1 Personality differences between sex and sexual orientation group

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4 Author Note

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Abstract

It has been argued that because some biological underpinnings affecting personality occur in a continuum (e.g. hormonal exposure), personality scores in a given population should also occur in a continuum. Personality sex differences have been widely studied but these do not allow to study personality as a continuum. To tackle this limitation, Lippa (2001) suggested using sexual orientation. The Shift and the Inversion Hypotheses have been proposed to predict how the personality scores of homosexual participants would differ from their heterosexual counterparts. However, these efforts have been largely ignored. This study used a large UK sample to compare these hypotheses using personality scores at the facet and domain level. The results suggested that there was evidence for the Shift and the Inversion Hypotheses at the facet level, but these patterns were obscured at domain level where groups tended to cluster according to sexual orientation. Moreover, Neuroticism was often responsible for the largest differences across groups at facet and domain level.

Keywords: personality, facet, domain, sex, sexual orientation

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Introduction

Personality differences between men and women have been thoroughly studied. Research suggests that sex differentiation happens on a continuum, hence it is an oversimplification to study it using just two categories – i.e. men and women. However, sexual orientation might map this spectrum better, yielding a more detailed picture of personality differences between men and women (Lippa, 2001). Research using sexual orientation is limited but provides evidence that personality scores of homosexual men tend to move away from their heterosexual counterparts toward heterosexual women. Similarly, personality scores of homosexual women tend to move away from heterosexual women toward heterosexual men. Additionally, it has been observed that personality shifts in homosexual participants tend to mirror personality differences between heterosexual men and women. This finding would support the idea that personality sex differences actually occur on a continuum.

Personality differences between men and women

Sex differences are present at an early age at different biological (e.g.: prenatal exposure to androgen levels, pain sensitivity) and psychological levels (e.g.: responsiveness to social cues). Some of these differences might precede certain personality differences later in life (Alexander & Wilcox, 2012). For instance, higher sensitivity to social cues may translate into higher Agreeableness. Personality differences between men and women have been thoroughly studied. On average, man's and woman's overall personality distributions overlap by less than a fifth. However, this percentage varies substantially across populations and it is especially large among developed countries (Charles & Bradley, 2009; Costa, Terracciano, & McCrae, 2001; Kaiser, 2019; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008).

Research on the Big Five converges in showing that women score higher in Neuroticism and, to a lesser extent, in Extraversion and Agreeableness. Results on sex differences on Conscientiousness and Openness to experience (Openness, for short) remain unclear. Specifically, women have been found to score higher in Extraversion in samples across the world, with effect sizes ranging (d_{range}) from .06 to .29 (Costa, Terracciano, & McCrae, 2001; Heineck, 2011; Kajonius & Mac Giolla, 2017; Lippa, 2005, 2008, 2010; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008). Sex differences in Agreeableness favoring women are slightly larger and have also been reproduced in cross-country samples – i.e. d_{range} = .15 - .60 (Costa, Terracciano, & McCrae, 2001; Heineck, 2011; Kajonius & Mac Giolla, 2017; Lippa, 2005, 2008; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008). The largest sex difference across studies tends to be in Neuroticism – i.e. d_{range} = .36 - .51 (Costa, Terracciano, & McCrae, 2001; Heineck, 2011; Kajonius & Mac Giolla, 2017; Lippa, 2005, 2008; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008). Sex differences in Conscientiousness favor women in some studies – i.e. d_{range} = .04 - .17 (Heineck, 2011; Kajonius & Mac Giolla, 2017; Lippa, 2005; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008), and men in others (Kajonius & Mac Giolla, 2017), but not all studies have found significant differences (e.g.: Costa, Terracciano, & McCrae, 2001). There are also contradicting results on sex differences in Openness to experience: some show small differences favoring women (Costa, Terracciano, & McCrae, 2001; Kajonius & Mac Giolla, 2017; Lippa, 2005; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008), others favoring men (Heineck, 2011; Kajonius & Mac Giolla, 2017; Schmitt, Realo, Voracek, & Allik, 2008).

Personality differences at lower levels of aggregation

Personality sex-differences are usually explored at domain level. However, this might obscure differences at lower levels of aggregation like nuances or facets (Booth & Irwing, 2011; Del Giudice, Booth, & Irwing, 2012; Kaiser, 2019; Mac Giolla & Kajonius, 2019;

Murphy, Fisher, & Robie, 2020). Nuances are the smallest level of granularity, and they roughly correspond to single items (McCrae, 2015). Nuances can be grouped into facets, which can be then combined into domains. Möttus et al. (2020) argued that there is not enough evidence proving the Big Five at domain level as the best model to explain personality's nature and they have limited predictive power, so they are mostly used for convenience, pragmatism, and familiarity.

Feingold (1994) meta-analysis suggested that sex-differences in Neuroticism could be in the *anxiety* facet and sex-differences in agreeableness could be mainly found in the *tenderness* and *trust* facets. Additionally, Costa, Terracciano, and McCrae (2001) found that all differences in Neuroticism and agreeableness followed the same direction at domain and facet level; contrary to Extraversion and Openness, for which not all the facets showed significant differences between men and women. Feingold (1994) also found that sex-differences in Extraversion could be driven by sex-differences in the *assertiveness* facet. Sex-differences at the facet level could also explain the inconsistent findings at domain level found for Conscientiousness or Openness (Booth & Irwing, 2011; Costa, Terracciano, & McCrae, 2001; Feingold, 1994).

McCrae (2015) and Möttus et al. (2020) argue that focusing on lower levels of aggregation like facets or nuances would, at least, improve the predictive validity of personality models. Research using nuances is limited but suggests that they contain genuine information about personality (McCrae, 2015; Möttus et al., 2020; Seeboth & Möttus, 2018) and share domains' properties like cross-cultural presence, temporal stability, observability across raters, and genetic basis (Achara-Amankwaa, Oloru, & Schroeders, 2020; e.g. Möttus, Kandler, Bleidorn, Riemann, & McCrae, 2017).

The Shift Hypothesis and the Inversion Hypothesis

It is hypothesized that personality sex differences occur on a spectrum because the biological factors contributing to them (e.g.: genes, hormones, etc.) are likely to operate on a continuum (Bao & Swaab, 2011). Operationalizing sex as two categories does not reflect this spectrum, but sexual orientation could (Lippa, 2001). R. Lippa exemplified this through his *Shift Hypothesis*. According to the Shift Hypothesis, personality traits could be either represented as (1) two continuums – for men and women independently – with heterosexuality at one end and homosexuality at the other, or as (2) a bipolar dimension with heterosexual men and heterosexual women standing at each extreme. In either case, homosexual individuals would shift away from the heterosexual pole and bisexual individuals should lay between the two. In this sense, evidence for the Shift Hypothesis on personality differences could serve as evidence that personality sex differences mirror the continuum on which certain biological precursors operate.

The Shift Hypothesis stands in opposition to the *Inversion Hypothesis*, which is based on Freud's (1953) idea of *gender inversion*. According to Freud (1953), homosexual men should show female traits and homosexual women should have male traits. Hence, the Inversion Hypothesis does not allow us to study sex differences as a continuum. There is some evidence supporting the Inversion Hypothesis, but it seems insufficient to explain personality differences across sexual orientations (Greaves, Barlow, Huang, Stronge, & Sibley, 2017).

Personality differences between heterosexual and homosexual samples

Few studies have tackled personality differences across sexual orientations and, those which have, only used the Big Five at the domain level. Of those, most have tested the Shift Hypothesis but almost none have studied the Inversion Hypothesis (see Table 1). Lippa (2005) and Lippa (2008) tested the Shift Hypothesis by comparing same sex heterosexual and homosexual participants. They also tested the Inversion Hypothesis by

124 correlating domain-level personality differences between heterosexual men and women with
125 the personality differences between homosexual participants and their heterosexual
126 counterparts. Lippa (2005) found a correlation of *.24* and *.89* in the male and women
127 samples, respectively. Lippa (2005) argued that there was evidence for the Inversion
128 Hypothesis in the women sample because the personality differences found between
129 heterosexual men and women mirrored the differences found between heterosexual women
130 and homosexual women. Later, Lippa (2008), found higher correlations (*.95* and *.94*
131 in the men and women samples), showing a stronger support for the Inversion Hypothesis.
132 These correlations are the average values across all comparisons hence, they could be
133 driven by specific traits. This approach does not allow to study the degree to which the
134 Shift and the Inversion Hypotheses accommodate personality differences in each trait.
135 Nevertheless, Greaves, Barlow, Huang, Stronge, and Sibley (2017) directly compared all sex
136 and sexual orientation groups and found consistent evidence for the Inversion Hypothesis
137 (see Table 1 for a summary of this studies).

138 Lippa (2005) found no differences in Extraversion between sexual orientation groups
139 but three years later, Lippa (2008) he found evidence supporting the Shift Hypothesis in
140 the women sample. Zheng et al. (2008) and Greaves, Barlow, Huang, Stronge, and Sibley
141 (2017) did not find differences in Extraversion between any of the groups. On the contrary,
142 Allen and Robson (2020) found evidence supporting the Shift Hypothesis for men and
143 women in their Australian sample, but only for women in their meta-analyses.

144 Lippa (2005) showed evidence for the Shift Hypothesis in their male samples for
145 Agreeableness. Greaves, Barlow, Huang, Stronge, and Sibley (2017) found that the
146 Agreeableness scores of homosexual men were no different from those of heterosexual
147 women – i.e. homosexual man's scores were inversed. Lippa (2008) and Allen and Robson's
148 (2020) Australian sample provided evidence for the Shift Hypothesis in both, the men and
149 women sample. Allen and Robson (2020) meta-analysis of representative samples found

evidence for the Shift Hypothesis only in the women sample. However, Zheng et al. (2008) and Allen and Robson (2020) non-population representative samples did not find any difference between groups.

Lippa (2005), Lippa (2008), and Zheng et al. (2008) showed evidence for the Shift Hypothesis in Neuroticism. Allen and Robson (2020) found evidence supporting the Shift Hypothesis for men in their meta-analyses but not in their Australian sample. Lastly, Greaves, Barlow, Huang, Stronge, and Sibley (2017) only found inversion of the homosexual male's scores. These results are interesting because they contradict the popular *Social Stress Theory*, which argues that non-heterosexual individuals are more likely to experience traumatic events – e.g.: bullying – and thus, should score higher on Neuroticism (Meyer, 2010).

Most research has found women scoring higher than men in Conscientiousness but there are some inconsistent findings. Hence, evidence for the Shift and the Inversion Hypothesis should be considered sample-specific. If in a given sample women have higher Conscientiousness, the Shift Hypothesis would predict that homosexual men would score higher than heterosexual men, and homosexual women would score lower than heterosexual women. This is precisely what Lippa (2005) and Allen and Robson (2020) Australian sample showed. Allen and Robson (2020) also found evidence supporting the Shift Hypothesis for men and women in their meta-analysis of population representative samples. However, Zheng et al. (2008) and Allen and Robson (2020) meta-analysis of non-population representative samples found no difference between groups. Lastly, Greaves, Barlow, Huang, Stronge, and Sibley (2017) found evidence for the Inversion Hypothesis only in the women sample.

Similarly to Conscientiousness, there is no consensus on Openness sex-differences. Zheng et al. (2008) and Greaves, Barlow, Huang, Stronge, and Sibley (2017) found no difference between groups however, Lippa (2005) and all studies in Allen and Robson

(2020) converged showing evidence for the Shift Hypothesis in both, male and female samples. Homosexual participants scoring higher than their heterosexual counterparts may be explained by the unconventional nature of those who defy the heteronormativity by defining themselves as homosexuals.

Summary and Hypotheses

Given that sex differentiation happens on a continuum, sex orientation as an independent variable might provide a more detailed approach to understand personality differences. Research on personality differences across sex orientation is scarce but, so far, it shows that personality scores of homosexuals tend to move away from their heterosexual counterparts. On the one hand the Shift Hypothesis implies that the personality scores of homosexual participants move away from their heterosexual counterparts. On the other hand, the Inversion Hypothesis proposes that homosexual men should score as heterosexual women and homosexual women should score as heterosexual men.

So far, evidence for the Shift Hypothesis is especially consistent for Extraversion, Agreeableness, and Neuroticism. However, there is also evidence for the Inversion Hypothesis across traits. The goal of this study is to compare the personality scores (at the facet and domain level) across sex and sexual orientation groups to assess the relevance of the Shift and the Inversion Hypotheses. Following previous research I hypothesize that:

- *Hypothesis 1:* Discrepancies between group differences at facet level may explain inconsistencies in in Conscientiousness and Openness sex differences reported in previous studies at domain level.
- *Hypothesis 2:* Homosexual participants score higher than heterosexual participants in Neuroticism and in Openness.
- *Hypothesis 3:* The personality scores difference between homosexual and

heterosexuals might depend on how large the difference is between heterosexual men and women.

- *Hypothesis 4:* Given that the Shift Hypothesis makes less rigid claims in terms of what the degree of personality change about personality shifts according to sexual orientations, it is likely that more evidence will support it.

Methods

Sample

Together with some colleagues, I created a life-outcomes and a personality questionnaire. The survey was uploaded to Formr (R. C. Arslan, Walther, & Tata, 2020) and published the link in various social media sites (e.g.: Twitter, facebook, Instagram, etc.) as well as in Prolific. A total of 1202 people landed on the survey. Participants under 18 years old were filtered out together with those who did not identified as men, women, heterosexual or homosexual (N= 172). After inspecting the data's quality with R's *careless* package (R. D. Yentes & Wilhelm, 2018), I further eliminated 13 participants that gave the same answer 10 or more consecutive personality times. This left 1017 participants (57% Women). Table 2 shows the sample demographics.

Materials

Sexual orientation. Measured through a single item asking participants to self-identify as heterosexual/straight, homosexual/gay/lesbian, bisexual, asexual or other. Due to the limited number of participants self-identifying as bisexual, asexual or other, only the data from heterosexual and homosexual participants was analyzed.

Personality. A total of 90 items were selected from the pool of items created by Henry, Möttus, & Vainik (in preparation), who screened the items to maximize their re-test reliability. Items were mainly retrieved from the International Personality Item Pool (IPIP,

Goldberg, 1999) and the Synthetic Aperture Personality Assessment (SAPA, Condon, 2018). Some items were written by the authors. Items were selected to maximize their re-test reliability ($M=.71$, $SD=.09$, Values range=.60-.85), their clarity, readability, as well as to minimize their redundancy. Following Condon et al. (2021) advice, items were selected and categorized into facets according to: (1) their re-test reliability, (2) feedback from Dr McCrae, and (3) fit within the IPIP's facet definitions. Domain scores were computed as the average across six facet scores, each computed as the sum scores of three items (see the full list of items at <https://osf.io/xeqch/>).

Analyses

Several packages R (Version 4.0.2; R Core Team, 2020) and the R-packages *careless* (Version 1.2.1; Richard D. Yentes & Wilhelm, 2021), *dplyr* (Version 1.0.7; Wickham, François, Henry, & Müller, 2021), *formr* (Version 0.8.5; R. Arslan, 2014), *ggplot2* (Version 3.3.5; Wickham, 2016), *gridExtra* (Version 2.3; Auguie, 2017), *kableExtra* (Version 1.3.4; Zhu, 2021), *knitr* (Version 1.33; Xie, 2015), *lme4* (Version 1.1.26; Bates, Mächler, Bolker, & Walker, 2015), *Matrix* (Version 1.2.18; Bates & Maechler, 2019), *MVN* (Version 5.8; Korkmaz, Goksuluk, & Zararsiz, 2014), *papaja* (Version 0.1.0.9997; Aust & Barth, 2020), *patchwork* (Version 1.1.1; Pedersen, 2020), *psych* (Version 2.0.12; Revelle, 2020), *readxl* (Version 1.3.1; Wickham & Bryan, 2019), *tidyr* (Version 1.1.3; Wickham, 2021), and *tinylabels* (Version 0.2.0; Barth, 2021) were used for all the analyses.

Cohen's d and Mahalanobis Distance

Personality sex differences are usually measured individually for each of the Big Five using Cohen's d , which estimates the difference between the group's means in standard deviation units (Del Giudice, 2019). Giudice (2021) explained the existence of a direct relationship between the number of variables and the size of Cohen's d , suggesting that sex differences might have been underestimated (e.g.: Hyde, 2005). Using more indicators – i.e. facets or nuances – would result in a more accurate estimate of personality sex

differences. This approach would raise the question of which variables to consider and how to combine them. For instance, the distance between two cities could be estimated using latitude, altitude, and longitude (Del Giudice, Booth, & Irwing, 2012). Choosing just one of these indicators will likely under or over-estimate the *actual* distance between these cities. Additionally, how these attributes are combined would also have a direct impact on the measurement's accuracy.

The *Mahalanobis Distance* (D) is the multivariate generalization of Cohen's d and represents the distance between the centroids (multivariate means) relative to the standard deviation along that distance (Del Giudice, 2019; Mahalanobis, 1936). Contrary to Cohen's d , Mahalanobis D , takes into account the pattern of correlation between the measured variables, which is especially relevant in personality research where traits tend to be correlated. Giudice (2021) proposed d_u and D_{Mu} to correct for the bias induced when having few observations per indicator (i.e. less than a hundred observations per trait). Mahalanobis D sensitivity to violations of normality assumptions calls for a rigorous examination of the data to ensure homogeneity of means and variances across groups.

Multivariate normality and homogeneity of variance-covariance matrices

Testing for multivariate normality (MVN) implies estimating whether a collection of variables follow an underlying normal distribution so that their linear combination is also normally distributed. It is usually recommended to use different MVN tests because there is not a single one that performs well under all circumstances (e.g.: Del Giudice, 2019; Christopher J. Mecklin & Mundfrom, 2003). This study used Mardia's, Doornik-Hansen's, Henze-Zirkier's, Royston's, and the Energy tests (Alpu, Yuksek, & Department of Statistics, Eskisehir Osmangazi University, Eskisehir 26480, Turkey, 2016; Farrell, Salibian-Barrera, & Naczki, 2007; Christopher J. Mecklin & Mundfrom, 2003; Christopher J. Mecklin & Mundfrom, 2005). If means and variance homogeneity cannot be proven, Cohen's d or its unbiased estimate (d_u) must be used.

Multivariate normality tests were run at the facet ($N=30$) and domain level ($N=5$) across all the pair combinations that could create out of the four groups – i.e. heterosexual men, heterosexual women, homosexual men, and homosexual women. Hence, the sample was first divided ($N= 1017$) into four different matrices with the raw personality item scores. There were 213 heterosexual men, 382 heterosexual women, 225 homosexual men, and 197 homosexual women.

Lastly, Box's M was used to test the homogeneity of variance-covariance matrices. Homogeneity of variance-covariance matrices guarantees that the spread of the distribution is similar across groups, which is relevant when estimating the distance between them. Note that Box's M is sensitive to normality departures.

Results

Comparisons at facet level

Multivariate Normality and homogeneity of variance-covariance matrices at facet level. First, facets' skewness and kurtosis were explored individually. There were no facets with skewness or kurtosis values higher than 1 or lower than -1.

Tables 3 shows MVN tests' results for each group. Given that none of the tests' values surpassed the significance level of .05, there was no evidence that the facets in any of the groups followed a multivariate normal distribution. Consequently, only Cohen's d could be used to estimate personality differences across groups.

Table 4 shows the results from the Box's M test for homogeneity of variance-covariance matrices. Given the lack of multivariate normality, it is unlikely that Box's M would represent an accurate estimate of variance-covariance matrices homogeneity. As Table 4 shows, none of the p-values were above the significance level of .05 hence, there was no evidence of homogeneity of variance-covariance matrices at facet level in any of the group comparisons.

Comparisons between heterosexual men and heterosexual women at facet level. Each sex and sexual orientation group had few participants – i.e. observations – per facet. Thus, d_u was used to estimate the distance between groups. The absolute value of d_u average between heterosexual men and women across all facets was 0.28 SD= |0.22|, indicating a medium to very large distance according to Funder and Ozer (2019) cut-off points. Table 5 shows that heterosexual men and women differed specially on Neuroticism facets (Table 5), although there were other relevant domains (find the d_u values for all facets across group comparisons in the supplementary materials).

Comparisons between heterosexual men and homosexual men at facet level. The average d_u between heterosexual and homosexual men was half of that between heterosexual men and women (M=|0.18|; SD=|0.12|), indicating a medium to large distance (Funder & Ozer, 2019). Table 5 shows that the facets with the largest d_u belonged to different domains.

Comparisons between heterosexual men and homosexual women at facet level. The average d_u between heterosexual men and homosexual women was almost identical to that between heterosexual men and heterosexual women (M=|0.28|; SD=|0.17|). Additionally, Neuroticism facets were prominent in the difference between heterosexual men and homosexual women (Table 5).

Comparisons between heterosexual women and homosexual women at facet level. The average d_u between heterosexual women and homosexual women was |0.16|, SD=|0.13|. This difference was slightly smaller than that found either between heterosexual and homosexual men, or between heterosexual men and homosexual women. Heterosexual women differed from homosexual women on various facets, specially those grouped under the Agreeableness domain (Table 5).

Comparisons between heterosexual women and homosexual men at facet level. The average d_u between heterosexual women and homosexual men was |0.18|, SD=|0.13|. This difference was similar to the difference between heterosexual women and

homosexual women, as well as to the difference between heterosexual and homosexual men. As found in these two group comparisons, there were several domains driving the differences between heterosexual women and homosexual men, especially Agreeableness (Table 5).

Comparisons between homosexual men and homosexual women at facet level. The average and distribution of d_u between homosexual women and homosexual men was the smallest across the groups comparisons: $M = |0.12|$, $SD = |0.1|$. As this was a smaller distance than that found between heterosexual men and heterosexual women, this already suggests some personality score shifts among homosexual participants.

Figure 1 is a summary of the percentage of facets – organized by domains – in each distance group (i.e very high, high, moderate, and small) and across group comparisons. As Figure 1 shows, differences between homosexual women and homosexual men were mainly driven by in Openness and Neuroticism facets. This was surprising because both have been found more open than their heterosexual counterparts and previous research has assumed high Openness as a common characteristic among homosexual individuals. For more details see Table 5.

Section summary. The personality distance (i.e d_u) between heterosexual men and heterosexual women was as large as the distance between heterosexual men and homosexual women. The distances between heterosexual women and the homosexual groups were smaller but not as small as the distance between both homosexual groups. Overall, the differences at facet level between heterosexual men and heterosexual women sourced from different domains but the largest differences came from Neuroticism and Agreeable facets. Interestingly, heterosexual men differed from homosexuals mainly on Neuroticism. Heterosexual women differed from homosexual men and women in various domains but specially on Agreeableness. From Figure 1 and Table 5 facets driving the differences across the four groups came mainly from Agreeableness, Neuroticism, and Openness.

The Shift Hypothesis vs. the Inversion Hypothesis at facet level

As mentioned in the introduction, the Shift Hypothesis would predict that the scores of homosexual people would shift away from their heterosexual counterparts. On the contrary, the Inversion Hypothesis predicts that there would be a complete cross-over, so homosexual men would score as heterosexual women and homosexual women as heterosexual men. In this section compares the four groups across facets to determine if there was evidence for any of these hypotheses. Figure 2 serves as a rough summary, displaying in a single dimension the average raw score of each group, facilitating the identification of shifts in personality scores across sex and sexual orientation groups. Note that the use of raw averages might distort the actual size of the distance between groups.

There was some support for the Shift Hypothesis (but not so much for the Inversion Hypothesis) on several Agreeableness facets. In “Modesty” and “Altruism” facets, personality scores of homosexual participants shifted away from their heterosexual counterparts toward the center, as the Shift Hypothesis would predict. Unilateral displacements of homosexuals man’s scores towards heterosexual woman’s scores in “Tender-Mindness” were observed. Similarly, homosexual woman’s scores displaced in “Straightforwardness” towards the heterosexual men. However, these unilateral displacements were not strong enough to fully support the inversion hypothesis. All four groups scored similarly in the “Cooperation” facet, although there seemed to be a small group division according to sexual orientation.

It could be said that Neuroticism facets supported the Social Stress Theory because homosexual men scored higher than heterosexual men in all facets and homosexual women scored higher than the rest of the groups in “Depression” and “Impulsiveness.” On the other hand, it could be considered that Neuroticism facets offered partial support for the Inversion Hypothesis, as homosexual men scored as heterosexual women in “Depression,” “Anxiety,” and “Anger.” In “Vulnerability” and “Self-Consciousness” facets,

homosexual man's scores unilaterally displaced towards the center but were still far from woman's scores. In the "Impulsiveness" facet all groups clustered together except for homosexual women who scored higher than the rest.

In Conscientiousness, the direction of the differences between heterosexual men and women varied across facets, potentially explaining why sex differences at domain level are not consistent across studies. Heterosexual men scored higher than heterosexual women in "Deliberation," "Competence," and "Achievement Striving" conversely, heterosexual women scored higher in "Self-discipline" and "Dutifulness." Lastly, all groups scored similarly in "Order." Conscientiousness facets offered poor support for either hypotheses. There was a unilateral inversion of homosexual women scores in the "Self-discipline" facet and, to a lesser degree, in "Dutifulness." The only evidence for the Shift Hypothesis was in the "Competence" facet as the scores of homosexual men and women simultaneously displaced towards the center. As found in "Impulsiveness" facet, homosexual women scored more extremely in the "Deliberation" facet compared to the rest of the groups. Lastly, in the facet where heterosexuals scored similarly -i.e. "Achievement striving"- homosexual scores were displaced in the same direction and groups cluster according to sexual orientation.

In Extraversion, as with Conscientiousness, the direction of the differences between heterosexual men and women varied across facets, which might explaining inconsistencies in the literature. Heterosexual men scored higher than heterosexual women in "Excitement-seeking," "Activity" and "Assertiveness," while heterosexual women scored higher in "Warmth" and "Positive emotions." Heterosexuals scored similarly on "Gregariousness." Extraversion facets did not provide much support for the Shift hypothesis, except in "Positive emotions" where homosexual women shifted towards heterosexual men and in "Excitement-seeking" where homosexual men shifted towards heterosexual women. There was a unilateral inversion of homosexual man's scores in "Assertiveness." Homosexual women separated from the other three groups in

“Gregariousness.” In the “Activity” facet groups were divided again according to sexual orientation.

Facets in Openness to experience offered some evidence for both, the Shift and the Inversion Hypotheses. As with Extraversion and Conscientiousness, the direction of differences between heterosexual men and women varied across facets. Heterosexual men scored higher in “Ideas” and “Action,” while heterosexual women scored higher on “Feelings.” Both heterosexual men and women scored similarly in “Values,” “Aesthetics” and “Fantasy.” Partially consistent with previous results, groups clustered according to sexual orientation in “Aesthetics” but not in “Fantasy,” where homosexual men scores actually inverted to resemble heterosexual women scores. Homosexual man’s scores also inverted in the “Ideas” facet. Results showed that homosexual man’s scores were unilaterally displaced towards the center in “Action” and “Feeling” facets. Lastly, homosexual woman’s scores in “Values” were displaced extremely away from the rest.

Taken together, these results support both the Shift and the Inversion Hypotheses. There was support for the Shift Hypothesis in Agreeableness and some more evidence was scattered across the rest of the domains, although it was often just unilateral shifts. There was strong support for the Inversion Hypothesis on Neuroticism and Openness to experience facets, but mostly referred to homosexual men. Finally, there was mixed evidence in the Conscientiousness and Extraversion facets. These results suggest that most evidence was partial, as there were few cases in which both homosexual groups changed their scores in the direction predicted by either of the hypotheses. Still, these results serve as evidence that sexual orientation is a relevant variable when studying personality as a continuum.

Comparisons at domain level

Multivariate Normality and homogeneity of variance-covariance matrices at domain level. The same MVN tests were run on the domain scores for each of the four groups. Aggregation tends to compensate for normality violations at lower levels. However, as Table 6 shows, there was mixed evidence for MVN in the homosexual women group and little evidence in the heterosexual women and homosexual men groups. For this reason it was decided to use Cohen's d for the rest of the analyses.

Comparisons between groups at domain level. Given that domain scores did not have MVN, d_u was used to estimate the distance at each domain. As table 7 shows, the results at the domain level mirror the results at the facet level across all group comparisons. The largest difference at domain level was between heterosexual men and homosexual women, closely followed by the distance between heterosexual men and heterosexual women. As found at the facet level, the smallest distance was between homosexual men and women. Altogether, the results at domain level also suggested that sexual orientation was a relevant factor influencing personality scores.

The Shift Hypothesis vs. the Inversion Hypothesis at domain level

Table 7 allows us to explore the Shift and the Inversion Hypotheses at domain level by comparing the univariate distance in each personality domain across group comparisons.

Replicating the findings at facet level, Agreeableness offered strong support for the Shift Hypothesis as heterosexual women scored the higher, heterosexual men the lowest and the scores of homosexual groups laid in between.

Neuroticism results at domain level partially supported the Inversion Hypothesis as homosexual men scored closer to the heterosexual women than to the heterosexual men. However, results could be better framed within the *Social Stress Theory* because, as found at the facet level, both homosexual groups scored higher than their heterosexual counterparts.

Given that the direction of the differences in Conscientiousness and Extraversion changed across facets, the resulting differences at domain level were small. In both Conscientiousness and Extraversion, groups were seen to cluster according to sexual orientation, having heterosexual participants scoring higher than homosexual participants. A similar phenomena was observed in Openness where heterosexual men and women scored similarly and lower than their homosexual participants. Moreover, homosexual women scored above the rest of the groups. These results do not support the Shift or the Inversion hypotheses but they replicate previous findings showing that homosexual participants tend to have higher Openness than their heterosexual counterparts.

In summary, at domain level there was little support for either hypotheses. As happened at facet level, there was a shift in homosexuals' Agreeableness scores for both, men and women. There was a unilateral inversion of homosexual men scores in Neuroticism. Lastly, results in Conscientiousness, Extraversion, and Openness were similar: groups clustered according to their sexual orientation. These findings show the relevance of using facets to explore personality differences across groups, as certain results patterns can be masked when aggregating data into domain scores.

Comparing results at facet and domain level

Each domain's d_u was explored to assess which were responsible for the largest differences. As table 8 shows, the personality traits driving differences across groups at facet level were also found at the domain level, evidencing a reasonable amount of consistency across analyses. At both, facet and domain level, Neuroticism yield the highest differences in most groups comparisons.

Differences between heterosexual men and women were concentrated in Neuroticism and Agreeableness at facet and domain level. Interestingly, Neuroticism strongly influenced the differences between heterosexual men and homosexual participants at both facet and

domain level. However, Agreeableness seemed to drive the differences between heterosexual women and the homosexual samples at domain and facet level. Openness was also relevant trait distinguishing them from homosexual women from heterosexual men (at domain level), heterosexual women (at domain and facet level), and homosexual men (at domain level). However, the differences between homosexual women and men at the facet level were larger in Neuroticism than in Openness.

Discussion

Personality differences between men and women have often been explored. However, few studies have considered personality differences across sexual orientation groups. Sexual orientation is a relevant variable, for it might reflect the continuum nature of personality traits better than sex does. Two competing hypotheses – the Shift Hypothesis (Lippa, 2001) and the Inversion Hypothesis (Freud, 1953) – have been proposed to predict how sexual orientation would shape personality scores.

Around a thousand participants from the UK were gathered through different social media platforms, as well as Prolific. The sample was divided into four groups according to participant's sex and sexual orientation (i.e. heterosexual men, heterosexual women, homosexual men, and homosexual women). There was no evidence for multivariate normality (MVN) and variance homogeneity at facet or domain level. Hence, personality differences were explored between the four sex and sexual orientation groups, using Cohen's d.

With respect to personality differences between heterosexual men and women, the results supported the hypotheses and replicated previous research showing that women scored higher than men in Agreeableness and Neuroticism at facet and domain level (e.g.: Costa, Terracciano, & McCrae, 2001; Heineck, 2011; Kajonius & Mac Giolla, 2017; Lippa, 2005, 2008; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008). On the

contrary, the results did not replicated sex differences in Extroversion at domain level as men and women scored similarly (e.g.: Costa, Terracciano, & McCrae, 2001; Heineck, 2011; Kajonius & Mac Giolla, 2017; Lippa, 2005, 2008, 2010; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008). Additionally, men scored higher than women in most of Extraversion facets. As was predicted in Hypothesis 1, there was a mix pattern of results at facet level in Openness to experience and Conscientiousness which, might explain why some researchers have found that women score higher (Costa, Terracciano, & McCrae, 2001; Kajonius & Mac Giolla, 2017; Lippa, 2005; Mac Giolla & Kajonius, 2019; Schmitt, Realo, Voracek, & Allik, 2008) while others have claimed the opposite (Heineck, 2011; Kajonius & Mac Giolla, 2017). Moreover, there was partial evidence for Hypothesis 2 as homosexual participants almost always score higher than heterosexual participants in Neuroticism and Openness. These results offer certain support the Social Stress Theory, as homosexual participants scored higher than their heterosexual counterparts in Neuroticism. None the less, homosexual men had lower Neuroticism scores than women at facet and domain level. Hence, the results suggests that Neuroticism rose as an important trait at facet and domain level, distinguishing men and women regardless of their sexual orientation.

Regarding the distance between groups, the biggest distance - the largest difference - at facet was between heterosexual men and women. At domain level, the largest distance was between heterosexual men and homosexual women. Interestingly, the smallest distance, at domain and facet level, was between homosexual men and women. These results replicate previous research suggesting that personality scores displace according to sexual orientation (Lippa, 2005). This finding could be taken as an indirect evidence for the Shift Hypothesis, as it shows that the distance between homosexual participants does not mirror that between heterosexual participants. However, this overall distance estimate could be biased by large differences on a few traits. Hence, both hypotheses were tested directly by comparing the four groups against each other.

In terms of the evidence supporting the Shift and Inversion Hypotheses, the results replicated Lippa (2005), showing that both may be found at facet and domain level. Similar to Lippa (2008), strong support was found for the Shift Hypothesis in Agreeableness at facet and domain level. Other researchers have found similar, but not as convincing, results (e.g.: Allen & Robson, 2020; Lippa, 2005). On the contrary, previous studies (e.g.: Lippa, 2005, 2008; Zheng et al., 2008) have observed solid evidence for the Shift Hypothesis in Neuroticism, but the results mostly supported the Inversion Hypothesis in homosexual men, replicating Greaves, Barlow, Huang, Stronge, and Sibley (2017). Contrary to Greaves, Barlow, Huang, Stronge, and Sibley (2017), there was evidence for the Shift Hypothesis and the Inversion Hypothesis on Conscientiousness at the facet level, which led to a mixed pattern at the domain level by which participants clustered according to sexual orientation. Similar results were found in Extraversion and Openness to experience. Hypothesis 3 proposed that the extent to which homosexual scores shifted would be related to the degree to which heterosexual men and women differed. Although this was not the case across facets and domains, homosexual scores were found to be displaced to extreme values when heterosexuals scored similarly. This was observed in Extraversion and Conscientiousness at the domain level, as well as in Openness at domain and facet level. Consistent with previous research (e.g.: Allen & Robson, 2020; Lippa, 2005, 2008), the homosexuals participants scored higher in Openness to experience than either heterosexual group. All in all, previous studies have found some evidence for the Shift Hypothesis in Extraversion, Agreeableness, and Neuroticism. Evidence for Conscientiousness has been less consistent and there has been no support in Openness to experience. This study replicated these results in Agreeableness. There was evidence for the Shift Hypothesis in other traits but only at the facet level and they often happened unilaterally; this is, either homosexual men or homosexual women shifting towards heterosexual of their opposite sex rather than having both groups of homosexual participants displacing towards the center. Similarly, the support for the Inversion Hypothesis was scattered across traits and was frequently

unilateral. The strongest evidence for the Inversion Hypothesis was in Neuroticism facets, especially as it regards to homosexual men. This partly contradicts Hypothesis 4 as, although the strict requisites of the of the Inversion Hypothesis should make it less likely to be occur, scores inversion were frequently observed.

This study suggests that there might be grounds to some stereotypes on behavioral differences between heterosexual and homosexual individuals. Besides this anecdotal connection, these personality differences across sex and sexual orientation groups might prove relevant in other settings where personality plays a role. For instance, personality sex differences might be related to personality differences across occupations. Interestingly, some of Lippa's studies (e.g.: Lippa, 2005, 2008) support the idea that there is also a shift in the occupational preferences of homosexual participants. According to Lippa (2005) "93% of lesbians have more male-typical interests than the average heterosexual woman does, and the effect size for gay versus heterosexual men implies that 90% of gay men have more female-typical interests than the average heterosexual man does" (p. 145). These results have been replicated in samples around the world like in China (e.g.: Zheng, Lippa, & Zheng, 2011) or Samoa (e.g.: Semenyna, 2016). The question remains about the relationship between the shifts in personality and in occupational preferences.

On the question of whether homosexual personality scores are better predicted by the Shift or Inversion Hypotheses, and following this discussion, the results did not provide a definite answer. However, they did show that sexual orientation was a relevant variable distinguishing participant's personality scores at facet and domain level. As discussed in the introduction, to the extent that scores' inversion imply a shift, the Shift Hypothesis is more comprehensive. Therefore, researchers might want to expand the definition of the Shift Hypothesis to accommodate any degree of displacement in personality scores according to sexual orientation. Still, further research is needed to test this hypotheses in other countries.

Limitations and strengths

The major limitation of this study is the impossibility to use a multivariate measure of the distance between groups. Future studies using larger sample sizes might overcome this limitation. The scope of this study was also limited in terms of the number of sexual orientations considered, participants self-identifying as bisexuals or asexuals were not included. Nevertheless, the sample had a reasonably big size considering that, according to the latest UK census, only 1.4% of the respondents self-identified as homosexuals, and just 0.9% as bisexuals (Office for National Statistics, 2020).

The main strength of this study was that group differences were measured at the facet and the domain level, which gives a more detailed account of what personality traits differentiate people across sex and sexual orientation. Moreover, been able to compare results at the facet and domain level helped identifying why previous research results might seem contradictory. Finally, this study is among the few that has explored personality differences between heterosexuals and homosexuals participants. Note that Jonason and Luoto (2021) recently hypothesized that this type of research might be deliberately ignored to avoid misinterpretation of research results. However, this line of research allows us to explore the continuous nature of personality and to further understand sexual differentiation.

Altogether, these results provide important insights to the role of sexual orientation in personality differentiation. However, more research is needed to explore which facets and domains are more likely to show scores' shifts or inversions. Further work is needed to determine if the tendency for homosexual and heterosexual's scores to cluster around extreme values in certain traits is a universal phenomenon. Additionally, future research is required to explore why scores' shifts do not manifest uniformly across personality traits.

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Table 1
Summary of facets and domains driving differences between groups

Sample type	Extraversion	Agreeableness	Conscientioussness	Neurocicism	Openness
Expected given previ- ous research	W > M	W > M	Unclear	W > M	Unclear
Lippa (2005). Meta- analysis US college student samples previ- ously collected by the author	No differences be- tween Ho and He	Shift for Ho-M	Shift for Ho-M	Shift for Ho-M and Ho-W	Higher in homo- sexual men and women
Lippa (2008). Inter- national sample	Shift for homosex- ual women.	Shift for Ho-M and Ho-W	NA	Shift for Ho-M and Ho-W	NA
Zheng et al. (2008). Chinese sample	No differences be- tween homosexu- als and heterosex- uals	No differences be- tween homosexu- als and heterosex- uals	No differences be- tween homosexu- als and heterosex- uals	Shift for Ho-M and Ho-W	No differences be- tween homosexu- als and heterosex- uals

Sample type	Extraversion	Agreeableness	Conscientioussness	Neurocism	Openness
Greaves et al. (2017). New Zeland sample	No differences between homosexuals and heterosexuals	Inversion for Ho-M	Inversion for Ho-W	Inversion for Ho-M	No differences between homosexuals and heterosexuals
Allen and Robson (2020). Australian sample	Shift for Ho-M and Ho-W	Shift for Ho-M and Ho-W	Shift only for men. No differences between homosexual and heterosexual women	No differences between homosexuals and heterosexuals	Higher in homosexual men and women
Allen and Robson (2020). Meta-analysis of international non-population representative samples	Shift for Ho-W	No differences between homosexuals and heterosexuals	No differences between homosexuals and heterosexuals	Shift for Ho-M	Higher in homosexual men and women

Sample type	Extraversion	Agreeableness	Conscientioussness	Neurocism	Openness
Allen and Robson (2020). Meta-analysis of international population representative samples	Shift for Ho-W	Shift for Ho-W	Higher for homosexual men than heterosexual men and lower for homosexual women than heterosexual women. This pattern suggests a shift	Shift for Ho-M	Higher in homosexual men and women

Notes. He= Heterosexual, Ho= Homosexual, M= Men, W= Women.

Table 2

Demographic variables of the sample

Sex	Sexual Orientation	N	Age		Education Category		Income Range	
			Mean	SD	Mean	SD	Mean	SD
Men	Heterosexuals	213	36.71	11.86	4.52	1.07	4.06	1.41
	Homosexuals	225	36.89	12.38	4.69	1.04	3.78	1.54
Women	Heterosexuals	382	37.25	10.82	4.63	1.00	3.50	1.47
	Homosexuals	197	33.08	11.80	4.71	1.01	3.38	1.40

Note: Education Category includes: 1= Primary School, 2= Secondary School, 3= Vocational Education / Apprenticeship, 4= Undergraduate Education, 5= Postgraduate education (e.g.: Master, Ph.D., etc.); Income Range includes 1= Less than 10 000 pounds a year, 2= Between 10 000 and 18 000 pounds a year, 3= Between 18 001 and 26 000 pounds a year, 4= Between 26 001 and 44 000 pounds a year, 5= More than 44 001 pounds a year

Table 3

Multivariate normality tests at facet level for each sex and sexual orientation group

Test	p-value
Heterosexual Men	
Henze-Zirkler	<.05
Royston	<.05
Doornik-Hansen	<.05
E-statistic	<.05
Mardia Skewness	<.05
Mardia Kurtosis	<.05
Heterosexual Women	
Henze-Zirkler	<.05
Royston	<.05
Doornik-Hansen	<.05
E-statistic	<.05
Mardia Skewness	<.05
Mardia Kurtosis	<.05
Homosexual Men	
Henze-Zirkler	<.05
Royston	<.05
Doornik-Hansen	<.05
E-statistic	<.05
Mardia Skewness	<.05
Mardia Kurtosis	<.05
Homosexual Women	
Henze-Zirkler	<.05

Royston	<.05
Doornik-Hansen	<.05
E-statistic	<.05
Mardia Skewness	<.05
Mardia Kurtosis	<.05

Table 4

Box's M, a test for homogeneity of variance at facet level for each group comparison

	Parameter	Df	p-value
Heterosexual men vs. Heterosexual women	579.68	465	<.01
Heterosexual men vs. Homosexual men	564.82	465	<.01
Heterosexual men vs. Homosexual women	605.01	465	<.01
Heterosexual women vs. Homosexual women	541.27	465	0.01
Heterosexual women vs. Homosexual men	601.85	465	<.01
Homosexual women vs. Homosexual men	590.20	465	<.01

Table 5

Facets with the highest distance, d_u , across group comparisons

Domain	Facet	Distance size
Heterosexual men vs. Heterosexual women (M= .28 , SD= .22)		
Agreeableness	Altruism	-0.70
Openness	Feelings	-0.70
Neuroticism	Self-Consciousness	-0.63
Neuroticism	Anxiety	-0.58
Neuroticism	Vulnerability	-0.54
Heterosexual men vs. Homosexual men (M= .18 , SD= .12)		
Neuroticism	Anxiety	-0.45
Agreeableness	Altruism	-0.37
Openness	Feelings	-0.35
Extraversion	Excitement-Seeking	0.34
Agreeableness	Cooperation	0.30
Heterosexual men vs. Homosexual women (M= .28 , SD= .17)		
Openness	Feelings	-0.68
Neuroticism	Anxiety	-0.61
Neuroticism	Vulnerability	-0.60
Neuroticism	Self-Consciousness	-0.57
Openness	Values	-0.45
Heterosexual women vs. Homosexual women (M= .16 , SD= .13)		
Openness	Values	-0.48
Agreeableness	Altruism	0.44
Conscientiousness	Dutifulness	0.38
Extraversion	Gregariousness	0.31

Agreeableness	Straightforwardness	0.30
Heterosexual women vs. Homosexual men (M= .18 , SD= .13)		
Conscientiousness	Dutifulness	0.47
Agreeableness	Straightforwardness	0.46
Extraversion	Positive emotions	0.38
Neuroticism	Self-Consciousness	0.35
Agreeableness	Altruism	0.34
Homosexual women vs. Homosexual men (M= .12 , SD= .10)		
Openness	Feelings	0.34
Neuroticism	Self-Consciousness	0.31
Openness	Values	0.28
Neuroticism	Vulnerability	0.26
Openness	Action	-0.22
<i>Note:</i> Labels indicate the reference group. Positive values means that the first group was higher, conversely, negative values reflect that it was lower. M= Mean distance across all facets; SD= Standard deviation across all facets		

Table 6

Multivariate normality tests at domain level for each sex and sexual orientation group

Test	p-value
Heterosexual Men	
Henze-Zirkler	0.3
Royston	0.45
Doornik-Hansen	0.9
E-statistic	0.22
Mardia Skewness	<.05
Mardia Kurtosis	0.96
Heterosexual Women	
Henze-Zirkler	<.05
Royston	<.05
Doornik-Hansen	<.05
E-statistic	<.05
Mardia Skewness	<.05
Mardia Kurtosis	0.26
Homosexual Men	
Henze-Zirkler	<.05
Royston	0.22
Doornik-Hansen	<.05
E-statistic	<.05
Mardia Skewness	<.05
Mardia Kurtosis	0.1
Homosexual Women	
Henze-Zirkler	0.11

Royston	<.05
Doornik-Hansen	0.77
E-statistic	<.05
Mardia Skewness	<.05
Mardia Kurtosis	0.9

Table 7

d_u sizes for each domain across group comparisons

Domain	Distance size
Heterosexual man vs. Heterosexual woman (M= .23 , SD= .23)	
Neuroticism	-0.49
Agreeableness	-0.46
Extraversion	0.08
Openness	-0.06
Conscientiousness	-0.03
Heterosexual man vs. Homosexual man (M= .20 , SD= .08)	
Neuroticism	-0.34
Extraversion	0.21
Openness	-0.20
Agreeableness	-0.14
Conscientiousness	0.12
Heterosexual man vs. Homosexual woman (M= .30 , SD= .19)	
Neuroticism	-0.60
Openness	-0.35
Extraversion	0.27
Conscientiousness	0.15
Agreeableness	-0.13
Heterosexual woman vs. Homosexual woman (M= .23 , SD= .07)	
Agreeableness	0.30
Openness	-0.29
Extraversion	0.21
Conscientiousness	0.19

Neuroticism	-0.13
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Heterosexual woman vs. Homosexual man (M=|.18|, SD=|.08|)

Agreeableness	0.32
Conscientiousness	0.16
Extraversion	0.14
Openness	-0.14
Neuroticism	0.13

Homosexual woman vs. Homosexual man (M=|.10|, SD=|.10|)

Neuroticism	0.25
Openness	0.15
Extraversion	-0.06
Conscientiousness	-0.04
Agreeableness	0.00

Table 8

Summary of facets and domains driving differences between groups

Group Comparison	Facet	Domain
Heterosexual Men vs. Heterosexual Women	Neuroticism and Agreeableness	Neuroticism and Agreeableness
Heterosexual Men vs. Homosexual Men	Neuroticism	Neuroticism
Heterosexual Men vs. Homosexual Women	Neuroticism and Openness	Neuroticism
Heterosexual Women vs. Homosexual Women	Agreeableness and Openness	Agreeableness and Openness
Heterosexual Women vs. Homosexual Men	Agreeableness and Conscientious- ness	Agreeableness
Homosexual Women vs. Homosexual Men	Openness	Neuroticism

Figure 1. Percentage of facets according to their domains yielding small, moderate, high, and very high distances across group comparisons. 'Very small' distance represents du values = (-.1, .1); 'Small' distance represents du values = [.1, .2] 'Medium' distance represents du values = [.2, .3]; 'Large' distance represents du values = [.3, .4]; 'Very large' distance represents du values equal or higher than [.4]

Figure 2. Average scores at each personality facet per sex and sexual orientation group.

Notes: According to the Shift Hypothesis, personality scores of homosexual people should shift away from their heterosexual counterparts. The Inversion Hypothesis predicts that homosexuals should cross-over and score as the heterosexuals of their opposite sex. In this figure, the Shift Hypothesis is supported when the circles representing homosexual participants lay in between the triangles, which represent heterosexual participants. Conversely, the Inversion Hypothesis is supported when a circle and a triangle overlap, provided they are from different sexes. See full details on supplementary materials.