

Does female personality drive mate preference and reproduction in wild house mice?

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Abstract

Personality, consistent individual behavioural variation, shapes how individuals move and engage with their socioecological environment, potentially influencing how they assess and choose mates. This makes personality a potential target of sexual selection. Indeed, personality is linked to partner choice, pair formation and mating outcomes in both human and non-human animals. However, it remains unclear whether personality shapes mating outcomes through active mate choice, or indirectly, by shaping which individuals encounter one another. Distinguishing between these pathways requires tracking mate choice across its successive stages, from preference and selectivity to realised reproduction. Here, we studied wild house mice in controlled mate preference assays and observed their matings in large semi-natural populations, allowing us to disentangle the stages of mate choice and test whether patterns from controlled conditions hold under naturalistic ones. Personality predicted female selectivity only in the controlled assay and produced assortative mating only in semi-natural conditions. Personality thus shapes different stages of mating depending on socioecological context, with assortative mating arising from personality-dependent space use rather than active preference. More broadly, personality may shape not mate preference itself but the processes generating it, so assessing its role in sexual selection requires tracking the full pathway from preference to reproduction.

Keywords: assortative mating, behavioural traits, behavioural variation, fitness, mate choice, mate preference, selectivity, personality, sexual selection

Introduction

In both human and non-human animals, choosing mates (i.e., mate choice) is a decision that directly affects an organism's fitness, for example through the number and quality of offspring produced, or the quality of parental care those offspring receive (Andersson & Simmons, 2006; Munson et al., 2020). Mate choice is therefore a central component of sexual selection, that is, of the variation in reproduction that arises from differences among individuals in their ability to compete for and choose mates/fertilisations (Andersson & Iwasa, 1996). By shaping not only who reproduces but also with whom, sexual selection through mate choice can act as a powerful force driving the evolution of phenotypic variation within populations (Kuijper et al., 2012).

Understanding why and how individuals choose their mates is fundamental to understanding broader patterns of reproduction and evolutionary change. Yet individuals differ markedly in their mating decisions, including the traits they prefer in potential partners, how selective they are and

whether they maintain or switch mates across reproductive attempts. Even in iconic monogamous species such as the mute swan (*Cygnus olor*), “divorce”, i.e. splitting up with the current partner and consecutively pairing with another, is not uncommon (Jeschke & Kokko, 2008) and genetic analyses reveal that the preferred social partner is not necessarily the reproductive partner (Hughes, 1998). Deciphering the mechanisms that underlie variation in these decisions is currently a frontier in both human and non-human animal research.

Among the candidate mechanisms underlying such variation in mate choice, personality is a strong one as it can affect the benefits an individual is expected to gain from a given mate, for example through nuptial gifts, competitive ability or parental investment (Schuett et al., 2010). Personality refers to consistent among-individual differences in behavioural responses to stimuli and situations, quantified as the proportion of total phenotypic variation attributable to such differences. Throughout this paper, we adopt the terms “personality (trait)/personality types” for non-human animals as well (but see Réale et al., 2026), to denote such consistent individual variation in behavioural traits that is conceptually comparable to the relatively enduring and distinctive variation in thoughts, feeling and behaviour that characterise individual humans across their lives (Adolphs & Xu, 2024; Baumert et al., 2017; Corr & Matthews, 2020). In humans, this variation is captured by multidimensional trait models such as the Big five (McCrae & Costa, 1987) and HEXACO (Ashton et al., 2014; Baumert et al., 2017; Liu et al., 2018); in non-human animals, this variation is expressed in traits such as exploration, boldness, stress-coping and sociability (Carere & Maestripieri, 2013; Dingemanse & Réale, 2005; Gosling, 2001; Koolhaas et al., 1999, 2007; Réale et al., 2007; Sih et al., 2015). Boldness and stress-coping, for instance, are considered broadly analogous to human neuroticism and are quantified using standardised tests, particularly in rodents (Gould et al., 2009; Koolhaas et al., 1999): individuals confronted with potentially dangerous situations show an active *versus* passive coping response, together with an “emotionality” (sometimes referred to as boldness) component, with bolder individuals showing reduced stress reactivity (Koolhaas et al., 1999). Crucially, such variation in stress-coping and boldness (i.e., in personality) shapes variation in mate choice and mating outcomes directly: bolder, less stress-reactive individuals may be more willing to explore and sample potential mates, increasing encounter rates and the pool of partners over which choice can be exercised, and *vice versa*.

Indeed, research in humans and animals has revealed the role of personality in mate choice and mating decisions. In humans, studies have indicated assortative mating in respect to personality, possibly because this facilitates the transmission of heritable behavioural traits (Robinson et al., 2017), because it satisfies a need for self-affirmation by validating one’s beliefs and values (Byrne & Clore, 1967; Liu & Ilmarinen, 2020) or because partners’ personalities converge over time. This assortativity

pattern remains true even in the relatively new context of dating apps, where participants show clear assortative preferences for traits related to agreeableness, openness and extraversion (De La Mare & Lee, 2023). As such, assortative mating in humans is well-documented (Buss, 1985; Luo, 2017) and is associated with greater relationship stability and shared emotional experiences (Gonzaga et al., 2007), among others. Comparable patterns have been documented across non-human animals, where personality influences mating decisions, from mate choice and pair formation to realised reproduction. In birds, individuals often pair with partners of a similar personality type, for instance, with respect to exploration in zebra finches, *Taeniopygia guttata*, (Faust & Goldstein, 2021), where such assortative pairing is associated with increased fitness, reflected in fledglings' condition (Both et al., 2005). Similarly, assortativity can also arise through personality convergence between partners over time, as shown in monogamous, biparental California mice (Rieger et al., 2021) or in monogamous fish, where this same pattern has been shown to enhance reproductive success (Laubu et al., 2016). Even in species with no biparental care, such as water striders or treefrogs, personality differences among individuals has been shown to influence mating (Feagles & Höbel, 2024; Montiglio et al., 2016). Together, these findings suggest that personality (of both the choosing and the chosen individual) influences mating decisions and ultimately fitness in animals (Moiron et al., 2020; Smith & Blumstein, 2008) and in humans (Baumert et al., 2017; Iwasa et al., 2008; Lahey, 2009).

Nevertheless, understanding how personality contributes to fitness via sexual selection in the context of choosing mates requires disentangling mate preference, i.e., the propensity to mate with certain phenotypes, from realised reproduction, i.e., the outcome of mate choice (Jennions & Petrie, 1997). Specifically, mating outcomes are shaped not only by individual preferences but also by mate availability, competition, mutual mate choice and opportunities for social interaction. Moreover, mating decisions and how individuals choose are often geared to the current environmental conditions that optimise fitness. Consequently, the personality of an individual's actual partner might not necessarily reflect that of their preferred partner (Stulp et al., 2013) and mate preference itself might be flexible across time and space. In other words, personality might influence mate preferences but not all preferences have the same likelihood of being realised, for example because different individuals vary in their interactions with their environment across space and time (Munson et al., 2020; Small & Adler, 2019). Taken together, these considerations may help explain the lack of a comparative framework for understanding how personality shapes partner preferences and ultimately shapes reproductive success (Holtmann et al., 2022; Holtmann & Dingemanse, 2022; Zietsch et al., 2011). Building such a framework requires considering the relationship between personality and mating at multiple, successive stages: from how individuals evaluate potential partners, to whom they prefer, pair with and finally to the reproductive consequences of those pairings.

Comparative work in non-human animals offers a powerful way to achieve this through experimental manipulation and direct observation of both mate preference, selectivity and mating success as a function of personality. Indeed, the effect of personality on selectivity (i.e., how strong a female's preference for a particular male is) has recently come into focus (Munson et al., 2020; Schuett et al., 2010). Here, we present the results of a study in wild house mice, *Mus musculus domesticus*, that combines long-term data from several replicated semi-natural populations that mimic the demography and social dynamics of free-living populations (König & Lindholm, 2012; Prabh et al., 2023) with data from a controlled mate preference experiment. Using this dual approach, we test how personality, measured as boldness and stress-coping using standardised tests, translates into female preference and selectivity across controlled and ecologically relevant contexts. Our study therefore bridges experimental and observational approaches to test whether personality-driven mate preferences expressed in simplified, controlled scenarios differ from those expressed under ecologically valid conditions, where social (e.g., mate availability) and ecological processes (access to food) shape the expression of preference, selectivity and, ultimately, reproductive success (Faust & Goldstein, 2021). Importantly, by simultaneously modelling the personality of both choosing and chosen individuals (Buss, 1985; Robinson et al., 2017; Vezirakis et al., 2026), we move beyond patterns that arise from one sex's preferences to those that require matching between partners.

Theory predicts a speed–accuracy trade-off in how individuals gather and use information when making decisions in general: bolder, more active stress-copers tend to sample their environment quickly but less thoroughly, whereas shyer, more passive individuals gather more information before acting, resulting in slower but more informed decisions (Chittka et al., 2009; Sih & Del Giudice, 2012; Trimmer et al., 2008). Because shyness and passive stress-coping often covary (Schuett et al., 2010; Sih et al., 2004; Sih & Del Giudice, 2012), females that are shyer and less active (i.e., spending less time in the centre and covering less distance in an open-field test) should be more selective. Consistent with this, slower female zebra finches, were more selective of their mates than faster females and fast, superficial space use decreased male choosiness in Eastern chipmunks, *Tamias striatus* (David & Cézilly, 2011; Vandal et al., 2024). Likewise, more exploratory females using larger home ranges may sample their environment less thoroughly, potentially encountering more mates but assessing each one less carefully, and thus showing lower overall selectivity (Munson et al., 2020; Schuett et al., 2010). Therefore, our first prediction is that more proactive (active stress-copers) and bolder females (or, in the human literature, individuals higher in neuroticism) would show weaker preferences and lower selectivity under both controlled and ecologically valid conditions, which should result in siring offspring with more males.

Personality-dependent space use can also generate assortative mating, since individuals of similar personality may predominantly encounter, and hence mate with, one another (Munson et al., 2020). Similarly, individuals may actively seek out specific social situations: for instance, more sociable individuals meeting similar types more frequently which can reinforce the very traits that led them there, creating a positive feedback loop (Caspi et al., 2005) and, ultimately, mating between similar types. Indeed, in zebra finches, females with low exploratory tendencies show no preference during mate choice for exploratory or non-exploratory males, yet moderately or highly exploratory female zebra finches prefer exploratory ones (Schuett, Godin, et al., 2011). Therefore, our second prediction is to find assortative preferences when animals are undisturbed by social or ecological constraints (i.e., in the mate preference test) and assortative realised reproduction in ecologically valid settings (i.e., in the semi-natural enclosures).

Methods

Animals

We studied male and female house mice, *Mus musculus domesticus*, ecological opportunists that live and reproduce in variable environments (Bronson, 1979; König & Lindholm, 2012) and that show consistent individual differences in exploration, stress-coping and boldness that ultimately shape fitness (Darmis & Guenther, 2026; Prabh et al., 2023). The mice originated from 16 pairs of wild populations sampled at the Cologne/Bonn region of Germany (CB N = 18 original breeding pairs) (50°45' N–51° N, 6°45' E–7° E). Our experimental design comprises two complementary parts: a semi-natural enclosure study (Part I, using generations F1–F6) and a controlled female-preference experiment (Part II, using generations F5 and F6).

Semi-natural enclosures (part I)

In 2019, laboratory-bred descendants of the founding wild mice (i.e., wild-caught founders bred in laboratory conditions) were introduced into two semi-natural enclosures (17.5m² each; Fig. 1a), each established with 20 unrelated males and females. These individuals, along with their subsequent offspring across generations, lived freely within the enclosures and maintained a naturally occurring level of inbreeding and (Prabh et al., 2023). In 2023 and 2024, we established four additional semi-natural enclosures (two per year), each founded using individuals derived from the F5 & F6 generations of the two original semi-natural enclosures. Importantly, conditions were identical across all six enclosures. Specifically, food and water were equally distributed across nine stations and replenished daily to be *ad libitum*, to mimic natural house mice populations where food is abundant (König & Lindholm, 2012). The food provided contained 3227 kcal/kg metabolizable energy (Altromin 1324,

SQ; 24% protein, 11% fat, 65% carbohydrates). Each enclosure further had natural daylight and temperature fluctuations, with underfloor heating keeping a minimum of 10°C since mice could not dig burrows to escape low temperatures. Enclosures were covered by a roof, inaccessible to predators and designed to resemble the natural conditions under which house mice would establish a colony, a barn or agricultural building (Fig 1a). Last, to prevent the negative effects of social crowding (i.e., increased mortality and reduced reproductive activity at carrying capacity), we removed the older generation whenever an enclosure reached ≥ 140 individuals large enough to be tagged. This threshold was reached infrequently (on $\sim 8\%$ of censuses), corresponding to a removal on approximately every eight to ten months per enclosure.

During monthly censuses, we captured all individuals within each enclosure (all RFID-tagged), measured their body mass and collected tissue samples (ear clip) for parentage assignment and reconstruction of reproductive events (i.e. litters, litter size and lifetime reproductive success) using microsatellite analysis. Pups exceeding 10g during censuses were fitted with RFID PIT-tags (Planet ID, 1.4×9 mm). This comprehensive sampling ensured that the entire population was known, allowing us to infer parentage with $>90\%$ certainty (see *Quantifying reproductive success* for details).

Quantifying personality

Adult, RFID-tagged mice were randomly trapped within each enclosure to assess stress-coping and boldness using the open field test, a widely used forced exploration assay that induces a stress response in small rodents (Gould et al., 2009; Walsh & Cummins, 1976). To conduct the test, approximately 20 live traps were distributed across each enclosure at or shortly after sunset. Trapping sessions lasted 4–5 hours, with traps inspected at 10–20-minute intervals. Captured individuals were immediately subjected to testing and subsequently released. To minimise handling time and stress, individuals captured in excess during peak trapping periods were released without testing. Each mouse was tested only once per night. To assess personality, a second trapping session was conducted one month later, targeting at least 20 previously tested individuals per enclosure.

Testing was conducted in a novel, brightly lit room. Individuals were transported in the live trap and released into the centre of a 60 × 60 cm white arena (Fig.1b) for five minutes (Gould et al., 2009). Behaviour was recorded using an overhead camera and later quantified using VideoMot2 (TSE Systems). We quantified stress-coping and boldness as the total distance moved and the time spent in the centre of the open field, respectively. Individuals exhibiting an active stress-coping strategy try to escape this situation actively, thereby covering a higher distance than animals showing a more passive stress-coping strategy. Individuals spending more time away from the walls (i.e., more in the centre of the open field) are usually less stressed by the situation and are considered bolder (Koolhaas et al.,

1999). Both behaviours capture comparable aspects to the neuroticism axis in human personality literature, i.e., how individuals react to stress (Costa & McCrae, 1987).

Quantifying reproductive success

We used 17 microsatellite markers and a standardised procedure to determine parentage and quantify the number of pups each mouse produced throughout its life (Linnenbrink et al., 2013). Specifically, DNA was extracted from ear clips during censuses, amplified using a Multiplex PCR kit (QIAGEN) and run on an ABI 3730 Sequencer (Applied Biosystems). We used GeneMarker (V2.6.4) to identify alleles, and Colony [©COLONY Zoological Society of London (ZSL)] to assign the parentages based on the maximum likelihood of each potential parental pair (Jones & Wang, 2010). We conditioned our parentage assignment on the following assumptions: sexual reproduction, polygamous mating system, possible inbreeding and all animals being present the month before sampling (i.e. when juveniles were born) as possible parents. Using the reproductive success of each mouse, we calculated if males and females that mated assortatively or dissasortatively in respect to personality had higher reproductive success (see **Statistical Analyses** & Table 1).

Controlled female preference experiment (part II)

For part II of our experiment (Fig.1c), we randomly selected male and female mice for which we had personality measurements from the semi-natural enclosures and tested them in a mate preference test (Linnenbrink & von Merten, 2017; Vezyrakis et al., 2026). Selected mice were first transferred to Macrolon Type III cages (L×W×H: 382×220×150 mm) containing woodchip bedding, a shelter, nesting material and a running wheel for enrichment after censuses. Adult males were housed individually to minimise aggressive interactions and females were housed in pairs. The mice were kept in the same light-dark and temperature conditions as in the enclosures, with food and water provided *ad libitum* as well. The animals were given several weeks to habituate to the new housing situation and to allow pregnant females to raise and wean their litters before the next phase of experiments.

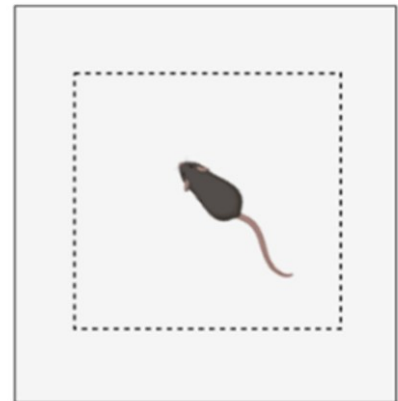
After this habituation period, we tested female mate preference by connecting three standard Macrolon Type III cages via Plexiglass tubes (Fig.1c). The central cage was connected to a satellite cage on each long side. Each connecting tube was fitted with two RFID antennas (©EuroID) to record the movements of the female. The satellite cages were divided by a metal grid, with roughly one-third of the cage towards the central cage (accessible for the female) and two-thirds on the outer side (where males lived). Females were placed in the central cage with access to both satellite cages, allowing sensory interaction via smell and vocalisation but no full physical contact or mating. The experiment lasted five days (Monday to Friday, approx. 96 hours). On the first day, we placed two males (from the

same enclosure) for which we had personality measurements in the outer parts of the two satellite cages to allow them to accept and mark them as their territory. On average, the males used in this part (part II) of the experiment had a standard deviation of 896 cm in the total distance covered during the open field test. Within each trial, the two males presented to a female differed in the distance covered in the open field by, on average, 900 cm (median = 772 cm; IQR = 453–1318 cm; range = 161–3244 cm). Thus, the personality contrast between males within a trial was approximately equivalent to one standard deviation of the natural variation in stress-coping, indicating that females were generally presented with different (in terms of personality) potential mates. On the morning of the second day, we placed a female (from a different enclosure than the males) for which we had personality in the central cage and monitored her movement (time spent by the female in each location, home cage and the two satellite cages) throughout the next three days (approx. 75 hours) using the RFID antennas until noon of the fifth day when all individuals were removed. Female house mice' preference has been found to stabilise after approximately 37 hours (Linnenbrink & von Merten, 2017), yet we allowed the experiment to run for twice that time to estimate preference with certainty.

a) A semi-natural enclosure



b) The open field test



c) The mate preference test

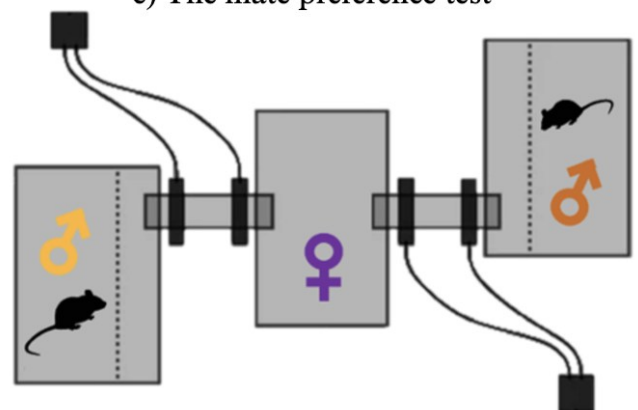


Figure 1. Our experimental setup. a) a semi-natural enclosure; b) the open field test, a well-established standardised personality test in rodents; c) the mate preference test setup: a female mouse is placed in the central

cage from where she can access two satellite cages, each containing one male. RFID antennas recorded its movement (see Methods for details on a-c).

Statistical analyses

We used R 4.4.1 (2024-06-14) in all analyses. We run models for at least 50,000 iterations for 2 chains using uniform priors in *brms* (Bürkner, 2017). Model convergence was assessed using $\hat{R}$ statistics and effective sample sizes and posterior predictive checks; random effects were visualised using caterpillar plots of posterior distributions. Where necessary, response variables were transformed (logarithmic or square-root transformation) to improve distributional assumptions, and all numeric predictors were standardised to aid model convergence and interpretation.

We first estimated the repeatability of the distance covered and of the time in the centre of the open field ($N = 294$ females; 148 with one trial, 143 with more than one trial) using Gaussian mixed-effects models, including trial number (1 & 2) as a fixed effect and individual and enclosure identity as random effects. Here, and throughout, data involving semi-natural enclosures were combined (pooled together) because enclosures were constructed to be comparable, with no systematic differences in design or environmental conditions beyond stochastic variation. To control for this latter source of variation, enclosure identity (1–6) was always included as a random intercept. Repeatability was calculated as the proportion of total variance attributable to between-individual variance. Between-individual variance indicates the extent to which individuals differ from each other in their average trait expression (Jenkins, 2011). Repeatability also gives the upper limit for the heritability of a trait because its variance components include both additive genetic but also environmental variance (Falconer & Mackay, 2009). Because repeatability was significant (see Results) and individuals were measured on average 1.52 times, we used the first trial per female per behaviour (distance covered in the open field or time in the centre of the open field) as a proxy for personality. A sensitivity analysis restricting the models to females with at least two measurements per behaviour yielded qualitatively and quantitatively similar repeatability estimates, indicating that including single-measurement individuals did not significantly bias our estimates.

Semi-natural enclosures (Part I)

To test whether female personality (stress-coping & boldness) predicts female selectivity, we modelled the number of mates and the number of multiple-sired litters per female as a function of personality using two Poisson generalised linear mixed-effects models (GLMMs). In both models, the two personality traits (the two behaviours quantified from the open field) were included as predictors, and the total number of litters per female was included as a covariate to control for variation in

reproductive opportunities. Generation and enclosure identity were fitted as random intercepts to account for non-independence among females sharing the same enclosure and for potential temporal variation in reproductive dynamics arising from overlapping generations.

To test whether female personality predicts the personality of her mating partners, we modelled the distance covered and the time spent in the centre of the open field of males that successfully mated with a female (mixed-effects model) as a function of the respective female personality trait (see Table 1), including trial number as a fixed effect and enclosure identity as a random intercept for the same reasons as above.

For personality traits showing evidence of assortative or disassortative mating, we assessed their fitness consequences to test whether this pattern (i.e., assortative or disassortative mating) was adaptive and thus could be under selection. We fitted GLMMs with a negative binomial error distribution, using the number of pups produced by each pair (inferred from parentage analyses) as the response variable. For each trait, models included the female's personality trait, her mate's corresponding personality trait and their interaction as fixed effects, with enclosure identity included as a random effect to account for shared environmental variation among pairs.

Controlled female preference experiment (Part II)

We randomly sampled males and females to conduct mate preference assays. Per female, we quantified a selectivity index $SI = SD / SD_{max}$ (Linnenbrink & von Merten, 2017), where SD is the standard deviation of the proportion of time spent with each male, and SD_{max} is the maximum possible SD (i.e., if a female spent 100% of her time with one male and 0% with the other). As a result, SI values ranged from 0 (no selectivity, equal time spent with both males) to 1 (absolute selectivity, all time spent with only one male). We calculated the SI for all females for each day and then took the average per female. We then tested whether female personality predicts female selectivity ($N_{females} = 30$) in a controlled mate preference test modelling selectivity as a function of both personality traits (distance travelled and time spent in the centre of the open field) using a linear model (selectivity $\sim$ distance + time in centre) with a Beta distribution, given that selectivity was measured as a bounded index ranging from 0 to 1.

We also examined whether female personality was associated with the personality traits of the male with whom she spent the greatest cumulative time over the three-day experiment, used here as an indicator of mate preference (Linnenbrink & von Merten, 2017; Vezyrakis et al., 2026). To do so, we fitted two linear mixed-effects models with the total time each female spent with each male across the three days as the response variable. Each model used the interaction between female and male personality trait (model 9: female distance*male distance; model 10: female centre time*male centre

time) as predictors. We chose to fit separate models because fitting 2 two-way interactions in one would lead to overparametrisation given our sample size ($N_{\text{observations}} = 30$). In each model we controlled for male body mass, measured prior to each mate preference test, to account for potential female preferences for heavier males, which are usually the most dominant. Male identity was included as a random intercept to account for the repeated use of males across trials.

Results

The distance covered in the open field, a measure of stress-coping, was repeatable at the population level ($R = 43\%$; 95 CI = 30% – 56%; Table 1) after accounting for trial number. Importantly, the estimate and the 95% credible intervals were similar when focusing on individuals with at least two measurements per behaviour ($R = 41,7\%$; 95 CI = 28% – 54%; Table 1). Similar results were obtained for the time spent in the centre of the open field, a measure of boldness (Table 1). We therefore retained the first observation (i.e., first trial) per female per behaviour as a measure of consistent among-individual differences, i.e., of personality (Vezyrakis et al., 2025). Below, we focus on stress-coping because boldness was not linked to either selectivity nor assortativity in the semi-natural enclosures or in the mate preference test (see Table 1).

Semi-natural enclosures

Female stress-coping did neither predict the number of mates nor the number of litters with multiple paternity (i.e., proxies of female selectivity) in the enclosures (mates: $b = 0.05$, 95 % CI = -0.14 – 0.21; multiple-sired litters: $b = -0.11$, 95 % CI = -0.57 – 0.22), yet we found strong evidence for assortative mating as a function of stress-coping: females that moved more in the open field tended to mate with males that also moved more in the open field ($b = 3.37$, 95 % CI = 0.89 – 5.85; Fig. 2a). This result remained quantitatively similar even when excluding one outlier ($b = 4.87$, 95 % CI = 2.57 – 7.13; Fig. 2b). Importantly, this assortative mating was not associated with a higher reproductive success ($\beta/\log\text{-mean} = -0.06$, 95% CI = -0.30 – 0.17).

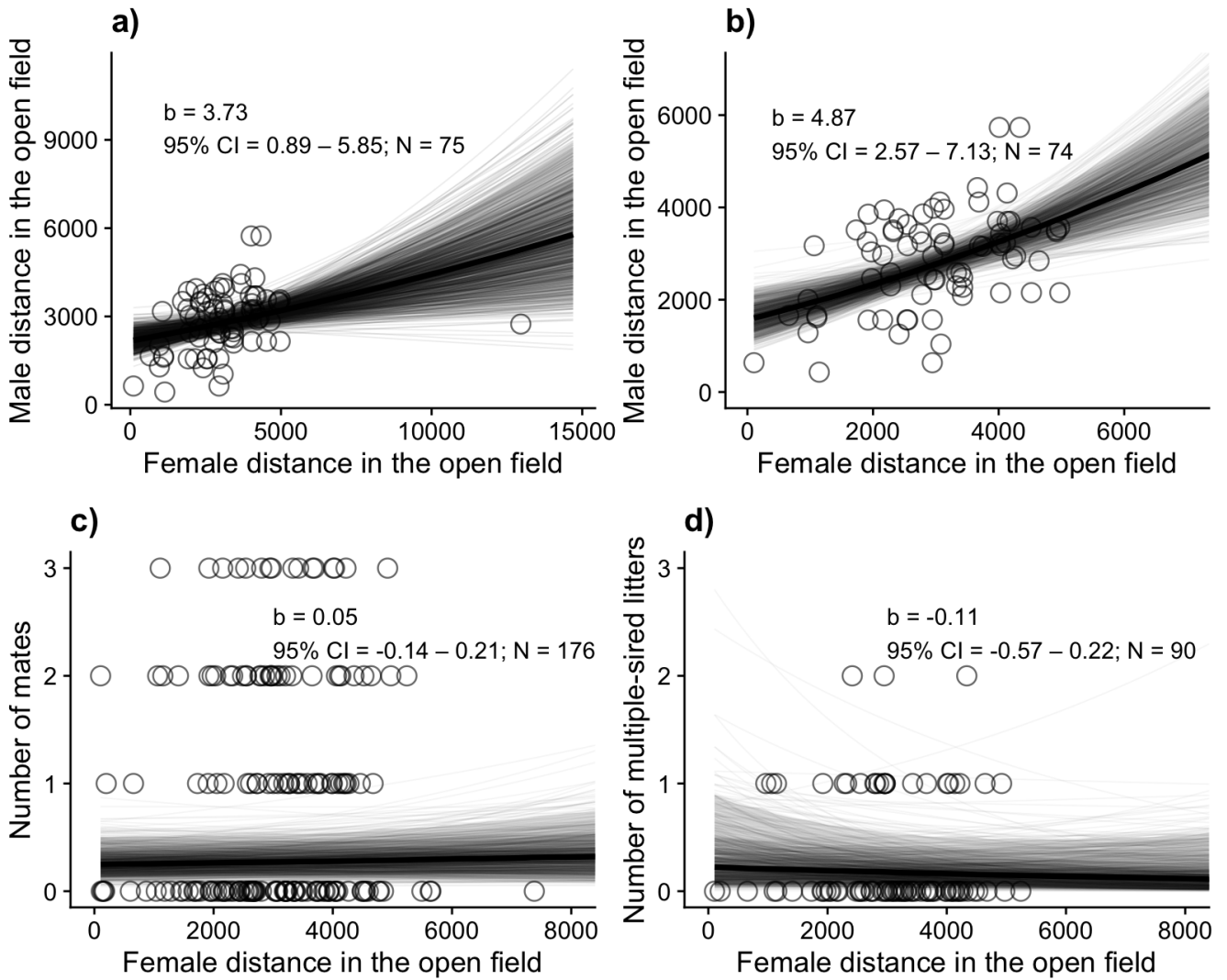


Figure 2. Results from the semi-natural enclosures. (a) Female stress-coping predicts the stress-coping of the male(s) with which they mated, that is assortativity in mating; panel (b) shows the same model as in (a) after excluding one outlier; (c) female personality predicts selectivity, quantified as the number of mates and (d) the number of multiple-sired litters across the female's lifespan. For (d), only females that had at least one litter ($N = 90/274$ for which we had personality data) were considered. Solid lines show the posterior mean predictions and thin coloured lines represent 1000 posterior draws.

Controlled mate preference experiment

In contrast to the results obtained from the semi-natural enclosures, female stress-coping predicted selectivity in the mate preference test: females that covered a greater distance in the open field were less selective ($b = -0.65$, 95% CI = -1.03 – -0.26; Fig. 3a). Similarly, again contrasting the semi-natural enclosures, male and female stress-coping did not interact to predict the time females

spent with males in the mate preference assay, i.e., there was no evidence for assortativity in preference (male stress-coping*female stress-coping: $b = 0.54$, 95% CI = -3.05 – 4.14; Fig. 3b).

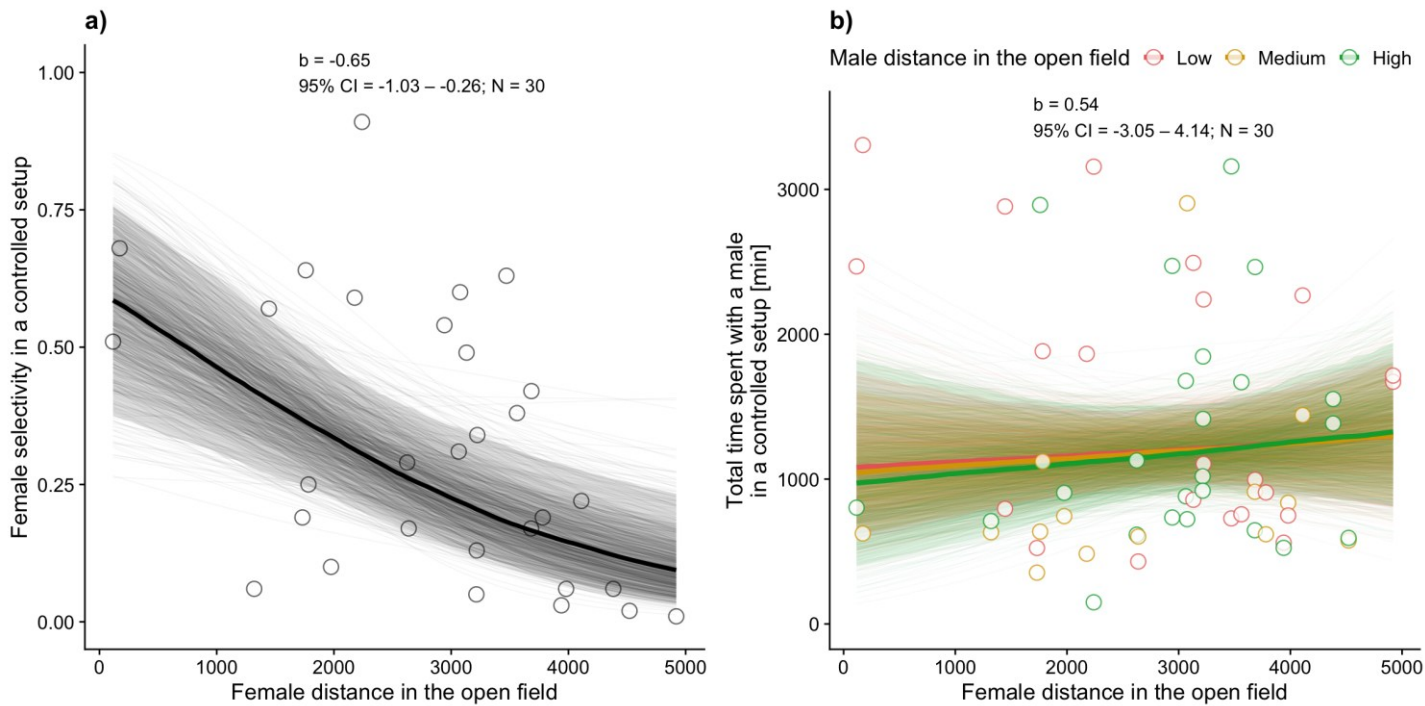


Figure 3. Results from the mate preference test. (a) Relationship between female personality (distance moved in the open field) and the selectivity index; (b) Effect of male (coloured on top; low, medium and high in comparison to the population average) and female personality (and their interaction) on the time females spent with males. Solid lines show the posterior mean predictions and thin coloured lines represent 1000 posterior draws.

Table 1. The Bayesian models and results of our analyses.

<i>Models</i>	<i>Structure</i>	<i>Est.</i>	<i>95% CI</i>	<i>Evidence</i>
Model 1: Repeatability of the distance covered in the open field of females	Trial + (1 population id) + (1 female id)	0.43	0.3 – 0.56	Significant repeatability
Model 2: Repeatability of the time in the centre of the open field of females	Trial + (1 population id) + (1 female id)	0.24	0.05 – 0.42	Significant repeatability
Model 3: Does female personality predict the no. of mates across female lifespan ¹ ?	Distance covered ² + Centre time ² + No. of litters + (1 population id) +	0.05	-0.14 – 0.21	No

	(1 generation)			
Model 4: Does female personality predict the no. of multiple-sired litters across female lifespan ¹ ?	Distance covered + Centre time + No. of litters + (1 population id) + (1 generation)	-0.11	-0.57 – 0.22	No
Model 5: Does female distance covered in the open field predict the distance covered in the open field of females' mates ¹ ?	Distance covered + (1 population id)	3.37	0.89 – 5.85	Yes, assortative mating
Model 6: Does female time in the centre of the open field predict the time in the centre of the open field females' mates ¹ ?	Centre time + (1 population id)	-0.04	-0.64 – 0.55	No
Model 7: Does assortative mating in respect to distance covered in the open field predict the number of offspring of the pair ¹ ?	Female distance covered*Male distance covered + (1 population id)	-0.06	-0.30 – 0.17	No
Model 8: Does female personality predict selectivity in controlled settings?	Distance covered + Centre time	-0.65	-1.03 – -0.26	Yes, greater distance in the open field is linked to reduced selectivity
Model 9: Is the time a female spends with a male in controlled settings predicted by the interaction between the male and female total distance covered in the open field?	Female distance covered*Male distance covered + Male weight + (1 male id)	0.54	-3.05 – 4.14	No
Model 10: Is the time a female spends with a male in controlled settings predicted by the interaction between the male and female total time spent in the centre of the open field?	Female time in the centre*Male time in the centre + Male weight + (1 male id)	-1.19	-5.01 – 2.68	No

¹In ecologically relevant conditions, i.e., inside the semi-natural enclosures; ²during the open field test.

Discussion

We investigated whether consistent among-individual differences in stress-coping and boldness in female wild mice (i.e., personality), quantified using a standardised open field assay, influence mating decisions under both experimentally controlled and ecologically relevant conditions. We found that stress-coping, but not boldness, was associated with both selectivity and assortative mating, though not in the same context. In the semi-natural enclosures, females mated assortatively according to their stress-coping level, yet neither stress-coping nor boldness predicted selectivity. In the controlled mate preference test, by contrast, more active stress-copers were less selective among the males available to them, even though there was no evidence for assortativity in preference as a function of stress-coping (or boldness). Overall, personality seems to be linked to different stages of the mating process as a function of the environment: it shapes realised mating patterns under semi-natural conditions but only female selectivity in a controlled preference experiment.

Our findings highlight the importance of considering both mate preference and successful matings (i.e., reproduction; approximated through genotyped offspring here) when investigating the role of personality on reproduction (Holtmann & Dingemanse, 2022; Munson et al., 2020; Schuett et al., 2010). Similar discrepancies between laboratory-assayed mate preferences and successful reproductive outcomes, as we report them here, have been shown in the wild, for example, in the strawberry poison frog *Oophaga pumilio* (Yang et al., 2019): while frogs mated assortatively in the wild, their preference in controlled laboratory settings did not follow the same pattern. We therefore emphasise the importance of considering all aspects leading to reproduction (mate preference, selectivity, actual mate choice and reproduction) within their ecological and social context when assessing the role of personality in sexual selection in wild populations.

Is there really a preference for reproducing with similar personalities?

The combination of our two approaches allowed us to disentangle, at least to an extent, the differences between mate preference and realised mating outcomes (i.e., reproduction). In the semi-natural enclosures, individuals could interact and mate within a socially complex and evolving population which closely replicates the social and spatial characteristics of free-living populations (König & Lindholm, 2012). In such conditions, boldness and stress-coping influence how individuals use and move through space. Indeed, explorative squirrels (*Tamiasciurus hudsonicus*) have larger home ranges, as predicted by trapping locations (Boon et al., 2008), and exploration predicts home range size in starlings *Sturnus vulgaris* (Minderman et al., 2010). In house mice, Krackow (2003) found that dispersal latency decreased with increasing distance moved in open field tests and other

studies have likewise detected an effect of the distance covered in the open field in space use in semi-natural enclosures (Krebs et al., 2019; Vezyrakis et al., 2025). In contrast, in bank voles (*Myodes glareolus*), boldness, rather than exploration, predicts home range size (Schirmer et al., 2019). Together, these studies suggest that, although the specific traits associated with movement might partially differ among species and ecological contexts, personality shapes how individuals move through space. Consequently, individuals with similar movement tendencies are likely to encounter one another more frequently and repeatedly, increasing the opportunity for non-random social interactions (Munson et al., 2020; Sih et al., 2015). These increased opportunities, in turn, elevate the chances that similar individuals mate and produce offspring more often (i.e., assortative mating in respect to personality), even without a strong preference for pairing with similar personalities. Therefore, assortative mating as we observed it in our enclosures can arise indirectly. A similar mechanism has been reported in tree swallows (*Tachycineta bicolor*), where personality similarity influences spatial overlap and ultimately mating outcomes. There, males and females choose nest box sites depending on their level of aggressiveness, whereby highly aggressive animals avoid settling into nest boxes exposed to high noise levels, resulting in assortative mating via habitat matching (Bird, 2021). Comparatively, in humans, there is a parallel observation for the formation of social ties (friendship or mating ties): spatial context, for example the probability that two individuals meet and decide to associate (Blau & Schwartz, 2017), plays a role in the formation of such ties (Small & Adler, 2019).

This indirect relationship between personality and reproduction would also explain why we did not observe a similar pattern in the controlled mate preference experiment. There, females were presented with two males they could assess and show preference for, removing some of the aforementioned “consequences” of personality differences that are present within an ecological context (e.g. the relationship with space use, territory holding potential and others). This allowed us to measure more closely the direct effects of personality on mate preference. As there was no universal preference for specific personality types, our findings further support the idea that the patterns observed in our enclosures, and by extension in wild populations, are more a byproduct of how personality shapes space use and social interactions rather than the outcome of targeted mate preference.

This distinction provides an alternative interpretation of assortative mating based on personality, with important consequences for evolution. Across human and non-human animals, assortative mating by personality type has been framed as the outcome of active preference for similar partners (Both et al., 2005; Laubu et al., 2016; Robinson et al., 2017). Often, this notion has been complemented by evidence that the personalities of partners converge over time (Gonzaga et al., 2007; Laubu et al., 2016; Rieger et al., 2021; Stamps & Biro, 2023). Our results, however, suggest that

assortative mating may instead emerge, at least in part, as a by-product of how individuals with different personalities interact with their environment. Consequently, similarity in personality among partners need not arise from active mate choice but from personality-dependent patterns of movement that increase the likelihood of encounter and thus reproduction. If assortative mating arises through such indirect processes, rather than active mate preference, it need not necessarily confer a direct fitness advantage. Consistent with this interpretation, we found no evidence that the reproductive success of pairs in semi-natural enclosures (measured as the number of offspring surviving to weaning) depended on how similar or dissimilar the personalities of the two partners were. Thus, although personality influences the probability of reproduction, our results provide no evidence that assortative mating by personality is adaptive, at least for the component of fitness we studied; nor that it contributes to sexual selection via increased reproductive success of similarly matched pairs (Class & Dingemanse, 2022). Nevertheless, there is the possibility that the fitness benefits of assortative mating by personality arise, for example, through enhanced coordination between partners or increased biparental care. Indeed, assortative mating in species with biparental care (unlike mice, in which only females provide direct parental care) improves cooperation and coordination, resulting in higher offspring survival rates (Burtka & Grindstaff, 2015; Leniowski & Węgrzyn, 2018; Rangassamy et al., 2015; Schuett, Dall, et al., 2011). Alternatively, if different personality combinations represent alternative but equally successful reproductive strategies, both assortative and disassortative pairings could be maintained by fluctuating selection without clear fitness differences on average.

Can personality influence how selective individuals are with their potential mates?

In contrast to the pattern we describe above, we found that selectivity was influenced by personality in the controlled mate preference test but not in the semi-natural enclosures. Specifically, more active stress-coping females (i.e. individuals who covered more distance in the open field) spent their time more evenly across the two presented males, while the more passive stress-copers showed a clearer preference, i.e., were more selective. Previous work has also shown the effect of other traits, such as boldness, on selectivity (David & Cézilly, 2011; Feagles & Höbel, 2024). Our findings here are consistent with the broader theory of a speed–accuracy trade-off in animal decision-making (Chittka et al., 2009), whereby rapid decisions are often made at the expense of acquiring or processing reliable information. This framework can be extended to animal personality: exploratory, bold and active individuals are proposed to favour faster but less accurate information gathering, whereas less exploratory, shy and passive individuals do invest more time in information acquisition, leading to slower but potentially more accurate decisions (Sih & Del Giudice, 2012). Applied to mate preference,

active stress-copers may prioritise rapid mating decisions and show weaker discrimination among potential mates, whereas passive stress-copers may invest more effort in assessing available males, resulting in stronger preferences and greater selectivity. Although empirical evidence remains very limited, some other studies are consistent with our findings. For example, female sand gobies experiencing high mating costs (in terms of time and competition) made faster spawning decisions but, in doing so, often chose males with poorer parental traits associated with offspring survival (Diaz Pauli & Lindström, 2021). Similarly, female fiddler crabs facing increased time constraints traded-off careful mate assessment against the costs of delayed mating by lowering their mate acceptance thresholds, resulting in faster but potentially less optimal mating decisions (Backwell & Passmore, 1996).

We found no equivalent effect of stress-coping on realised mating outcomes (which we used as a proxy of selectivity) in the semi-natural enclosures. Specifically, stress-coping did not predict the number of mates a female had or the number of multiple-sired litters she produced over her lifetime. Similarly, in humans, personality does not predict the number of matches individuals receive in the novel context of online dating (De La Mare & Lee, 2023). Our results most likely mean that realised mating outcomes are shaped not only by female mate preferences and selectivity, but also by partner availability, mutual mate choice, spatial overlap, competition and other ecological and social processes (Andersson & Simmons, 2006; Munson et al., 2020; Stulp et al., 2013). Any effect of personality type on female selectivity may therefore be masked once mating decisions are embedded within a socially complex environment that includes many partner choices over a female's lifetime. Alternatively, unlike in the controlled test, the measures we used might not quantify female selectivity accurately. Instead, they might represent the realised outcome of repeated mating interactions over a female's lifetime and therefore integrate the decisions of both sexes, together with the complexity of the social environment that we discussed above.

There are two further, non-mutually exclusive explanations that may account for why we found an effect of personality on selectivity in the controlled preference test but not in the enclosures. First, in the former, chosen individuals (i.e., males) could not express the full range of behaviours that females may normally use when assessing potential mates, such as territory acquisition, territory defence or competitive interactions with other males. If females normally rely on such cues when assessing potential mates, their absence in our experimental setup may favour females that are thorough explorers (i.e., passive stress-copers) and take more time to carefully assess their environment, consequently investing more in mate assessment (i.e., show higher selectivity) based on the available information. The second possibility relates to the costs associated with mate assessment. Previous studies have shown that choosiness can depend on the costs of sampling potential mates

(Backwell & Passmore, 1996), including time constraints and ecological or social limitations (Diaz Pauli & Lindström, 2021). In the mate preference test, these costs were largely reduced: females had access to potential partners under controlled conditions for several days, without the energetic, temporal or other constraints typically associated with mate search in wild or semi-natural settings. This reduction in sampling costs may have therefore facilitated more extensive assessment and allowed females to maintain stronger preferences and selectivity.

Conclusions

Our findings suggest that personality shapes different stages of mate choice and that this influence is context-dependent: social complexity determines when and where personality differences translate into realised mating. Under controlled, "simple" conditions, personality differences affected female selectivity when they were presented with a direct choice (here, between two males), whereas under near-natural conditions, personality predicts assortative mating patterns but not female selectivity. Importantly, the former likely reflects active preference, as females were able to directly exert a choice among a fixed set of options, whereas under near-natural conditions any such preference may be masked by variation in mate availability and encounter opportunities: the population-level assortative mating pattern usually observed across species there does not necessarily indicate an absence of preference, but rather that preference can be masked by personality-dependent differences in space use and, consequently, in which mates are actually encountered. Thus, personality may shape mating patterns through two co-occurring pathways: directly, via active mate preference, and indirectly, through its effects on space use and encounter rates—with social complexity determining which pathway is detectable.

This distinction between preference and actual realised outcomes extends beyond mice and is central to understanding sexual selection more broadly. Indeed, mate preferences do not necessarily translate into realised mating in humans (Conroy-Beam & Buss, 2016), where opportunities for choice are constrained by mate availability, social sorting and convergence over time (Gonzaga et al., 2007; Luo, 2017; Robinson et al., 2017). As such, in mice as in other species, reproduction depends not only on what individuals prefer, but on personality-dependent opportunities that shape whom they encounter and ultimately mate with. Encounter and opportunity as a function of consistent individual behavioural differences therefore represent a general, cross-taxonomic component of mate choice that has often been overlooked in favour of preference alone.

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