A multi-faceted, open source, measure of personality

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Abstract

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1. Introduction

1.1. Short history and relevance of the Big Five

Over the last decades, the Five Factor Model as well as the Big Five model have become widely accepted models for describing general attributes of personality. Often the terms are even used synonymously, which is why we will refer to the Big Five from here on. The Big Five is a hierarchical model which describes human individual differences in personality at the dispositional level: one of the most basic, universal, biologically-influenced and stable layers of human inter-individual differences in behavior, cognition and feeling (McAdams & Pals, 2006). Its hierarchical nature is relevant to acknowledge behavior from the most specific (nuances), to the most broad differences in temperament and character (dimensions), through a varying number of mid-level personality characteristics called facets. Most of the research concerning criterion validity of the Big Five inventories has focused on the covariation between the Big Five dimensions and relevant external outcomes. However, specific dispositional characteristics captured on the facet level might be of extreme utility to provide more complex descriptions of individuality and to predict life outcomes to a major extent (John et al., 2014; Lounsbury, Sundstrom, Loveland, & Gibson, 2002; Paunonen & Ashton, 2001). Unfortunately, the number and nature of the facets below the Big Five and being measured by different personality instruments is far from being consensual. In fact, different facet level models have been proposed (XXXX). One potential reason for this could be that many facet level models were developed after a questionnaire version without such a level had been published. Thus, the facets were developed as an elaboration. While this has many theoretical advantages it also has the disadvantage of potentially limiting the search space of possible facets. In this work we aim at maximizing this search space and present a personality questionnaire which is broad at the facet level, open-access, and measurement invariant across two different cultures.

1.2. A short history of the Big Five

Francis Galton proposed the fundamental lexical hypothesis as a ground from where to describe interpersonal differences in personality. The hypothesis states that every apprehended characteristic in the realm of personality should have its place in the natural language, a corollary derived from this first statement is that the essential features must represent a unique word in the lexical universe of this language. Galton himself (1884), and later Allport and Odbert (1936) and still later Norman (1967) used English dictionaries for a systematic collection of all adjectives which could be related to human personality characteristics. Using exploratory factor analyses on self- and other ratings five broad factors could repeatedly be extracted from the data. These efforts were also replicated in different languages, such as in German (Klages,...), Baumgartner,...

Cattell was one of the first researchers who systematically applied exploratory factor analysis in order to explore personality structure. He inspected the correlation structure of the items in the word lists of his predecessors, finding 16 personality oblique factors, including one factor specifically for intelligence, these factors form the 16-PF. These 16 factors were the primary factors in a hierarchical structure for Cattell (coetany to L.L. Thurstone and undoubtedly influenced by him). Cattell himself viewed personality as a hierarchical structure, containing three layers (Cattell, 1956). The second order factors resemble the Big Five dimensions (Digman, 1990).

Different researchers followed Cattell in the study of dispositional traits of personality. One of the most influential models was Eysenck‘s Big Three. Grounded on a strong biological basis, Eysenck‘s theory supposed a link between temperament and personality. Its structural proposal concerned at first two big factors, named Neuroticism vs. Emotional stability and Extraversion vs. Introversion. These two dimensions were later joined by a third factor that Eysenck called Psychoticism. This label was criticized by others who suggested that a more appropriate term would be psychopathy (Digman, 1990). Eysenck‘s big two are still „alive“ today in the Big Five, and his third factor, psychoticism, can be operationalized

as two dimensions of the Big Five: Agreeableness (or . . .) and Conscientiousness (or . . . .).

A large number of studies have focused on the problem of personality structure resulting in a five factor solution (Fiske, 1949; Norman, 1963; Tupes & Christal, 1961; Borgatta, 1964). Possibly the two most widely cited works relating to the foundations of the Big Five are those by Goldberg (. . .) and McRae Costa (. . .). Goldberg can be seen as one of the first who extended research concerning the Big Five, while McRae and Costa‘s importance rests on popularizing the terminology (OCEAN) and the development of one of the most used tools to assess personality based on the Big Five: the NEO-PI. The Big Five dimensions are labeled as follows: I) Extraversion vs. Introversion. II) Agreeableness or Friendliness. III) Conscientiousness or Achievement or Will. IV) Emotional Stability vs. Neuroticism. V) Openness or Intellect or Culture.

One of the most important features of the Big Five is the fact that it could be replicated in different languages. Research is available in Japanese, Vietnamese, German, Spanish, Greek, (refs)... This finding suggests that the way human beings construe personality is at some point universal and that its basic features are retained within the Big Five. Another essential characteristic relies on its hierarchical nature. The five domains are useful to retain the big picture of personality, maximize the situation consistency and reliably assess difficult subjects such as children. Nonetheless, each dimension is conceptualized as a latent construct formed by more specific narrow factors called facets, which in turn are useful to depict the impact of personality characteristics into specific behaviors and concrete life outcomes.

The Big Five has proven to be a valid theoretical and empirical model to predict relevant life outcomes. Research such as Ozer and Benet-Martinez (2006) or Roberts; Kuncel; Shiner; Caspi & Goldberg (2007) has shown that scores for the Five Dimensions (and their related facets) are able to explain outcomes such as Academic and work performance, health, personality disorders, political attitudes and many more. The empirical findings linking Big Five measures to life outcomes have reinforced the concurrent validity of

the test scores interpretations. At the same time, the broad nature of the domains has spurned research into the more fine-grained lower order structure of facets.

1.3. Facet Structures

There are a number of models that include a facet structure below the five broad domains. The most widely known model is the one suggested by Costa and McCrae (XXX). Other popular models have been suggested for the Big Five Inventory 2 (BFI-2, Soto & John, 2017), the IPIP (JRP paper), and the HEXACO model (XXX), which assumes six broad domains. Table 1 gives an overview of these different models listing their facets per domain as well as some information regarding their psychometric properties.

table 1

As shown in table 1, there are many different possibilities of facets forming the domains. However, there is still a degree of overlap on the facets covered by the different instruments. Soto and John (2009) inspected the convergences between the NEO-PI-R and the first version of the BFI, suggesting that two constructs per domain were measured at the facet level by both inventories. The constructs defined by Soto and John (2009) were: Assertiveness and Activity for Extraversion; Altruism and Compliance for Agreeableness; Order and Self-Discipline for Conscientiousness; Anxiety and Depression for Neuroticism; and Aesthetics and Ideas for Openness. The convergence holds for the four instruments listed in table 1, as these ten constructs are covered within the facets for every instrument. Some of the constructs are explicitly covered at the facet level (e.g. Anxiety); meanwhile others are mainly covered though the four instruments, although sometimes implicitly (e.g. Liveliness in HEXACO resembles the "core" construct Activity, present in all other instruments). The reverse is not always true, not every facet within the four instruments is covered by the constructs proposed by Soto & John (2008). As an example we find Self-Consciousness, a Neuroticism facet defined by the NEO-PI-R and the IPIP-NEO-120, which is clearly tapping at a construct different from Anxiety or Depression.

The nomological network commonly assumed in Big Five questionnaires is drawn from nuances through facets to domains, from more specific to more general. Relying in domains to explain and predict behavior can benefit from ease of interpretability. However, optimal predictions for specific contexts can be enhanced if a more specific set of traits is used. On the other hand, using nuances to predict behavior might yield even stronger predictive ability (Seeboth & Mottus, 2018), but as the number of predictors grows the interpretations become more complex. Facets are on a middle ground between nuances and domains, in a compromise between specificity and sensitivity in the bandwidth-fidelity dilemma. This narrow aggregation both satisfies the specificity of predictions to concrete situations and environments and also enhances the ease of interpretability when summarizing individual personality characteristics.

Furthermore, there is a large corpus of research which points towards facets as important criterion predictors showing incremental validity to domains. For academic achievement, Paunonen and Ashton (2001) showed that the facets achievement motivation and intellectual curiosity increased the variance accounted for by college students' grades, above and beyond its respective dimensions: Conscientiousness and Openness to experience. Similarly, Lounsbury et al. (2002) provided evidence regarding the facets work drive and aggression, which added an extra 12% of explained variance over the Big Five domains on 10th grade students' GPA. Ziegler, Danay, Schölmerich, and Bühner (2010) showed that better performance in college grades was associated with low gregariousness, excitement seeking and order as well as high activity, openness to ideas and openness to values. Often different facets within the same domain can have effects in opposite directions, partially canceling out the predictive ability when only paying attention to the domain score. This is the case for Openness to ideas vs. Openness to fantasy, as the former is related positively to academic achievement whereas the latter is related negatively (**???**), resulting in a potential masking effect on the ability of Openness predicting the academic achievement.

As described above, facet measures often yield scores that have stronger test-criterion

correlations than their respective domain scores (e.g., Ziegler et al., 2012; . . .). However, facet scores have also been shown to be related to personality disorders. Thus, the combination of a higher fidelity along with the potential clinical relevance of facet scores might open up unique advantages for clinical research.

1.4. The Big Five and Personality Disorders

Personality disorders are steadily shifting from a categorical definition into a continua conceptualization within the clinical realm. This process is not new for personality science history, as the subject itself moved from a qualitatively distinct set of definitions, called types, into a subset of continuous domains in which both normality and extreme tendencies were moving along, named traits. In fact, the new version of the Diagnostic and Statistical Manual of mental disorders, DSM- V, now proposes two different ways of assessing personality disorders: 1) A descriptive model of personality disorders in section II which mimics the former model of assessing personality disorders and; 2) A novel trait model that follows research on the personality scientific domain (In section III), which conceptualizes personality disorders as extreme tendencies located in the continuum of the Big Five domains and facets (American Psychiatric Association, 2013; Widiger & Mullins-Sweatt, 2009)

This paradigm shift in clinical assessment of personality has led to the construction of the Personality Disorder Inventory (PID-5; Krueger, Derringer, Markon, Watson, & Skodol, 2013), a 25-facet and five-dimension self-report inventory, with an informant-report version (Markon, Quilty, Bagby, & Krueger, 2013). The big five dimensions mirror the Big Five domains, although with a focus on the maladaptative end of the continuum,: I) Detachment (Big Five's introversion), II) Antagonism (absence of Big Five's Agreeableness), III) Disinhibition (absence of Big Five's Conscientiousness), IV) Negative affect (Big Five's Neuroticism) and V) Psychoticism (Absence of Big Five's Openness). The PID-5 has shown satisfying evidences of criterion validity (. . . summary). However, the limited number of facets on the PID-5 has already raised some concerns due to the low reliability when

studying developmental phenomena of personality disorders (Clercq et al., 2014)‘, and may also limit the capacity of portraying vivid personality profiles which are suitable for explanatory purposes in the clinical domain.

In line with what has been stated previously for academic achievement, the examination of facets may result in an enhancement of the specificity of assessment when looking at the nature of PDs (Clark, 2005; Samuel & Widiger, 2008). This improvement of specificity resulted in a predictive gain ranging from 3% to 16% when comparing facets to domains predicting PD in the Reynolds and Clark (2001) study. Furthermore, the use of facets may be of extreme utility for those PD whose personality profile is less clear at the domain level. As Saulsman and Page (2004) point out, Schizotypal and Obsessive-Compulsive disorders are examples of PD which are not well covered by Big Five domains. A reason for it may be found in a pattern inconsistency of facets within the same dimension or in a lack of coverage for essential characteristics of the PD. For example, aberrant cognitions are essential characteristics of schizotypal disorder and are not covered by some instrument's facets like the NEO-PI-R (Samuel & Widiger, 2008; Saulsman & Page, 2004). Likewise, the expected high scores on warmth and low scores on assertiveness could mask the effects of extraversion when predicting Dependent Personality Disorder, following the theoretical correspondence between PD and Big Five facets proposed by Costa Jr. and Widiger (1994). Moreover, the PID-5 has prompted the elaboration of a number of Five Factor Model Personality Disorders (FFMPD) scales to maximize the facet coverage in relation to specific PDs (Bagby & Widiger, 2018).

Facet analysis and dedicated Big Five questionnaires have been used to solve issues like those mentioned in the last paragraph. We propose to base such research on a broader facet basis. To this end we suggest a general instrument to cover a broad number of facets which could aim for fine grained assessments.

1.5. This study

We present in this paper an instrument for personality assessment which aims to cover the need for an internationally usable, open source, and differentiated measure at the facet level. Two studies are presented, for each one inspects the factor structure of the instrument in a different sample drawn from a different culture (American vs. German). Measurement invariance across samples will be examined. Internal consistency and test-criterion correlations will be estimated for all scores. To sum up, the aim for this research project was to provide an instrument that can be used in non-clinical but also in clinical research which emphasizes the facet level of the Big Five.

2. Methods

Two different studies are presented in this work. The first study uses sample drawn from a USA bachellor student population. The aim is to detect and confirm a measurement model that maximizes the facet space of the IPIP instrument. An Exploratory Factor Analysis (EFA) is used to identify the number of facets per domain. A Confirmatory Factor Analysis per facet is modelled in order to confirm the item - facet relationship. Finally, an Exploratory Strucutural Equation Model (ESEM) is fitted to integrate the measurement model of the facets with the dimensions. ESEM is a somewhat novel method which allows the researcher to use Structural Equation Modelling (SEM) without the need of imposing an independent cluster solution, as its common in the CFA procedure. ESEM has gained reputation in the personality field, where the independent cluster model may not capture the complexity of the constructs measured (Marsh et al., 2010).

The second sample is drawn again from a graduate student population, albeit based in Germany. The aim for the second study is to replicate the structure found in study one, plus assess the degree of measurement invariance of the proposed model.

2. Study 1 - US-American Sample

2.1.1. Participants. The sample consisted of 726 American undergraduate students (59.3% male) who participated voluntarily. The mean age was 21.6 years (SD=5.9). Students were emailed a link to a computerized assessment battery that included the IPIP items as well as several other tests not reported in this paper.

At a first data preparation the data set was randomly split in two equally sized samples. Both samples were matched in relation to missing values, outliers and extreme values. In Sample 1 the mean age was 21.8 years (SD=6.3), in Sample 2 the mean age was 21.5 years (SD=5.6).

2.1.2. Measures.

International Personality Item Pool (IPIP). Altogether, 525 items from the *International Personality Item Pool (IPIP)* were used to measure Neuroticism, Extraversion, Openness (to experience), Agreeableness and Conscientiousness. The IPIP is an open source database of personality items, which was launched in 1996, and contains over 2000 items (L. R. Goldberg et al., 2006). Participants were asked to rate themselves on typical behaviors or reactions on a 5-point Likert scale, ranging from 1 ("Not all like me") to 5 ("Very much like me").

GPA. This measures academic achievement.

Satisfaction With Life (SWL). Scale of satisfaction with life

2.1.3. Procedure

EFA with subsample 1. To determine the number of possible facets per domain Velicer's (1976) Minimum Average Partial (MAP) method and Horn's (1965) parallel analysis (PA) method were employed for every domain. Based on these results an exploratory factor analysis was calculated for each domain via Mplus using a geomin rotation (Quelle) and a maximum likelihood estimator (ML). The decision for the preferred number of facets per domain was based partly on comparing model fits (CFI, RMSEA, SRMR). More importantly though was the interpretability of the facet solution. After all

facet solutions of other personality measures were looked at to compare it to the found facet structure. If there were important parts missing to present the domain with regards to content, new facets would be added afterwards.

CFA and ESEM with subsample 2. To confirm the structure of facets the EFAs delivered, multiple confirmatory factor analyses were calculated via Mplus. In a first step measurement models were estimated for each of the facets. To obtain balance between the facets, the items were reduced to five per facet based on item content and loading pattern in a second step, afterwards the estimations for the measurement models on facet levels were repeated. For both steps estimators were WLSMV (weighted least squares adjusted for means and variances). Aim was to ensure an optimal breadth and sufficient reliability. In a final model, all five domain structural models were integrated using exploratory structural equation modeling (ESEM) (Asparouhov & Muthén, 2009). Marsh et al. (2010) could show that ESEM fits personality data better and results in substantially more differentiated factors than it would using CFA, while using an EFA measurement model with rotations in a structural equation model. All facets were able to load on all domains. If there would show up facets that do not significantly load on the intended domain, this facets would get eliminated subsequently. The estimators used were ML (maximum likelihood), factor scores were used as indicators and the rotation was oblique (using Geomin). Model fit was determined based on the guide lines by Hu and Bentler (1999) as well as Beauducel and Wittmann (2005). Consequently, to consider a good fit of a proposed model, the Comparative Fit Index (CFI) should be at or over .95, the standardized root mean squared residual (SRMR) smaller than .08 and the root mean square error of approximation (RMSEA) smaller than .06.

Criterion validity evidence. To examine the nomological structure of the facets and domains to external constructs like life satisfaction and education, correlations and multiple regression were computed.

2.2. Results

Results of EFA. In *Table 2* you can see model fits for the chosen facet model for each domain as well as Eigenvalues and results from MAP and PA test.

To ensure that each facet is homogeneous and therefore, to reduce the risk of cross domain loadings, items with factor loadings less than .30 were eliminated. This was only done when item content was also judged as being non-central to the domain in question (Ziegler, 2014).

According to that Agreeableness consists of eight facets after two facets were eliminated due to weakly loading and inconsistent items. The remaining facets are named Appreciation, Integrity, Low Competitiveness, Readiness to Give Feedback, Search for Support, Good Faith, Genuineness and Altruism.

Conscientiousness consists of nine facets after one facet with item factor loadings less than .30 was excluded, which are named: Dominance, Persistence, Self-discipline, Task planning, Goal orientation, Carefulness, Orderliness, Wish to work to capacity and Productivity.

Extraversion comprises of nine facets, after a new facet (Energy) was added. The original model with eight facets did not explain the physical part of Extraversion very well. The facets are Sociability, Readiness to take risks, Wish for affiliation, Positive attitude, Forcefulness, Communicativeness, Humor, Conviviality and Energy.

Neuroticism (here interpreted in the way of emotional stability) consists of seven facets. One facet was dropped due to poor interpretability, and was therefore not included in the subsequent analyses. The final set of facets are named Equanimity, Confidence, Carefreeness, Mental balance, Drive, Emotional robustness and Self-attention.

Openness to experience comprises of nine facets. One facet was identified as a method factor and eliminated, because it solely contained negatively formulated items and no coherent underlying trait could be identified. Furthermore another facet (Intellect) was added, because the remaining facets lacked an intellectual content. The facets of Openness

are named Creativity, Wish for variety, Open-mindedness, Interest in reading, Artistic interests, Wish to analyze, Willingness to learn, Sensitivity and Intellect.

The items to each facet are listed in the appendix (A).

Results of CFA and ESEM.. All measurement models for the facets were fitting well, results can be found in *Table 3*.

Table 3

The exploratory structural equation model (ESEM) of the final model with all five domains fits well with CFI = .87, RMSEA = .072, SRMR = .036. As you can see in *Table 4* nearly all facets load significantly on their intended domain, but sometimes have loadings on other domains also, which are conform with the theory and the facet content.

Table 4

Reading model: esem_all facets on all domains without o8, a5, a4, e2.out

Study 2 – German Translation

Methods

Participants. The representative sample consisted of 387 German speakers (49.1% male) with a mean age of 45.6 years (SD=17.5).

Measures. The five items per facet derived from Study 1 were translated and back-translated by bilingual experts, creating a German version of the measure used there.

Procedure

Step 1 – Examining the structure. To check the facet structure Study 1 delivered, multiple confirmatory factor analyses were calculated via Mplus following an analogue procedure to Study 1. First, measurement models were estimated for all facets, estimator was WLSMV. Model fit was determined based on the guide lines as before. In a final model, all five domain structural models were integrated using again exploratory structural equation modeling (ESEM).

Step 2 – Testing for measurement invariance. In a next step, measurement invariance between German and US samples was examined. We followed the procedure suggested by Sass (2011) and tested configural, factorial and strong factorial invariance. The cutoffs suggested by Chen (2007) were applied to compare model fits. According to this configural measurement invariance can be assumed when the same item is associated with the same factor in each domain, while the factor loadings can differ. If the factor loadings of each item would not differ between the samples, factorial measurement invariance can be assumed. Strong factorial measurement invariance can be assumed when on top of that the intercepts of each item are equal. The limit to factorial measurement invariance was set to Δ CFI $< .01$, Δ RMSEA $< .015$ and Δ SRMR $< .03$, at which the limit to strong factorial measurement invariance was set to Δ CFI $< .01$, Δ RMSEA $< .015$, Δ SRMR $< .01$ (Chen, 2007).

Results

Results of CFA. The measurement models of the American sample were replicated for the reduced number of item per facet. Model fits can be seen in Table 4. The ESEM with all five domains fits well with CFI = .82, RMSEA = .078, SRMR = .044. Table 5 shows the ESEM factor loadings for the German sample. All facets load significantly on their intended domain but can have loadings on other domains as well.

Results of MI

For analyzing the measurement invariance the latest facet model structure (with additional facets) was taken. The results are shown in Table 6. Configural measurement invariance is assumed for the facets Appreciation of others, Superiority/Grandiosity, Need to be liked, Crybabiness, Manipulation, Altruism (facets of Agreeableness), Perseverance, Task Planning, Goal-orientation/Achievement striving, Preferred Load, Procrastination (facets of Conscientiousness), Assertiveness, Sociability/Gregariousness, Activity (facets of Extraversion), Irritability, Self-serving Attention (facets of Neuroticism), Self-attributed

Inginuity, Openness to actions and activities, Openmindedness/Judgement, Love of Learning, Openness to feelings and Intellect (facets of Openness).

Factorial measurement invariance is assumed for the facets Meanness, Trust (facets of Agreeableness), Control of others, Lack of (Self-) Control, Deliberation/Caution, Lack of Tidiness/Order (facets of Conscientiousness), Sensation Seeking, Reclusiveness, Emotionality, Humor (facets of Extraversion), Depression, Anxiety, Self-assuredness, Lethargia, Sentimentality (facets of Neuroticism), Openness to reading, Openness to arts and Need for cognition (facets of Openness).

The only facet with strong factorial measurement invariance is Shyness, a facet of Extraversion

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Table 1

Model fit for each facet

	Agreeableness	Conscientiousness	Extraversion	Openness	Neuroticism
A1	-0.383***	0.124	0.261***	0.095	0.446***
A2	0.638***	-0.218*	-0.181**	0.13	-0.099
A3	0.757***	0.058	0.063	0.102	0.118
A6	-0.229***	0.007	0.407***	0.226**	0.137
A7	0.635***	-0.172	-0.034	0.144	-0.001
A8	-0.347***	-0.003	0.246***	0.132	0.334***
C1	0.677***	0.273***	0.081	0.041	0.177
C2	0.033	-0.325**	-0.203**	0.457***	-0.169*
C3	0.265***	-0.302*	0.096	0.533***	0.163*
C4	0.183*	0.816***	-0.097	0.034	0.012
C5	0.068	0.681***	0.133	-0.147	0.184*
C6	-0.071	0.585***	-0.194*	0.013	0.321***
C7	0.032	-0.46***	0.045	0.364***	0.185**
C8	0.054	0.35***	0.114	0.148*	0.191*
C9	0.12*	0.4***	0.077	-0.24**	0.16*
E1	-0.082	0.015	-0.746***	0.025	-0.002
E3	0.045	0.078	-0.694***	0.029	0.456***
E4	-0.081	0.169*	0.547***	-0.163	0.249***
E5	0.6***	0.039	0.196***	-0.007	0.398**
E6	0.113	-0.077	0.699***	0.36***	-0.001
E7	0.08	-0.203**	0.289***	-0.027	0.414***
E8	0.048	0.012	0.744***	0.137	0.083
E9	0.106	0.042	0.492***	-0.264***	0.11
N1	0.46***	0.011	-0.055	0.389***	-0.135
N2	0.052	-0.1	-0.489***	0.54***	0.083
N3	0.003	0.144	-0.243**	0.755***	0.09
N4	0.204*	-0.013	0.064	-0.411***	0.537***
N5	0.027	-0.365**	-0.234**	0.587***	0.006
N6	-0.162	0.247*	0.055	0.729***	-0.129
N7	0.136*	0.106	0.009	0.629***	-0.089
O1	0.22	-0.236***	-0.014	-0.158**	0.806***
O2	-0.184**	0.121	0.284***	0.038	0.42***
O3	-0.082	-0.012	0.066	-0.095	0.768***
O4	-0.208**	-0.04	-0.173**	0.107	0.543***
O5	-0.27**	-0.095	0.031	0.056	0.586***
O6	-0.001	0.154*	-0.152*	0.065	0.776***
O7	-0.246**	0.137*	0.044	-0.05	0.706***
O9	0.073	0.17**	-0.114	-0.197***	0.623***

Table captions

Table 1. Model fit for each facet

Appendix

Appendix