**Discussion**

Surprisingly, our meta-analysis failed to find significant sex differences in either trait means or trait variability for personality-like behaviours. When personalities were divided into their respective trait type (the Big Five) we found several significant sex differences in means for some personality types within some taxonomic groups (birds: Sociality; reptilia: Exploration; invertebrates: Aggression, Boldness). However, only exploratory behaviour for birds and aggressive behaviour for fish had significant sex differences in variability, both skewing towards females. Finally, personality and SSD interacted significantly to show strong sex-bias for mean personality, yet only within mammals (male-bias for all personality types except activity, which had a female-bias) and fish (female-biased aggression), and did not moderate sex differences in variability for any personality type or taxonomic group.

Despite suggestions that greater male variability should exist for most shared traits (e.g. Reinhold & Engqvist 2013), the scarcity of male-biased sex differences found by our meta-analysis hints that greater male variability might be true only for traits important for reproduction. First, we found almost no male-bias in either trait means or variability for behavioural types where we expected strong male-bias (e.g. aggression). This result was surprising given that male aggression should correlate with male-male competition and reproduction (reference). In contrast, human antisocial personality types (equivalent to aggression in animals) show greater male than female variability (references). Aggressive personality traits in humans are thought to be maintained by negative frequency-dependant selection whereby it’s beneficial for male reproductive success to have fewer extremely aggressive males in the population (references). Second, our chosen sexual selection moderators (SSD and mating system) did not significantly change either mean trait expression or variability; while SSD did interact with personality trait type for mean trait expression in mammals, SSD had no significant effect on variability for any taxonomic group. As such, it’s unlikely that sexual selection plays a major role in the maintenance of personality-like behaviours in animals.

* So what about human personality? A lot of personality axes with strong male bias are thought to be maintained by negative frequency dependant selection and to be important for reproduction. Other personality traits often have no difference in means or variability between males and females
* Archer and Mehdikhani (2003) talk about and compare means and variances between males and females for personality-like traits related to sexual selection and unrelated to sexual selection. They found that traits related to sexual selection (directly like physical aggression, or indirectly through a change in reproductive strategy) consistently had significant greater male variability, while traits unrelated to sexual selection had no difference in variability, but often greater female means. *Good paper to relate my main finding that, depending on the context under which a personality trait is measured, there’s likely to be no sex differences in variability! Especially where a trait is related to survival…*

For non-sexual shared traits, the sex chromosome hypothesis suggests that trait variability should reflect sex chromosomal arrangement. While we did observe a tendency for mean variability estimates to skew towards the heterogametic sex (especially mammals and birds), most estimates were nonsignificant. Again, this result was surprising considering the number of studies that report underlying sex chromosomal arrangement as the mechanism for greater male trait variability. Greater male than female variability has been reported for traits like personality types in humans (Budaev 1999, Archer & Mehdikhani 2003, Karwowski *et al*. 2016), cognition and intelligence (Halpern & LaMay 2000, Jones *et al.* 2003, Arden & Plomin 2006, Johnson *et al.* 2008, 2009), and for morphological traits like body size (Reinhold & Engqvist 2013), and brain structure (Arnold 2004, Van der Linden *et al*. 2017, DeCasien *et al*. 2020). Importantly, these traits are also considered important for reproduction; in men, extraversion and creative personality types attract more mating opportunities (Buss 1995, Nettle 2006), while body size is a condition-dependent trait important for male-male competition for females (refs). Therefore, we should expect traits related to reproduction to have greater male variability, and not because of sex chromosomal arrangement. Since we did not observe significant sex differences in variability following patterns of sex chromosomal arrangement, animal personalities could encompass behaviours that don’t differentially affect reproductive outcomes for the heterogametic sex. *Garbage*

* Can also mention greater female variability in some traits, like vision (both mice and humans) which might indicate some traits are more beneficial for females to express variation (finding food, seeing predators?) (see Shaqiri *et al*. 2018, and also Suzie’s paper)
* We might see greater male variability in morphological traits, like body size, brain structure and in traits directly related to morphology, like intelligence or cognition (see that chimp paper), but we don’t see such sex differences in behavioural traits ??? This could be explained by behaviours having a complex genetic underpinning (controlled by multiple genes that aren’t sex-linked?) or that personality-like behaviours are important for survival in both sexes so there is no sexual conflict ??? Something like this I guess
* Aggression and invertebrates is probably due to sexual selection, yet we only see differences in mean trait expression and not variability. Females can be aggressive too – reference that female intrasexual aggression paper about the importance of female aggression in parental care, high investment in offspring requires defence… However, inverts might have had a greater mean aggression than females because most female invertebrates, especially the species in our meta-analysis, don’t really provide parental care – although we lacked the parental care data to test this idea.
* Wyman and Rowe (2014) conducted a meta-analysis comparing heritabilities and additive genetic variances of phenotypic traits for males and females. When using a t-test, they found that mean male coefficients of variance were not significantly different from mean female coefficients of variance for non-reproduction-related phenotypic traits, as well as traits important for reproduction. – *this is most similar to my results and more comparable to lnCVR*
  + But there was a significant skew towards male-bias for coefficients of phenotypic variance for reproductive traits, non-reproductive traits, and the entire dataset.
  + Reproduction traits showed more male-biased phenotypic variance than not-reproduction related traits

Personality traits are frequently measured under the context of survival; personality encompasses antipredator responses (‘risky’ behaviour, or Boldness), foraging (Activity/Exploration), and other behaviours related to survival that are important for both sexes. Indeed, we found no sex differences in Activity and only one instance of male-biased Boldness behaviour for invertebrates. Where we did find sex differences in personality, the traits and their direction tended to reflect life-history differences between the sexes. For example, male reptiles were more explorative than females which might indicate male-biased dispersal (e.g. cane toads *Rhinella marina*; reference), while female birds were more sociable than males which likely reflects social group behaviour (e.g. zebra finches *Taeniopygia guttata*; reference). Additionally, because there are costs (e.g. energetic investment) and benefits (e.g. faster growth, more feeding opportunities) associated with the expression of personality types (reference), both sexes likely experience trade-offs that lead to similar trait means and variabilities. Previous meta-analyses have found evidence of trade-offs between personality and survival (Smith & Blumstein 2008, Moiron *et al*. 2020), and we found some evidence that the degree of SSD might impact trade-offs between personality and survival for the sexes differently. For example, strong interactions between SSD and personality trait types for mammals, and between boldness and SSD for invertebrates, show that larger males trade-off risk-adverse behaviour for larger body size. In mammals, as males became larger than females, males became bolder, more explorative and more aggressive than females. Male mammals are quite often the larger sex, due to sexual selection, so as males become larger they likely face more intense male-male competition (reference). Similarly, larger animals are less likely to suffer mortality from predation, but also require more food to fuel their bigger bodies, so males trade-off risky behaviour for increased foraging opportunities.

* Supports pace-of-life I guess

*Where can this bit fit?*

* For our significant measures of phylogeny on heterogeneity (I2) for lnCVR in birds and mammals, we can say that this suggests heritability of personality in these groups – heritability measures the degree of phenotypic variation due to genetic (not environmental) variation. This would suggest that variability in personality traits, for birds and mammals, are not driven by environmental conditions but are instead heritable. As such, any sex differences in variability in personalities would be due to heritable variation
* Greater variability in wild populations? Tarka *et al*. 2018, Smith & Blumstein 2008, Moiron *et al*. 2020