the R^2 cutoff of .50 for inclusion in Fig. 3. A3 Altruism had an R^2 value of .50 and was oriented towards the S region of the Holland circumplex. A6 Tender-mindedness had an R^2 value of .77 and was oriented towards the A–S region of the circumplex. The remaining four Agreeableness facets obtained R^2 values ranging from .02 to .33 and were not included in the integrated model illustrated in Fig. 3.

7.1.2. Conscientiousness
For the Conscientiousness facets all six reached the R^2 cutoff of .50, with a range from .71 to .92. The orientation of the Conscientiousness facets consistently pointed towards the C and E-C regions of the Holland circumplex, encompassing a 28° range from C6 Deliberation ($\theta = 148°$) to C1 Competence ($\theta = 176°$).

7.1.3. Extraversion
For the Extraversion facets all six reached the R^2 cutoff of .50, with a range from .50 to .93. The Extraversion facets covered an 85° range of the Holland circumplex, ranging from the E5 Excitement-seeking ($\theta = 172°$) facet that was oriented towards the E-C region of the circumplex and overlapped with the Conscientiousness facets, to the E1 Warmth facet ($\theta = 257°$) that was oriented towards the S type.

Table 1
Property vector fitting results for NEO-PIR facets with significant RIASEC correlations.

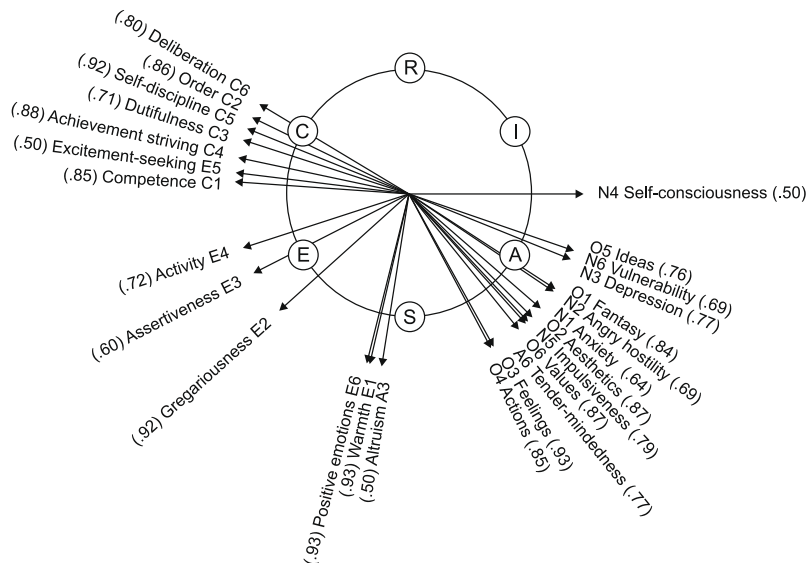| Personality facet	R^2	Angle
A1. Trust	0.22	300
A2. Straightforwardness	0.33	341
A3. Altruism	0.50	261
A4. Compliance	0.02	106
A5. Modesty	0.17	23
A6. Tender-mindedness	0.77	309
C1. Competence	0.85	176
C2. Order	0.86	153
C3. Dutifulness	0.71	162
C4. Achievement striving	0.88	168
C5. Self-discipline	0.92	158
C6. Deliberation	0.80	148
E1. Warmth	0.93	257
E2. Gregariousness	0.91	222
E3. Assertiveness	0.60	207
E4. Activity	0.72	198
E5. Excitement-seeking	0.50	172
E6. Positive Emotions	0.93	255
N1. Anxiety	0.64	319
N2. Angry Hostility	0.69	326
N3. Depression	0.77	338
N4. Self-consciousness	0.50	360
N5. Impulsiveness	0.79	313
N6. Vulnerability	0.69	341
O1. Fantasy	0.84	327
O2. Aesthetics	0.87	315
O3. Feelings	0.93	299
O4. Actions	0.85	298
O5. Ideas	0.76	341
O6. Values	0.87	312

Fig. 3. Property vector fitting results for NEO-PI-R personality facet correlations with SDS RIASEC interest measures. Values in parentheses represent the variance accounted for (R^2) in the analyses. R = Realistic, I = Investigative. A = Artistic, S = Social, E = Enterprising, C = Conventional.

7.1.4. Neuroticism

For the Neuroticism facets all six reached the R^2 cutoff of .50, with a range from .50 to .79. The Neuroticism facets were oriented towards the A region of the circumplex, encompassing a 47° range from N5 Impulsiveness (θ = 313°) to N4 Self-consciousness (θ = 360°).

7.1.5. Openness

For the Openness facets all six reached the R^2 cutoff of .50, with a range from .76 to .93. The Openness facets were oriented towards the A and A–S regions of the circumplex, encompassing a 43° degree range from O4 Actions (θ = 298°) to O5 Ideas (θ = 341°).

7.2. Interest Profiler—IPIP data

Correlations between the Interest Profiler RIASEC scales and the IPIP personality facet scales are presented in Table 2. After a Bonferroni correction for the number of correlations calculated, four of the 30 facet scales were found to have no statistically significant correlations with the six RIASEC types: C1 Self-efficacy, C5 Self-discipline, N2 Anger, and N3 Depression. The remaining 26 facets were then fit into the RIASEC circumplex using property vector fitting, and a bootstrapping procedure was used to estimate standard errors and confidence intervals for the R^2 and angle of each facet. The results of the property vector fitting analyses for facets with statistically significant interest correlations are presented in Table 3, and the vectors for facets with R^2 values greater than .50 are illustrated in Fig. 4.

7.2.1. Agreeableness

For the Agreeableness facets five of the six IPIP scales reached the R^2 cutoff of .50 for inclusion in Fig. 4, with a range from .62 to .79 and R^2 standard errors ranging from .03 to .09. The Agreeableness facets illustrated in Fig. 4 encompass a 16° range in the A–S region of the RIASEC circumplex from A1 Trust (θ = 281°) to A2 Morality (θ = 297°). The remaining facet, A5 Modesty, had an R^2 standard error (.08) that was comparable to the other Agreeableness facets, although its 95% R^2 confidence interval (.01–.32) did not overlap with the other confidence intervals. Additionally, the standard error of the angle for A5 Modesty was very large (52°) in comparison to the other Agreeableness facets, which had angle standard errors ranging from 4 to 7 degrees. Therefore, the use of bootstrapping to estimate the standard errors for R^2 and angles can improve the interpretation of property vector fitting results by clarifying the magnitude of observed differences between property vectors.

7.2.2. Conscientiousness

For the Conscientiousness facets, four of the six IPIP scales had significant RIASEC correlations, and three of these four facets reached the R^2 cutoff of .50 for inclusion in Fig. 4, with a range from .55 to .80 and R^2 standard errors ranging from .07 to .12. The C2 Orderliness facet was oriented towards the E type (θ = 219°), and C3 Dutifulness (θ = 283°) and C4 Achievement (θ = 264°) were oriented towards the S type. Similar to the results for Agreeableness, the one Conscientiousness facet

Table 2
Correlations between RIASEC scales and IPIP personality facet scales.

Personality facet	R	I	A	S	E	C
A1. Trust	−.07	−.02	.03	.30**	−.02	.06
A2. Morality	−.23**	−.06	−.02	.23**	−.20**	−.15**
A3. Altruism	−.22**	−.07	.11*	.49**	−.03	−.16**
A4. Cooperation	−.18**	−.06	.03	.24**	−.14**	−.08
A5. Modesty	−.04	−.02	−.10	.05	−.17**	−.01
A6. Sympathy	−.22**	−.03	.11*	.42**	−.11*	−.11*
C1. Self-efficacy	−.10	−.03	−.05	.09	.03	−.08
C2. Orderliness	−.16**	−.08	−.12	.05	.04	.04
C3. Dutifulness	−.19**	−.05	−.05	.19**	−.12*	−.07
C4. Achievement-striving	−.17**	−.06	−.04	.19**	.03	−.07
C5. Self-discipline	−.09	−.03	−.09	.10	.05	−.02
C6. Cautiousness	−.09	.00	−.09	−.01	−.14**	.05
E1. Friendliness	−.18**	−.10	.05	.32**	.10	−.18**
E2. Gregariousness	−.15**	−.11*	.03	.26**	.25**	−.10
E3. Assertiveness	−.09	−.06	.03	.19**	.19**	−.12*
E4. Activity Level	−.09	−.05	−.04	.14**	.05	−.04
E5. Excitement-seeking	.11*	.06	.09	.09	.20**	−.12*
E6. Cheerfulness	−.13*	−.05	.15**	.33**	.09	−.15**
N1. Anxiety	−.20**	−.08	.01	.10	−.04	.02
N2. Anger	−.07	−.09	−.01	−.07	.04	.05
N3. Depression	.05	.05	.10	−.03	−.02	.09
N4. Self-consciousness	−.02	−.01	−.01	−.06	−.15**	.09
N5. Immoderation	−.06	−.08	.04	.06	.12*	−.02
N6. Vulnerability	−.14**	−.10	.04	.08	−.04	.02
O1. Imagination	.00	.08	.36**	.12*	.01	−.12*
O2. Artistic Interests	−.17**	.07	.46**	.36**	.01	−.15**
O3. Emotionality	−.28**	−.12*	.15**	.37**	.01	−.08
O4. Adventurousness	.05	.12*	.13*	.12*	.04	−.12*
O5. Intellect	.08	.24**	.23**	.03	−.05	−.02
O6. Liberalism	.00	.13*	.16**	−.02	−.05	−.04

Note. Results based on responses of 1186 college students.
  * $p < .05$ after Bonferroni correction.
 ** $p < .001$ after Bonferroni correction.

Table 3
Property vector fitting results for IPIP facets with significant RIASEC correlations.

Personality facet	R^2	SE	R^2 CI	Angle	SE	Angle CI
A1. Trust	.62	.09	.44, .76	281	7	267, 295
A2. Morality	.62	.06	.48, .73	297	6	286, 309
A3. Altruism	.79	.03	.72, .85	283	4	276, 290
A4. Cooperation	.62	.08	.46, .76	291	7	277, 304
A5. Modesty	.12	.08	.01, .32	27	52	276, 130
A6. Sympathy	.72	.05	.63, .81	290	4	282, 299
C2. Orderliness	.69	.12	.44, .88	219	11	196, 241
C3. Dutifulness	.55	.09	.37, .71	283	8	266, 299
C4. Achievement	.80	.07	.65, .92	264	7	250, 278
C6. Cautiousness	.12	.10	.01, .36	62	72	207, 165
E1. Friendliness	.89	.03	.82, .95	272	4	264, 281
E2. Gregariousness	.90	.03	.83, .96	253	5	244, 262
E3. Assertiveness	.83	.06	.70, .92	261	6	249, 272
E4. Activity Level	.78	.11	.53, .94	253	11	230, 275
E5. Excitement-seeking	.18	.10	.02, .40	293	29	251, 341
E6. Cheerfulness	.93	.02	.87, .97	282	4	274, 290
N1. Anxiety	.62	.10	.39, .79	262	10	242, 283
N4. Self-consciousness	.30	.15	.04, .60	77	25	36, 128
N5. Immoderation	.84	.10	.61, .98	245	12	222, 269
N6. Vulnerability	.60	.13	.32, .82	264	12	241, 288
O1. Imagination	.84	.05	.73, .93	325	6	315, 337
O2. Artistic Interests	.96	.01	.93, .98	306	3	300, 312
O3. Emotionality	.89	.03	.84, .94	276	4	269, 283
O4. Adventurousness	.76	.09	.57, .90	332	10	313, 352
O5. Intellect	.95	.03	.87, .99	9	7	355, 23
O6. Liberalism	.85	.06	.66, .97	1	10	342, 21

Note. SE = Standard Error; CI = Confidence Interval.

Fig. 4. Property vector fitting results for International Personality Item Pool facets with statistically significant RIASEC correlations. Values in parentheses represent the variance accounted for (R^2) in the analyses. R = Realistic. I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional.

with a low R^2 value, C6 Cautiousness, had an R^2 confidence interval that did not overlap with the other facets integrated in the Holland circumplex and also had a very large angle standard error (72°).

7.2.3. Extraversion

For the Extraversion facets, five of the six IPIP scales reached the R^2 cutoff of .50 for inclusion in Fig. 4, with a range from .78 to .93 and R^2 standard errors ranging from .02 to .11. The Extraversion facets illustrated in Fig. 4 encompass a 29° range in the S region of the RIASEC circumplex from E4 Activity Level and E2 Gregariousness (θs = 253°) to E6 Cheerfulness (θ = 282°). Similar to the A5 and C6 facets, the Extraversion facet with a low R^2 value, E5 Excitement-seeking, had an R^2 confidence interval that did not overlap with the other Extraversion facets integrated into the Holland circumplex and an angle standard error that was much larger than the other Extraversion facets (29°).

7.2.4. Neuroticism

For the Neuroticism facets, three of the four IPIP scales with significant RIASEC correlations reached the R^2 cutoff of .50 for inclusion in Fig. 4, with a range from .60 to .84 and standard errors ranging from .10 to .13. The three Neuroticism facets illustrated in Fig. 4 are oriented towards the S region of the circumplex, encompassing a 19° range from N5 Immoderation (θ = 245°) to N6 Vulnerability(θ = 264°). Unlike the case for the other facets with low R^2 values that were not integrated in the RIASEC circumplex (i.e., A5, C6, and E5) the R^2 confidence interval for N4 Self-consciousness ranged from .04 to .60 and overlapped with the confidence intervals for N1 Anxiety and N6 Vulnerability.

7.2.5. Openness

For the Openness facets all six IPIP scales reached the R^2 cutoff of .50 for inclusion in Fig. 4, with a range from .76 to .96 and R^2 standard errors ranging from .01 to .09. The Openness facets illustrated in Fig. 4 encompass a 93° range of the RIASEC circumplex, however, the facet O3 Emotionality is oriented towards the S type (θ = 276°) and the remaining five Openness facets are oriented towards the A and I-A regions of the circumplex from O2 Artistic Interests (θ = 306°) to O5 Intellect (θ = 9°).

7.3. Comparison of NEO-PI-R and IPIP results

When comparing the results of the analyses fitting the NEO-PI-R and IPIP facets into Holland's RIASEC circumplex, there are three potential points of disagreement between the two sets of measures. First, it is possible for a NEO-PI-R facet to be successfully integrated into the circumplex, but with the equivalent IPIP facet not integrated either due to a lack of statistically significant RIASEC correlations in the IPIP measure, or because the R^2 value for the IPIP facet was below .50. Second, it is possible for an IPIP facet to be successfully integrated into the circumplex, but with the equivalent NEO-PI-R facet not integrated due to an R^2 value below .50. And third, it is possible that the equivalent facet from both sets of personality scales was integrated into the circumplex, but with angles that point towards different RIASEC types that offer potentially incompatible interpretations of the relations between personality and interests.

When examining disagreements between the two sets of measures based on correlations and R^2 values, in the case where the NEO-PI-R measure was fit into the RIASEC model but the equivalent IPIP scale was not, there were seven facets with this type of disagreement. Three of the IPIP Conscientiousness facets were not integrated into the model, with C1 Self-efficacy and C5 Self-discipline not producing any statistically significant RIASEC correlations, and C6 Cautiousness producing an R^2 value of .12. Similarly, three of the IPIP Neuroticism facets were not integrated into the model, with N2 Anger and N3 Depression not producing any statistically significant RIASEC correlations and N4 Self-consciousness producing an R^2 value of .30. Finally, the IPIP Extraversion facet E5 Excitement-seeking produced an R^2 value of .18. In comparison there were three NEO-PI-R facets, all of which were measures of Agreeableness, that did not reach the .50 cutoff for integration, but the equivalent IPIP facet measures were integrated: A1 Trust, A2 Morality, and A4 Cooperation.

For the 19 personality facets that were integrated into the RIASEC model using both the NEO-PI-R and IPIP measures, the level of agreement between the interpretation of the property vectors for equivalent facets can be evaluated by examining the absolute value of the differences between the angles. For example, with the NEO-PI-R data the angle of O1 Fantasy was 327° and the angle of the equivalent IPIP facet, O1 Imagination was 325°, and this difference of 2° suggests that the two measures offer virtually identical interpretations of the relationship between the O1 facet and interests (i.e., oriented towards the A-region of the Holland circumplex) despite the fact that different labels are used for O1 in the two sets of facet measures. In comparison, the facet of C3 Dutifulness is assigned the same label in both personality measure, but produced an angle of 162° in the NEO-PI-R data and an angle of 283° in the IPIP data. This difference of 121° between the two measures of the same facet offer very different interpretations of the relationship between Dutifulness and interests, with the NEO-PI-R measure oriented towards the C region of the interest circumplex and the IPIP measure oriented towards the S region.

For the two sets of facet measures of Openness, all six facets were integrated for both the NEO-PI-R and IPIP scales with an average angle difference of 24° and a range from 2° for O1 Fantasy/Imagination to 49° for O6 Values/Liberalism. Similarly, for the five Extraversion facets that were integrated for both measures, the average angle difference was 36° with a range from 15° for E1 Warmth/Friendliness to 55° for E4 Activity/Activity Level. With the two Agreeableness facets integrated in both measures, the angle difference was 19° for A6 Tender-mindedness/Sympathy and 22° for A3 Altruism. In comparison, for the three Neuroticism facets integrated with both sets of measures the average angle difference was 67° with a range from 56° for N1 Anxiety to 76° for N6 Vulnerability, and for the three Conscientiousness facets integrated with both sets of measures the average angle difference was 94° with a range from 66° for C2 Order/Orderliness to 121° for C3 Dutifulness.

8. Discussion

Consistent with Holland's (1999) writing on the use of personality facets with the RIASEC types, the results of the present study provide new insight into the relations between personality and interests. By using the property vector fitting techniques presented in the Atlas model (Armstrong et al., 2008), the current study extends previous research on links between personality and interest by accounting for Holland's (1997) structural model of interests when linking personality facet measures with interests. By using facet scales, the current study further clarifies the relations between specific aspects of the big five personality traits and Holland's RIASEC structure. This information may be useful for working with clients in career counseling and other applied settings who are attempting to link their educational and career plans with their interests and personality. Interesting questions emerge from these results regarding how interests and personality interact in the career choice process and also highlight future research questions related to the development of integrated models of individual differences.

When interpreting differences between the NEO-PI-R and IPIP facets in terms of their locations in the RIASEC model, both Holland's theory and a geometric interpretation of angles as correlation coefficients may be useful for clarifying the meaning of results. When the RIASEC model is represented as a circumplex, the difference between each of the six adjacent types corresponds to a distance of 60°. Additionally, angles can be interpreted as correlation coefficients using the formula $r = \cos \theta$. Interpreting differences between facet angles in terms of the Holland types and the implied correlation between the vectors representing the facets may augment information obtained from the angle confidence intervals generated for the IPIP scales using the bootstrapping procedure. For example, the angle of the O3 Feelings/Emotionality facet was 299° with the NEO-PI-R data and was 276° for the IPIP data. Assuming that the standard error and confidence interval for the NEO-PI-R facet angle is similar to the observed values with the IPIP data, the 23° difference in angle would be statistically significant. However, this angle difference is equivalent to a correlation of $r = .92$, which suggests that the interpretation of the two property vectors should be similar, despite the observation that the IPIP facet is oriented towards the S type and the NEO-PI-R facet is oriented between the A and S types. In comparison, the angle of the N6 Vulnerability facet was 341° with the NEO-PI-R measure and was 264° with the IPIP measure. This angle difference of 56° is the equivalent to an correlation of $r = .24$, which further supports the visual interpretation of the results as indicating that these two measures of Vulnerability are providing different interpretations of the relationship between Neuroticism and interests.

8.1. Openness and Artistic Interests

Of the five personality traits represented by facet scales in the current study, the most consistent pattern of relations between personality and interest across the two sets of measures emerged with the Openness to Experience facets. Both sets of

six facets from the NEO-PI-R and IPIP had statistically significant correlations with at least one RIASEC type, and in all cases the property vector fitting analyses produced R^2 values greater than .50. When comparing the results for equivalent facets in the two sets of scales, the average angle difference of 24° translates into an average correlation of $r = .91$, which suggests that the links between Openness and Artistic Interests illustrated in Figs. 3 and 4 are robust against the variability in measures and sampling used in the present study.

The overall pattern of results between the Openness facets and Artistic Interests is consistent with previous studies examining these relations using broader measures of the Openness trait (e.g., Larson et al., 2002). However, the use of facet measures allows for a more nuanced interpretation of these results based on the relative locations of facets in the RIASEC circumplex. For example, in Fig. 4 the location of the O3 Feelings/Emotionality facet suggests that emotional openness may be tied more to Social interests, and the location of O5 Intellect/Ideas facet between Investigative and Artistic suggests that intellectual openness may be tied to both scientific and creative interests. These results may also help clarify our understanding of Holland's (1959, 1997) typology, in particular, the key assumptions in the RIASEC model that degree of similarity between types is represented by their proximity in the circumplex. More specifically, the personality trait of Openness to Experience may be one of the mechanisms that accounts for the relative positions of the I, A, and S types in the Holland model. On a global level, Openness to Experience is linked to the A type, but the facet of intellectual openness may be part of an underlying link between Investigative and Artistic Interests that results in their adjacent positions in the RIASEC circumplex. Similarly, emotional openness may be part of the link between Artistic and Social interest that results in their adjacent positions in Holland's model of the world of work.

8.2. Extraversion and people-oriented interests

Of the five personality traits, the Extraversion facets produced the second most consistent pattern of relations between personality and interest across the two sets of measures. Similar to the Openness results, both sets of six NEO-PI-R and IPIP facet measures produced significant RIASEC correlations. However, one of the IPIP facets, E5 Excitement-seeking was not successfully integrated into the RIASEC model due to a low R^2 value obtained in the property vector fitting analysis. The remaining five Extraversion facets reached the R^2 cutoff for both sets of measures, and were oriented towards both the E and S types. With the NEO-PI-R facets the range of the circumplex covered includes both the E and S types, but in comparison the IPIP facets are more closely grouped around the S type. However, for the five equivalent facets embedded from each set of personality measures the average angle difference 36°, which is equivalent to a correlation of $r = 81$, suggesting a similar interpretation of the links between Extraversion facets and interests across measures.

In addition to supporting previous research linking Extraversion with Social and Enterprising interests, the current findings with Extraversion facets may also help clarify the dimensional interpretations of the RIASEC model put forward by Prediger (1982) and Hogan (1983). More specifically, in Prediger's dimensional formulas for calculating the Things-People dimension $(2R + I − A − 2S − E + C)$, the People end of the dimension is anchored by the S type, which is given twice the weight of the A and E types that also contribute to the People end of the dimension. In other words, Prediger's model suggests that the S type has the strongest association with of people-oriented interests and that the E and A types are equally associated with people-oriented interests. In comparison, Hogan (1983) has suggested that there is a sociability dimension that underlies the RIASEC circumplex oriented in between the E and S types. The present results tend to support Hogan's interpretation over Prediger's, in that the ordination of Extraversion facets tended to fall in between the E and S types, but there were no Extraversion facets oriented towards the A type.

8.3. Agreeableness and Social interests

The results linking Agreeableness facets with the RIASEC model were somewhat mixed. On one hand, there was agreement between the NEO-PI-R and IPIP results. With the A3 Altruism and A6 Tender-mindedness/Sympathy facets there were significant RIASEC correlations observed and the R^2 cutoff was achieved. The property vectors for these facets were generally oriented towards the S region of the circumplex with both data sets, although the A6 Tender-mindedness facet from the NEO-PI-R measures fell in between the S and A types. However, the angle differences between the matching facets across datasets (20.5°) is equivalent to a correlation of $r = .94$, indicating that the interpretation of these results are consistent across measures. There was also agreement for the A5 Modesty facet, in that there were significant RIASEC correlations observed, but the overall pattern of correlations across the six interest areas was incompatible with the order predictions in the Holland model.

Conversely, there was also disagreement between the two sets of measures for the A1 Trust, A2 Straightforwardness/Morality, and A4 Compliance/Cooperation facets. With the NEO-PI-R data these facets were not integrated into the RIASEC circumplex, but for the IPIP data these facets reached the R^2 cutoff and were found to be oriented towards the S region of the circumplex. Overall, these results suggest that there are certain facets of Agreeableness that can be tied to Social interests, such as Altruism, Sympathy, and Tender-mindedness, and at least one facet of Agreeableness, Modesty, is structurally incompatible with Holland's RIASEC model. The remaining facets may also be tied somewhat to Social interests, but these results should be interpreted with caution due to the differences observed across measures and datasets.

8.4. Conscientiousness, Neuroticism and Interests

The results obtained linking Conscientiousness and Neuroticism facets to interests were contradictory across the two sets of personality and interest measures, both in terms of the number of facets integrated into the RIASEC model in each dataset, and also due to the different interpretations offered by the relative orientations of the facets from each personality measure. With the NEO-PI-R data the six Conscientiousness facets were consistently linked with business-related interests in the RIASEC circumplex, oriented towards the C type and the area in between the E and C types, which reflects the combination of positive correlations between Conscientiousness facets and the E and C interest measures, combined with negative correlations with the A type, reported by De Fruyt and Mervielde (1997). In comparison, the IPIP-based results were different, with three of the six facets not successfully integrated due to either a lack of significant RIASEC correlations or because the pattern of correlations were incompatible with the structure of Holland's model. The three IPIP Conscientiousness facets that were integrated into the RIASEC circumplex had different orientations from the corresponding NEO-PI-R facets, with C3 Dutifulness and C4 Achievement oriented towards the S type and C2 Orderliness oriented towards the E type. The average angle difference between matching Conscientiousness of 94° is equivalent to a correlation of $r = -.07$, which further highlights the lack of agreement between the two sets of results.

For Neuroticism the results of the property vector fitting results should be interpreted with caution, because in several cases the strongest correlations with the RIASEC measures were negative. Therefore, the critical area of the circumplex tied to the facet may actually be in the opposite direction of the property vector. For example, in Fig. 3 the N6 Vulnerability facet points towards the A type, but an examination of the De Fruyt and Mervielde data suggests the orientation of this facet is mostly influenced by the significant negative correlations between N6 and the E and C types. Therefore, instead of focusing on the implied link between Vulnerability and Artistic Interests, it may be more appropriate to focus on the low levels of Vulnerability associated with the E and C types. Additionally, the relatively poor agreement between the two sets of facet scales should also be taken into consideration when examining potential links between Neuroticism and interests.

8.5. Limitations and future directions

There are a number of limitations to the current research, including the sample of participants and the interest and personality measures used in the study, that need to be addressed in future research. One potential issue with the current study is its generalizability to populations other than the current samples of college students. Although Holland's (1959, 1997) RIASEC structure is generally supported in research (Armstrong, Hubert, & Rounds, 2003; Rounds & Tracey, 1996), this finding is based primarily on the analysis of interest measures with U.S. samples of students and employed adults, and may not generalize to more diverse populations. In the present study we examined the inter-correlations among RIASEC scales from the Interest Profiler and on the basis of the initial results decided to use a revised scoring system developed by Rounds (2007) to improve the structural validity of the scales. However, we were unable to conduct a similar analysis on the Dutch-speaking sample obtained from De Fruyt and Mervielde (1997) because RIASEC correlations were not reported in that study. Therefore, deviations from the RIASEC structure in the design of the Dutch translation of the SDS may contribute to differences in results across the two datasets analyzed.

When interpreting the results fitting personality facets into the RIASEC circumplex, a number of issues emerge concerning how to interpret differences observed between the two datasets analyzed in this study. In particular, differences in the magnitude and patterns of correlations between personality facets across the two data sets may be due to differences in the instruments, or due to differences in sample characteristics. The correlations between NEO-PI-R facets and SDS RIASEC scales ranged from $-.39$ to $.58$, whereas the correlations between IPIP facets and Interest Profiler RIASEC scales ranged from $-.23$ to $.49$. This difference in the range of observed correlations may be due to measurement issues, because the Dutch translations of the NEO-PI-R and SDS were developed by the same group of researchers. In fact, De Fruyt and Mervielde (1997, p. 91) indicated that they dropped some of the RIASEC items from their analyses due to concerns about item overlap between their personality and interest measures. However, the wider range of academic programs represented in the De Fruyt and Mervielde sample students were enrolled in, or the fact that these students were preparing to graduate from college, may also contribute to the wider range of correlations observed in comparison to the more restricted sample of undergraduates enrolled in introductory psychology courses who completed the Interest Profiler and IPIP facet scales.

8.6. Summary and conclusions

Overall, the obtained results support Holland's (1999) claim that personality facets can be used to increase our understanding of the RIASEC model. Additionally, the current findings provide new information linking personality facets, interests, and the career choice process, thereby expanding the range of information in the Atlas of Individual Differences (Armstrong et al., 2008) that can be presented to clients in career counseling and other applied settings. The use of facet-level personality measures expands the range of concepts that can be presented to individuals who are in the process of exploring career options. Differences in sample characteristics, differences in personality measures, differences in RIASEC measures, or interactions between samples and measures may contribute the lack of agreement regarding the orientation of Conscientiousness and Neuroticism facets. Conversely, these differences in methods strengthens the validity of findings that are consistent across measures and samples linking Extraversion, Openness, and Agreeableness facets with interests.

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