

Innateness is for animals: Intuitive biology, intuitive psychology, and the folk concept of innateness

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Abstract

People like to distinguish between capacities that are 'innate', 'in the genes' or 'biological' and those that are 'acquired', 'learned' or 'psychological'. These are, or at least build on, folk distinctions. We hypothesize that they represent characteristic processes of, respectively: intuitive biology, the evolved cognitive system for gathering knowledge about animals; and intuitive psychology, the evolved cognitive system for managing relationships with other people. This hypothesis predicts a privileged connection between appraising an agent as animal or animal-like, and judging its capacities to be innate. We present five pre-registered studies with 1008 UK adult volunteers, testing different aspects of this prediction. Participants judged the same capacity more innate if the actor was described as an animal (study 1), and judged an actor less human if its capacities were described as innate (study 2). The degree to which a capacity was considered innate in humans was very strongly predicted by the degree to which it was thought present in other animals (study 3). We also investigated differences in innateness judgement by autism spectrum diagnosis (studies 4 and 5) and sex. We discuss the implications of the findings. If the folk concept of innateness represents our default mode of making inferences about animals, then certain scientific claims, for example concerning flexibility and individuality in animals, or innate bases of cognition in humans, will jar with many people's intuitions.

Introduction

The notion that capacities can be divided into those that are ‘innate’ and those that are not is widely deployed both within scientific argumentation, and in more general talk. Likewise, people see some capacities as more ‘biological’ or ‘in the genes’, and others as more ‘psychological’ or ‘in the environment’ (e.g. Ahn et al., 2009). Though these distinctions may seem straightforward, detailed examination shows that they are not. The innateness concept, for example, is used in scientific writing to pick out a number of quite different properties that may or may not go together (Mameli & Bateson, 2006, 2011). ‘In the genes’ could mean heritable, or could mean under tight genetic control during development, neither of which implies the other (Harden, 2022). Philosophers of science who have examined the innateness concept vary from those who believe the concept to be irretrievably incoherent and never epistemically useful, to those who argue that, with care, a useful scientific concept of innateness can be salvaged (Birch, 2009; Griffiths & Linquist, 2022). However, all parties agree that the concept of innateness started life as a folk or intuitive concept; and that the folk concept, like a specter, continues to haunt attempts to employ the concept of innateness productively in scientific research (Griffiths & Linquist, 2022; Linquist et al., 2011).

What then is the folk concept of innateness, and whence does it come? Linquist et al. (2011), using experimental philosophy methods, showed that for Australian students, two constitutive features of the innateness concept are: fixity (the capacity will come out the way it does regardless of environmental and developmental circumstances); and typicality (the capacity can be assumed to be present in all individuals of the same kind, where kind is usually interpreted as (folk) species). Linquist et al. (2011) initially suggested a third element, that of having a function or final cause (if capacity is innate it must be good for the species in some way), but their data did not support for this as a feature driving innateness judgments. Henceforth, we will refer to the combination of assumed fixedness and typicality as *innateness schema*. Linquist et al. (2011) refer to the folk innateness concept as a key component of intuitive biology. Intuitive biology is the intuitive cognition that people deploy for thinking about the natural world, particularly other animals. Fixedness (tigers will come out carnivorous however they are raised), and typicality (species membership is the most important variable, because individuals of the same species have the same basic properties) have indeed been shown to typify people’s thinking about non-human animals across many cultures (Atran, 1998; Medin & Atran, 2004; Nettle, 2010; Sousa et al., 2002). This is, plausibly, good functional design. The function of intuitive biological cognition is to attach to animals in the environment their most relevant affordances, for example goodness to eat or dangerousness (Atran, 1998; Barrett & Broesch, 2012). Assuming a fixed essence that by default generalizes to all individuals of the same species may represent a computationally efficient way of delivering this function.

Although Linquist et al. (2011) characterize the folk concept of innateness as part of intuitive biology, they do not directly test the most obvious implication of this claim. Namely, the application of a judgement of innateness to an entity should have a privileged connection to *the entity being an animal*. This raises the question: an animal as opposed to what? The obvious contrast case is a human. Humans are animals too, of course, but there is abundant evidence that they are not thought of as animals just like any other. More specifically, other humans, from very early in childhood, automatically entrain a set of mechanisms of intuitive psychology. These mechanisms assume all actions to be underlain by a rich set of thinking process: beliefs, desires, goals, and thoughts (Ho et al., 2022; Jara-Ettinger et al., 2017, 2020). Whereas innateness schema sees all members of a species as the same, intuitive psychology’s schema is that every individual has an idiosyncratic and dynamic set of beliefs and goals that dictates and explains what they do. Whereas innateness schema assumes that the individual’s propensities would come out the same way regardless of context,

intuitive psychology represents contextual contingencies, such as what the subject knows or has experienced, as critical (Jara-Ettinger et al., 2015, 2017). These properties too make sense in terms of the function of intuitive psychology: humans have personal, changing, collaborative relationships with other individual people. They need to manage each of those ongoing relationships, anticipating and intervening on the other's needs and decisions, not just classify people into broad categories. Thus, where innateness schema is the assumption that behaviours are fixed and typical, *mind schema*, the characteristic output of intuitive psychology, is the assumption that observable behaviour is underlain by a mental world of individual- and context-specific thoughts, desires, knowledge, beliefs and so on. Mind schema is roughly synonymous with Dennett's notion of the intentional stance (Dennett, 1987).

In this article, we adopt the broadly accepted claim of developmental cognitive science, that humans bring to their psychological development several discrete cognitive systems that they use to build their intuitive understanding of different domains of their worlds (Spelke & Kinzler, 2007; Wellman & Gelman, 1992). Each of these core systems is preferentially activated by stimuli in the world belonging to a certain class, and each has a characteristic set of representational and inferential consequences (each constitutes an 'intuitive theory'). Relevant to the present discussion, intuitive biology is preferentially activated by cues of animality, and characteristically produces innateness schema. Intuitive psychology is preferentially activated by cues of humanness, and characteristically produces mind schema. This leads to a clear hypothesis when it comes to judgements of innateness: the stronger the cues of animality as opposed to humanity, the more strongly intuitive biology will be activated; hence, the more likely an explicit judgement of innateness will be produced, and assumptions of fixedness and typicality entrained.

Some aspects of this hypothesis have already been tested. For example, when thinking about animals rather than humans, UK students were more prone to assume species-typicality and fixedness, operationalized as inability to adapt to changing conditions (Nettle, 2010). For US adults thinking about human psychological capacities, innateness is a dis-preferred conclusion: they prefer accounts in terms of learning, underestimate the likely role of prepared knowledge, and fail to appreciate how early in development capacities appear (Berent et al., 2019; Wang & Feigenson, 2019). What those studies did not do, however, is run an animal condition, where the judgements of the same capacities were made about non-human animals instead. We hypothesize that when the entity is presented as being an animal, innateness judgements and innateness schema will be much more readily evoked.

It is not for all human capacities that people resist the judgement of innateness and prefer mind schema. Rather, it is specifically for cognitive or epistemic capacities (Berent et al., 2019). Across cultures, and from early in development, people think about other people in a dual-aspect way: people have bodies, which account for one subset of their capacities, and minds, which account another subset (Bloom, 2004; Cohen et al., 2011; Weisman et al., 2021). Though the two aspects are understood to be integrated (Barlev & Shtulman, 2021; Cohen et al., 2011), their processing is separate enough that people can come to believe, under some circumstances, in immortal souls, disembodied agents, telepathy, zombies and other mindless bodies or bodiless minds. One way of interpreting the dual-aspect nature of humans in intuitive cognition is that core cognitive systems operate in parallel. It is possible for both intuitive psychology and intuitive biology (and indeed intuitive physics; Saxe et al., 2006) to be activated by the same rich stimulus. Nonetheless, intuitive biology and intuitive psychology have different tunings for stimulus features: the better the stimulus fits intuitive biology's preferred tuning to animals and animal-like features, the more we would expect innateness judgements to follow. In accordance with this, including information about a

bodily basis for a human capacity reliably increases innateness-schema thinking about that capacity (Berent & Platt, 2021b, 2021a; Dar-Nimrod & Heine, 2011; Nettle et al., 2022). In short, we hypothesize that animals will elicit innateness thinking very generally, whereas humans will elicit more or less innateness thinking depending on which capacities of humans are being discussed and how those capacities are presented.

Berent and colleagues have recently presented two important studies relevant to the hypothesis outlined above. The first study showed that people with a diagnosis of autism spectrum disorder were more prone than control participants to judge human epistemic capacities as innate (Berent et al., 2022a). The second showed a difference between men and women, with men readier to make innateness judgements (Berent, 2023). The first of these studies only became known to us after completing studies 1-3, below; it has been taken into consideration in studies 4 and 5. The second became known to us after completing all five studies, but can be incorporated in terms of post-hoc analyses of sex differences. Berent and colleagues argue that men (Greenberg et al., 2023) and people with autism spectrum disorder (Baron-Cohen et al., 1985) are populations in which intuitive psychology is characteristically less available, and they see judgements of innateness as reflecting the low activation of intuitive psychology. Berent et al.'s experiments, however, all use human examples. There is no animal condition, in which the same capacities are presented but assigned to animals. We would predict not only higher judgements of innateness overall in such a condition, but that sex and autism spectrum differences would be abolished. Since intuitive biology is by presumption the dominant mechanism engaged by other animals, the relative availability of intuitive psychology should be a less important determinant of innateness judgements in the animal case. We note, by the way, that Berent's theoretical interpretation of the findings is somewhat different than the account we will present here (Berent et al., 2022a, p. 1 ; Berent, 2023, p. 1); we return to these differences in the General Discussion.

In what follows, we present five studies examining innateness judgements, innateness schema and their relationship to animality in British adults who are not professional scientists or science students. Studies 1 and 2 respectively examine the effect of being an animal on perceived innateness, and of being innate on perceived animality. Study 3 examines attributions of innateness to human capacities, examining how the extent to which the presence of the same capacity in animals relates to the likelihood of it being judged innate in humans. Studies 4 and 5 were added after learning of Berent et al. (2022a); they attempt to replicate that work and extend it to judgements about innateness in animals.

Study 1 introduction

In study 1, we provided participants with a vignette describing a capacity. We experimentally manipulated, between subjects, whether the possessor of the capacity was described as an animal or a human. The outcome variables were, firstly, judgements of innateness and its near synonyms 'in the genes' and 'biological'; and, secondly, the respective hallmarks of innateness schema and mind schema. We measured innateness schema, as in previous work, through judgements of fixity and typicality (Linguist et al., 2011). We measured mind schema with an item about subjective utility. That is, agents with minds are thought of as doing things because those things have a subjective value for them (Jara-Ettinger et al., 2020). We predicted that in the animal condition, the capacity would be judged more innate, in the genes and biological; more fixed and typical; and as having less subjective utility for the agent. We predicted that judgements of innateness would mediate effects of condition on inferred fixity and typicality, since we assume that inferred fixity and typicality are

downstream sequelae of judging something innate. We accept however that it is somewhat artificial to characterize the causality in this direction, rather than for example that seeing something as an animal activates perceptions of fixity and typicality, which in turn drive the explicit judgement of innateness. Our claim is that these components are tightly integrated, whichever way around one describes the sequence.

Study 1 methods

Preregistration. We performed two pilot studies prior to study 1, which are briefly described in Supporting Information, section S1. Study 1 was preregistered at: <https://osf.io/7wbzx>. Pre-registered predictions are listed in table 1. After the study, we learned of Berent's (2023) work on sex differences in innateness judgements. We had not planned or pre-registered analyses of sex differences. However, we present a brief analysis of sex differences after our main pre-planned analysis.

Participants. Participants were 200 UK-based adult volunteers recruited online from Prolific. Prolific provides online volunteers for research studies. Data quality is typically adequate and many in-person psychology findings replicate when data are collected this way (Peer et al., 2022). We have investigated the UK Prolific pool elsewhere: relative to the national population, there is an over-representation of younger people and people with university degrees (Radkani et al., 2022). However, most pool members are not students, and they are older than typical student pools. In study 1, participants were 99 men, 98 women, 3 not stated; mean age 41.1 years (s.d. 13.1), 18 with current student status, 150 without, 29 not specified. Participants were recompensed £0.50, which equates to a rate above the UK Living Wage for the very short study.

Design. A between-subjects two-condition (animal/human) between-subjects design with multiple dependent variables. Four different capacities were used (navigating/finding wild fruits/hiding on hearing sudden noises/avoiding direct sunlight). Each participant saw only one. Thus, capacity was another between-subjects factor, cross-factored with condition. However, differences in judgement across capacities are not the primary focus and thus no predictions or tests were made regarding them.

Procedure and materials. Participants were asked that they had moved to a new place and observed an individual person or animal there. They had noticed a certain capacity: that it is good at navigating around the place/is good at finding wild fruits/hides on hearing sudden noises/avoids direct sunlight. They were asked to guess, dichotomously, if this capacity is innate, in [his/its] genes, and biological or psychological. Fixity was measured by assent with: [He/it] behaves this way because of the specific experiences [he/it] has had' (reverse scored); and typicality with 'This behaviour will turn out to be typical of other [people in the village/animals of this kind'. As for subjective utility, it was measured with 'Does [he/it] [enjoy navigating around the place/like wild fruits/dislike sudden noises/dislike direct sunlight]?', again with Yes/No response options. The order of the two sets of DVs (set 1: innateness, genes, biological; set 2: fixity, typicality, subjective utility) was counterbalanced, and the order of the three questions within each set was random.

Data analysis. Condition effects were tested using generalized linear models (binomial family because of the dichotomous outcomes). Capacity was entered as a random effect. Covariance between outcomes was investigated with the ϕ correlation coefficients between pairs of variables, with χ^2 inferential tests. To test whether seeing the behaviour as innate predicted other judgments, we created an 'innateness score' (sum of judgements of innateness, in the gene, and biological, with 'Yes' = 1), to use as a predictor in models. Mediation analyses were performed using the 'mediation' R package (Tingley et al., 2014).

Data and code availability. Data and code for all studies reported in this paper are available at: <https://osf.io/6qyca/>.

Results

Main analysis. Figure 1 summarises participant judgements by condition, and table 1 shows the results of the tests of the pre-registered predictions. Participants were much more likely to make judgements of innateness, in the genes and biological in the animal condition than the human conditions (table 1, P1, fig. 2A-C). In all three cases, the ‘innate’ option was the majority response in the animal condition, and the ‘non-innate’ option the majority response in the human condition. Judgements of innateness, in the genes and biological covaried positively (table 1, P4). For the animal condition data considered separately, the covariations were all positive and significant (innateness-genes: $\phi = 0.46$, $\chi^2 = 19.82$, $p < 0.001$; innateness-bio.: $\phi = 0.42$, $\chi^2 = 16.39$, $p < 0.001$; genes-bio.: $\phi = 0.61$, $\chi^2 = 36.57$, $p < 0.001$). For the human condition data, the covariations were all positive, but only two out of three were significantly so (innateness-genes: $\phi = 0.42$, $\chi^2 = 14.85$, $p < 0.001$; innateness-bio.: $\phi = 0.11$, $\chi^2 = 0.63$, $p = 0.426$; genes-bio.: $\phi = 0.30$, $\chi^2 = 6.52$, $p = 0.011$).

Participants were also more likely to judge the behaviour as fixed and typical in the animal than the human conditions (table 1, P2, fig2D, E). The ‘innateness’ score (the number of positive responses to ‘innate’, ‘biological’ and ‘in the genes’), and this positively predicted judgements of fixity and typicality (table 1, P5). Judgement of innateness partially mediated the effect of condition on judgements of fixity, whilst the mediation of the effect of condition on judgements of typicality was not significant (table 1, P6).

The only prediction about the effect of condition that was not supported concerned subjective utility. Judgements that the agent obtained subjective utility from whatever they were doing were almost universal in both conditions, and hence there was no difference between the human and animal condition (table 1, P3; figure 1F).

Sex differences. We fitted an exploratory model predicting innateness score (as defined above) from sex, condition and their interaction. The main effect of condition was highly significant ($B_{\text{animal}} = 0.93$, s.e. 0.21, $t = 4.48$, $p < 0.001$). There main effect of sex was not significant ($B_{\text{male}} = -0.25$, s.e. 0.21, $t = -1.20$, $p = 0.232$), but there was a significant interaction between sex and condition ($B_{\text{interaction}} = 0.74$, s.e. 0.29, $t = 2.53$, $p = 0.012$). This was driven by men having significantly higher innateness scores in the animal condition (men: 5.29, s.d. 1.00; women: 4.80, s.d. 1.22; $t = 2.24$, $p = 0.028$), but not the human condition (men: 3.61, s.d. 0.85; women: 3.87, s.d. 0.97; $t = -1.4$, $p = 0.183$).

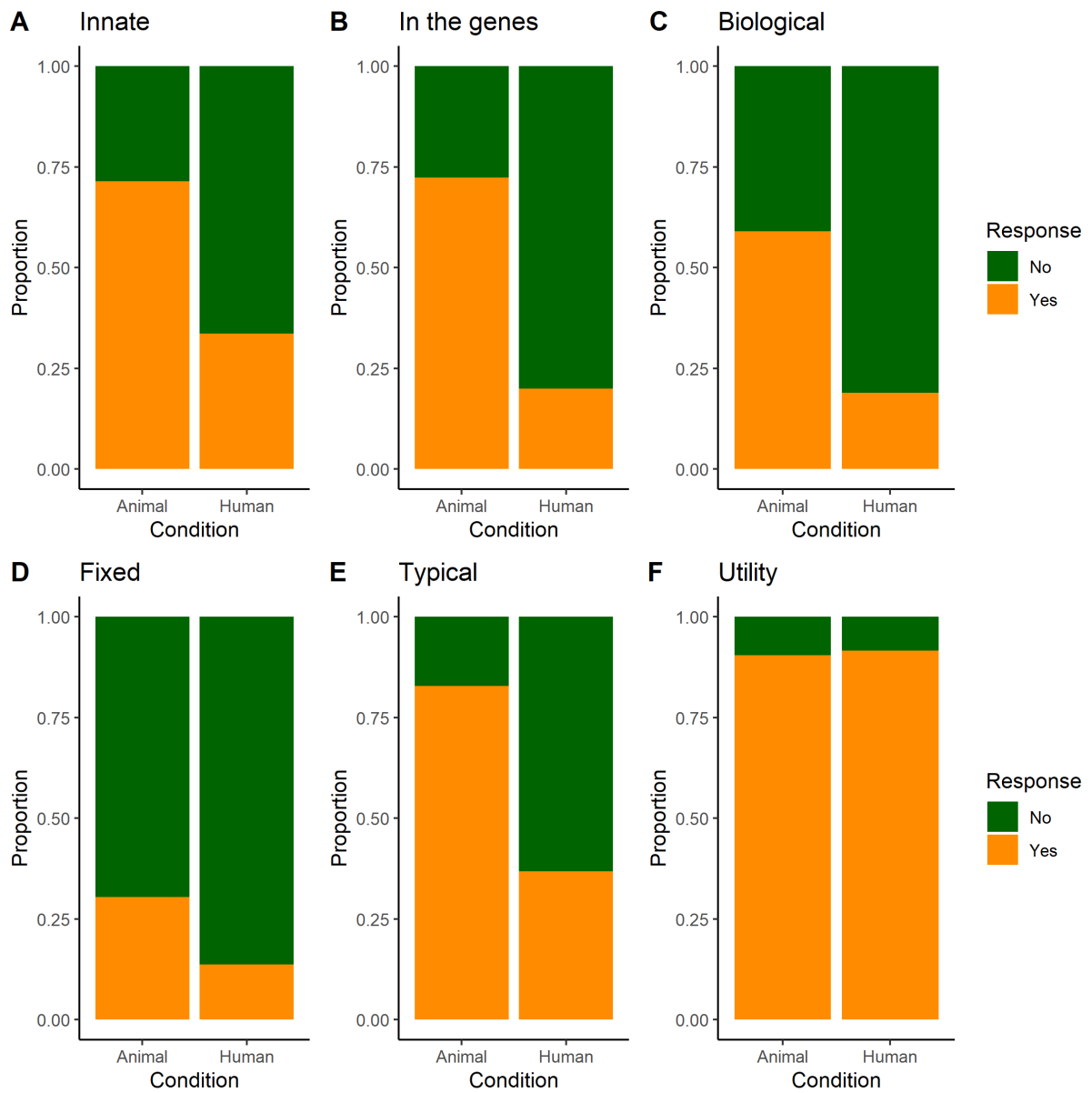


Figure 1. Study 1 results. Stacked bars show the proportion of 'yes' and 'no' responses to each dependent measure by condition. A. Innateness; B. In the genes; C. Biological; D. Fixed; E. Typical; F. Having subjective utility.

Table 1. Pre-registered predictions and corresponding results, study 1

No.	Prediction	Supported?	Results
P1	Participants will be more likely to judge the behaviour as innate, in the genes, and biological in the animal condition.	Yes (all three)	Innateness: OR 5.05 (95% CI 2.77 – 9.46), $p < 0.001$ Genes: OR 10.81 (95% CI 5.61 – 21.83), $p < 0.001$ Biological: OR 6.17 (95% CI 3.29 – 12.00), $p < 0.001$
P2	Participants will be more likely to judge the behaviour as fixed and as typical in the animal condition compared to the human condition	Yes (both)	Fixity: OR 2.77 (95% CI 1.38 – 5.83), $p = 0.004$ Typicality: OR 8.29 (95% CI 4.27 – 16.34), $p < 0.001$
P3	Participants will be more likely to judge the behaviour as having subjective utility in the human compared to the animal condition.	No	OR 0.87 (95% CI 0.32 – 2.31), $p = 0.963$
P4	Judgements of innateness, in the genes, and biological will covary positively.	Yes (all)	Innateness-genes: $\phi = 0.55$, $\chi^2 = 57.35$, $p < 0.001$ Innateness-bio.: $\phi = 0.39$, $\chi^2 = 29.28$, $p < 0.001$ Genes-bio.: $\phi = 0.59$, $\chi^2 = 67.86$, $p < 0.001$
P5	Judgements that the behaviour is innate will predict inferences that it is fixed and typical.	Yes (both)	Fixity: OR 1.71 (95% CI 1.27 – 2.32), $p = 0.002$ Typicality: OR 1.95 (95% CI 1.48 – 2.62), $p < 0.001$
P6	Judgements that the behaviour is innate will partially mediate condition effects on fixity and typicality.	Yes (fixity) No (typicality)	Fixity: Prop. Mediated = 51%, $p = 0.022$ Typicality: Prop. Mediated = 13%, $p = 0.16$

Note. All odds ratios for condition are expressed with human as the reference category (i.e. the odds ratio is the change in odds when condition changes from human to animal), regardless of the direction of wording of the prediction. Odds ratios for P5 are per one unit change in innateness score, where innateness score is the sum of ‘yes’ answers for innateness, genes and biological.

Discussion

In a simple description of a behavioural capacity, we manipulated whether the actor was a human or an animal. We predicted that the actor being an animal would trigger judgements of innateness, and that this would in turn produce innateness schema: the inferences that the behaviour was fixed and typical. We also predicted that people would apply a ‘naïve utility calculus’ (the assumption that whatever the actor is doing is because they are getting subjective utility from it) to the human case more than the animal case.

The predictions concerning innateness, fixity and typicality were strongly supported. Where the actor was an animal, most participants assumed that its behaviour was innate, in its genes and biological, and this was in turn associated with increased judgements that the behaviour was fixed (i.e. the actor would have done that regardless of what environmental inputs it received), and typical (all members of that species would do that). By contrast, the actor being a human produced majority judgements that the behaviour was not innate, not in the genes, and not biological; and that, in turn, it was less likely to be fixed (an individual having different experiences would behave differently), nor typical (other individuals would not necessarily behave that way). A couple of caveats to this pattern need to be noted. First, the absolute level of fixity judgements was low in both conditions. Thus, at least when presented with our particular wording, most of our participants endorsed the view that environmental inputs affect behaviour, even for animals. Second, that the typicality question was slightly different for the human than the animal case. Whereas for animals, the typicality referred to

the whole species, in the human case, the question implied typicality for an unfamiliar social group to which the person belonged. This is a weaker form of typicality, not species-wide, but group-level. Despite this, judgements of typicality were still sharply lower for the human than the animal case.

The only prediction that was not at all supported concerned subjective utility. Regardless of condition, participants almost universally endorsed the view that if an actor (human or animal) routinely did something, that must mean it liked the outcome, or disliked the outcome it was avoiding. It is possible our choice of wording simply made the alternative response seem nonsensical. Moreover, the 'naïve utility calculus' involves not just the inference that people do things which they like or want the consequences of, but their behaviour is *caused* by their liking or wanting those consequences (Jara-Ettinger et al., 2015, 2017). It also possible that the naïve utility calculus is not uniquely a feature of intuitive psychology, but extends to intuitive biology too.

In a non-preregistered analysis of sex differences, men made higher ratings of innateness than women did, but only in the animal condition. There was no trend for such a difference in the human condition. This is puzzling, since Berent's (2023) observation of sex differences were in a study where only human capacities were rated. However, it does suggest that sex may be an important variable in explaining variation in innateness judgements, a possibility we return to in studies 3-5.

The striking thing about study 1 is how minimal the differences in the stimuli are, and yet how strong, in most cases, the difference in the judgements. Admittedly we did not provide a 'cannot say' option and thus cannot know how many people would reserve judgement if not forced, but in general our participants very readily inferred innateness, along with all its near-synonyms and consequences, for a non-human animal. This aligns well with the hypothesis set out in the introduction of a privileged connection between intuitive biology, which is presumptively the system activity by animals, and the concept of innateness.

Study 2

Study 1 showed that making an actor an animal increased innateness judgements and innateness schema. Study 2 tests the same idea, but reversing the parts that are manipulated and measured. That is, by manipulating whether the capacity is described as innate or not, can we influence the judgements of whether the actor is human or non-human?

Methods

Preregistration. The study was preregistered at: <https://osf.io/jzgp5>. Pre-registered predictions are shown in table 2.

Participants. Participants were 298 UK-based adult Prolific workers (149 men, 149 women; mean age 41.8 (s.d. 13.5); 30 current student status, 232 without, 36 not specified). Given the large effect sizes from study 1, we pre-registered a sample size of 150. After 150 participants, the critical test of P3 was significant by Poisson regression but non-significant in a Gaussian model (see 'Data analysis' below). We therefore decided to increase the sample size to 300 to increase confidence in the main result. Participants were recompensed 50p.

Design. Study 2 was a three-condition (innate/not-innate/baseline) between-subjects design. Participants read a short vignette describing some things about an 'alien creature'. This included the information that it has a particular capacity, which is either described as innate, non-innate, or with no further information (baseline condition). The capacity was randomly chosen from the same four

used in the previous study. The participant was asked to imagine the creature and briefly describe it using a free text response. The primary outcome variable was the participant's response to 'how like a human is this creature?' (humanness). Secondary outcome variables were ratings of fixity and typicality.

Procedure and materials. Participants were told about an alien creature 'that lives on the coast, in somewhere very warm and forested. One of the capacities from study 1 was presented, followed by either: 'this behaviour is innate and in its genes'; this behaviour is not innate; it acquired the behaviour through experience'; or nothing. Participants rated fixity and typicality in similar ways to study 1. Participants were asked to spend a moment imagining the alien, and describe what it looked like in at least 20 words. Finally, they were asked: 'in your mind, how much does the alien resemble a human being?'

Data analysis. We used generalized linear mixed models. Capacity was treated as a random effect in all models. P1-P3 strictly concern only the difference between the innate and non-innate conditions. Thus, using 'non-innate' as the reference category, the critical test is the difference of the coefficient for 'innate' from zero. We made no prediction about the significance of the 'baseline' coefficient.

We analyzed the data after 150 participants. The 'humanness' variable was highly right-skewed with a preponderance of responses close to zero. Thus, we departed from our pre-registered Gaussian model and used a Poisson model to test P3. The critical test was highly significant. However, using our pre-registered Gaussian model, it was non-significant ($p = 0.13$). As our claim that P3 was supported depended on using a non-preregistered analysis, we therefore decided to double the sample size. Multiple rounds of peeking at data increases type-I error rates, which can be compensated by reducing the α -level required in the final analysis (Sagarin et al., 2014). In this case, the critical value is reduced to 0.034, which should be interpreted as the threshold of statistical significance in what follows. After running the extra participants, the main result for P3 was significant both with a Poisson model (as reported below) and a Gaussian model ($B_{\text{innate}} = -9.89$, s.e. 4.14, $t = -2.39$, $p = 0.017$). We also performed exploratory analyses on the free text responses (see Results).

Results

Fixity and typicality were relatively low for the non-innate condition, relatively high for the innate condition, and intermediate for the baseline condition (table 2, P1 and P2; figure 2A, B). The absolute level of ratings for the typicality variable were higher than for fixity, though. For the humanness variable, there was a wide range of responses in all conditions. However, in the innate condition, there was a greater preponderance of responses close to zero, driving a significant condition effect (table 2, P3; figure 2C). The baseline condition closely resembled the non-innate condition.

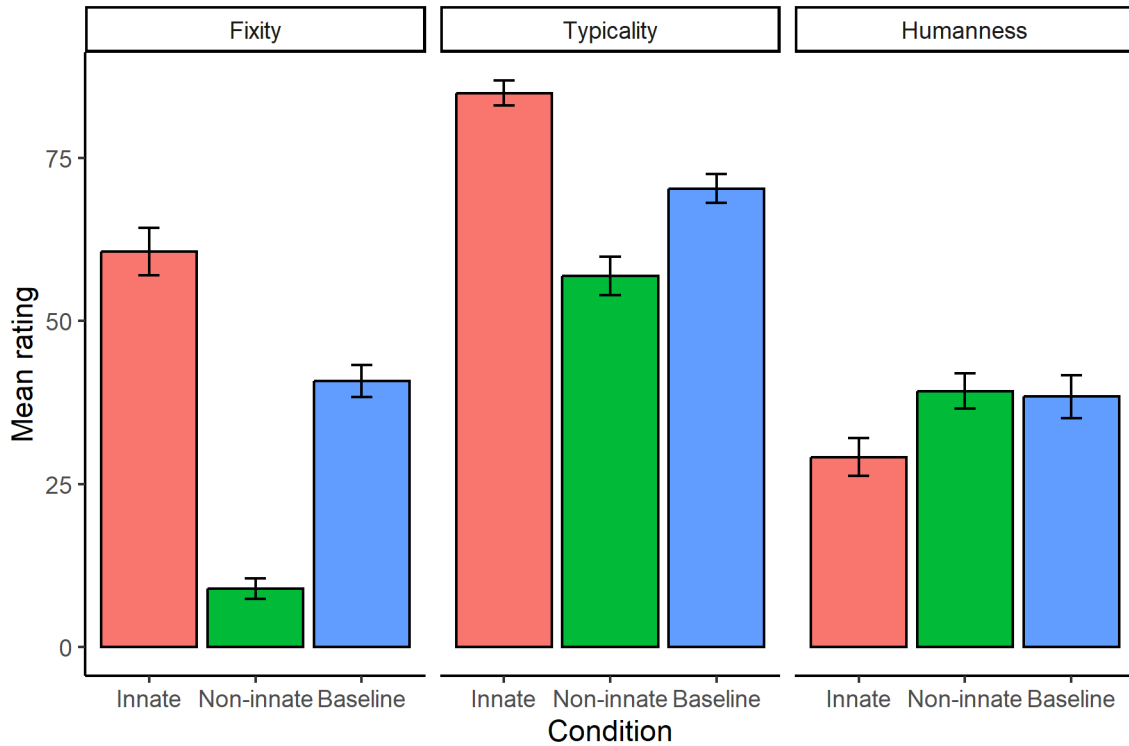


Figure 2. Mean judgements of fixity, typicality and humanness by condition, study 2. Error bars shown one standard error.

Table 2. Pre-registered predictions and corresponding results, study 2

No.	Prediction	Supported?	Results
P1	Participants will judge the behaviour as more fixed in the innate condition than the non-innate condition	Yes	$B_{\text{innate}} = 51.12$, s.e. 3.61, $t = 14.18$, $p < 0.001$
P2	Participants will judge the behaviour as more typical in the innate condition than the non-innate condition	Yes	$B_{\text{innate}} = 28.04$, s.e. 3.40, $t = 8.25$, $p < 0.001$
P3	Participants will rate the alien as more like a human being in the non-innate condition than the innate condition	Yes	Poisson model : $B_{\text{innate}} = -2.89$, s.e. 0.02, $z = -11.78$, $p < 0.001$

Note. Critical tests compare the innate to the non-innate condition; no predictions were made concerning the baseline condition.

We also carried out some exploratory analyses of the participants' free text descriptions of their aliens. There were not large differences in content by condition. For example, animals (the word itself or particular types of animal) were not much more mentioned in the innate than the non-innate condition (innate: 38/97 (39%); non-innate: 31/103 (30%); Fisher's exact test, $p = 0.18$). Neither were humans mentioned less (innate: 13/97 (13%); non-innate: 10/103 (10%); $p = 0.38$). Human-specific pronouns (he/his etc.) were used in more of the descriptions in the non-innate condition (innate: 2/97 (2%); non-innate: 7/103 (7%)), but this difference was not significant ($p = 0.17$). We were struck by properties of mind that were mentioned in descriptions in the non-innate

condition ('smart in thought'; 'able to communicate freely'; 'I see it as marvelling at its location'; 'it has a soul'). We have not quantified this further as numbers were small.

Discussion

Study 2 showed that, when given the information that a behavioural capacity was innate, participants understood it to be fixed (i.e. developed that way regardless of environmental circumstances), and increased their belief that it would be typical (i.e. other beings of the same kind would display the same behaviour). Fixity and typicality have been identified as so central to the folk concept of innateness in previous research (Linguist et al., 2011; Machery et al., 2019; and study 1) that these results were expected. Indeed, they represent a kind of manipulation check: if they were absent, we might have seriously doubted the participants had considered the materials.

The key finding of study 2 was that, when cued with the information that the capacity of a creature was innate, participants imagined a less human-like creature than when they were cued that the behaviour was not innate. The effect was not large, since the human-likeness ratings were very variable in all conditions, and the difference was not clearly evident in the free-text responses. It does however support the overall contention of a privileged connection between innateness and intuitive biology, that is cognition about animals and animal-like beings.

Study 3

If we consider variation across human capacities (for example, walking, sweating, remembering, talking), our hypothesis predicts that the more a capacity activates intuitive biology, the more it should be judged as innate. To test this, one needs an independent measure of how activated intuitive biology is. One such measure is the extent to which the capacity is thought characteristic of non-human animals. Since animals represent the proper domain of intuitive biology, then a capacity that feels plausibly typical of non-human animals must be one for which intuitive biology has a processing affinity. Thus, comparing across capacities, we ought to find that rating the capacity as typical of non-human animals should covary positively with rating it as innate.

Berent et al. (2019) have presented relevant findings. They showed participants a series of 80 capacities, ascribed to a human adult. One group of participants rated the capacities as 'thinking', 'emotion' or 'action'. A second group of participants rated the likelihood that each capacity was innate (indirectly, by speculating whether an individual growing up without the ability to learn from others would display it). The more a capacity was rated as involving thinking by the first group of participants, the less it was rated as innate by the second group. Berent et al. (2019) argue that this means that the engagement of intuitive psychology is incompatible with the judgment of innateness. An alternative interpretation is that the capacities rated as involving thinking were also those that one would not find in animals. This was not measured.

Study 3 replicated and extended Berent et al. (2019)'s study 1. We took a diverse subset of 30 capacities from their original 80. One group of participants rated how plausible they felt it to be that this capacity is innate in humans. A second group rated the extent to which the capacity involved thinking. A third group rated how typical the capacity is of a non-human animal. Taking the capacity as the unit of analysis, we predicted that its average innateness rating would covary positively with how typical it is of a non-human animal; would covary negatively with the extent to which it involves thinking; or both.

Methods

Preregistration. The study was preregistered at: <https://osf.io/8np24>. In addition to our planned analysis, we briefly present an analysis of sex differences in innateness judgments, in the light of Berent (2023), which came to our attention after the study.

Participants. Participants were 117 UK-based adult Prolific workers (59 male, 58 female; mean age 39.9 (s.d. 11.8); 10 current student status, 95 none, 12 not specified). Berent et al. (2019) used 20 participants per group. For greater precision, we aimed for 40 per group. After exclusion for incomplete responses, 38 participants rated innateness, 39 rated typicality for animals, and 40 rated involvement of thinking. Participants were recompensed £0.75.

Design. Study 3 was a correlational study. All participants saw the same list of 30 capacities, presented as ‘things that adult humans are often able to do’. Group 1 participants were asked how likely they found it that each capacity is innate. Group 2 participants were asked to what extent this capacity involves thinking. Group 3 participants were asked to what extent they thought this capacity present in non-human animals.

Materials and procedure. The list of capacities was chosen from the broader list used by Berent et al. (2019) such that all three questions could be plausibly asked of the same items (see Supporting information, section S2). There were a few minor wording changes for our purposes. Participants were asked to read statements ‘about things most adult humans can do’ and, on a 100-point slider, indicate either: how likely it is to be innate (group 1); the extent it is present in animals other than humans? (group 2); or the extent it involves thinking (group 3).

Data analysis. For each capacity, we calculated the mean innateness rating, by averaging the responses of the group 1 participants; the mean presence rating for non-human animals from the group 2 participants; and the mean rating for involving thinking from the group 3 participants. We tested our predictions using linear regression, with capacity as the unit of analysis. For our preregistered analysis, we ran separate models for presence in animals predicting innateness, and involvement of thinking predicting innateness, since we anticipated that presence in non-human animals and involving thinking might correlate negatively so highly to preclude them being separately in the same model. In a non-preregistered analysis, we included them both in the same model. We also used the Akaike Information Criterion (AIC) to choose the most parsimonious model for explaining variation in innateness judgements. For the analysis of sex differences in responses in group 1, we use linear mixed models with individual response rather than capacity as the unit of analysis.

Results

Main analysis. The judgement of innateness was strongly positively related to the judgement of presence in non-human animals (figure 3A; $\beta = 0.87$, $t = 9.48$, $p < 0.001$); and strongly negatively related to the judgement that the capacity involves thinking (figure 3B; $\beta = -0.76$, $t = -6.28$, $p < 0.001$). Presence in non-human animals and involvement of thinking were strongly negatively related to one another ($r = -0.83$, $p < 0.001$). A model predicting innateness from presence in animals alone had a lower AIC (47.9) than a model with involvement of thinking alone (64.7) or both predictors (49.9). Moreover, in a model containing both predictors, presence in animals remained a significant predictor ($\beta = 0.76$, $t = 4.62$, $p < 0.001$), whereas involvement of thinking was not a significant predictor after adjustment for presence in animals ($\beta = -0.13$, $t = -0.81$, $p = 0.426$).

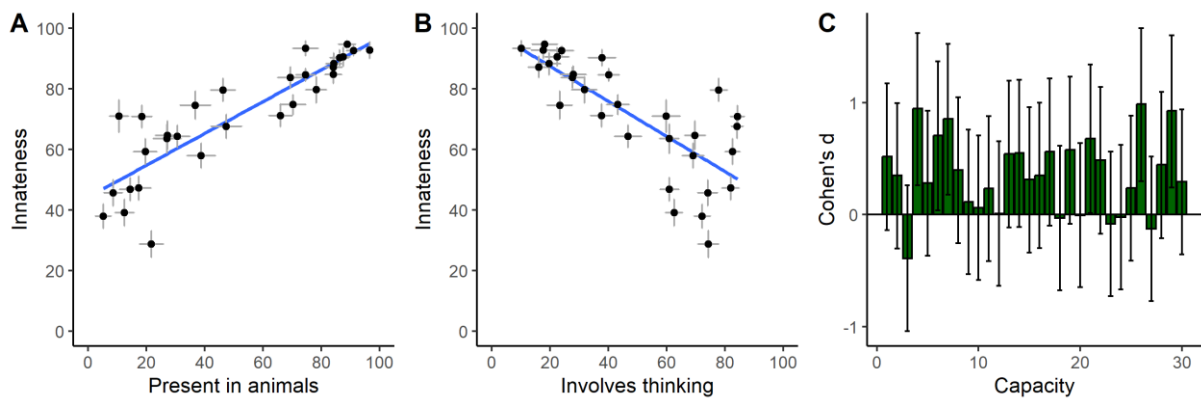


Figure 3. Results of study 3. A. The rated likelihood of a capacity being innate against (A) rating of the extent to which it is present in non-human animals; and (B) ratings of the degree to which thinking is involved. Points represent means across the relevant group of participants. Error bars represent ± 1 standard error. (C) Effect size (Cohen's d) for the sex difference in innateness ratings. A positive number indicates higher innateness ratings in men. Error bars represent the 95% confidence interval. The capacities are listed in an arbitrary order (for numbering, see Supporting Information, section 2).

Sex differences. Men rated the capacities more innate than women did overall (women: mean rating 66.6 (s.d. 29.6); men: 74.0 (s.d. 28.8)). In a linear mixed model, a significant interaction between sex and capacity rated ($F(29, 1044) = 1.58, p = 0.027$) suggested that men's greater ratings differentially applied to certain capacities. We calculated an effect size for the sex difference (Cohen's d) for each of the thirty capacities (figure 3C). Twenty-five of the thirty were numerically positive (i.e. men made higher innateness ratings); in six cases, the 95% confidence interval did not include zero. These were: smelling the scent of food; feeling fear at danger; running when in a hurry; speculating about the causes of events; forming myths; and having preferences concerning aesthetics. There is no obvious pattern to these in terms of presence in animals or involvement of thinking. We note that study 3 was not well powered for the detection of sex differences, with just 16 women and 22 men in the innateness group.

Discussion

As in Berent et al. (2019) study 1, human capacities rated as involving more thinking were rated as less likely to be innate. However, we go beyond their analysis by showing that whether or not the capacity is present in non-human animals is an even stronger driver of innateness judgements. Indeed, when the two predictors are pitted directly against one another, it is presence in animals that trumps. Involvement of thinking is only a predictor indirectly, via its negative relationship with presence in animals. Thus, these data support the basic claim of the present work, that judgements of innateness have a privileged connection to intuitive biology and hence to animals. This suggests a slightly different interpretation of Berent et al. (2019)'s findings. It is indeed the case that human capacities judged more innate are seen as involving less thinking; but this may be because capacities are judged of as more innate when they are animalistic; and we conceive of animals, compared to humans, as thoughtless. We return to the differences between these two interpretations in the General Discussion.

Although study 3 was underpowered as a test of sex differences in innateness judgements, it did produced some evidence in support of the hypothesis that men make the judgement of innateness more readily than women (Berent, 2023). Trends for higher male ratings were observed across most

capacities, and the effect sizes were substantial for several. However, there was no obvious pattern in terms of which ones showed a sex difference. Those with large differences included highly animal-like traits, and highly epistemic ones.

Study 4

Berent et al. (2022a) showed, amongst other findings, that a sample of Prolific workers who had received a diagnosis of an autism spectrum condition judged human psychological traits to be more innate than controls did. Their rationale for studying judgements of innateness in autism was that, according to various lines of evidence (Atherton & Cross, 2019; Baron-Cohen et al., 1985; Moran et al., 2011; Senju et al., 2009), intuitive psychology is typically less active or available in people with autism spectrum conditions compared to others. They reasoned that, if the judgement of innateness reflects the non-activation of intuitive psychology, then that judgement should be made more strongly by people with autism spectrum conditions.

Berent et al.'s (2022a) study 3 did not test whether the judgement of innateness is made differently for humans and animals, or, more relevantly here, test whether animal/human status interacts with autism spectrum phenotype. Concretely, we hypothesized that, judging the capacities of animals, all participants would predominantly activate intuitive biology, and conclude that innateness is likely; whereas, judging the capacities of humans, participants without an autism spectrum phenotype would predominantly engage intuitive psychology, and rate innateness less likely. On the other hand, participants with an autism phenotype may engage intuitive psychology relatively less, and continue to endorse innateness. That is, we predicted an interaction between autism spectrum phenotype and animal/human status.

Study 4 tested for this interaction, by repeating study 1's exercise of judging the innateness of a capacity in either an unknown human (human condition) or an unknown animal (animal condition). We recruited two groups of participants: one of Prolific workers who self-reported having received a diagnosis of an autism spectrum condition, and one self-reporting no such diagnosis. To replicate the findings of study 1, we would see a main effect of condition, with higher innateness judgements for animals than humans. We additionally predicted an interaction between group and condition.

Methods

Preregistration. The study was pre-registered at: <https://osf.io/unhj9>. No predictions regarding sex differences were pre-registered, but we present a brief analysis of sex differences after the main analysis. For this, we focus on the innateness dependent variable, since this was closest to that measured by Berent (2023).

Participants. At the time of registering for the Prolific pool, participants self-report if they have ever been given a formal diagnosis of various conditions, including autism spectrum conditions. We used this self-report to target our potential respondent groups (as did Berent et al. (2022a), though their participants were not restricted to the UK). We aimed for 100 participants per group, resulting in a realized sample size of 194 (autism spectrum group, AS: $n = 98$; control group, NT: $n = 96$; 101 men and 93 women; mean age 35.2 (s.d. 11.8); 55 current student status; 134 without; 5 not specified). Sex was balanced within each group as well as overall. Participants were recompensed £1, which equated to a rate above the UK Living Wage pro rata.

Design. A 2 (participant group: AS, NT) by 2 (condition: animal, human) semi-experimental study. Materials were as for study 1, but we used continuous ratings rather than the forced choices for the dependent variables, and dropped the items about fixity, typicality and subjective utility.

Procedure and materials. Participants saw the same text as study 1, with the exception that the dependent variables were phrased as ‘how likely...to be innate’, etc., with responses on 100-point sliders initiated at 50. After completing the task, participants completed the Short Autism Spectrum Quotient questionnaire (S-ASQ) (Allison et al., 2012). This ten-item scale has high sensitivity and specificity for identifying individuals with a diagnostic history of autism spectrum conditions, and was used here to verify the expected group difference.

Data analysis. As we had three dependent variables (innateness, in the genes, and biological), we first performed an omnibus analysis using all the ratings, with the identity of the variable rated, group and condition (and their interactions) as predictors. This model contained random effects of participant and capacity. To aid interpretation, we then examined each dependent variable separately in general linear models with random effects of capacity. For studies 4 and 5, we report F-ratios for inference, rather than t-tests on individual parameter estimates as in earlier studies. This is because we are often dealing with variables with more than two levels.

Results

Main analysis. The two groups differed significantly in mean S-ASQ scores (AS: mean 6.24, sd 1.97; NT: mean 4.52, sd 1.60; $t = 6.68$, $p < 0.001$, $d = 0.43$). However, the magnitude of the difference was not as great as that reported for this scale in a large validation sample (Allison et al. (2012); AS: mean 7.93, sd 1.93; NT: mean 2.77, sd 2.00, $d = 2.63$). The dependent variables were moderately correlated with one another (innateness/genes: $r = 0.65$; innateness/bio: $r = 0.41$; bio/genes: $r = 0.44$; all $ps < 0.001$).

We predicted (P1) that ratings of innateness, in the genes and biological would be higher for animals than humans, collapsing across participant groups. This prediction was supported (omnibus model: $F(1, 190.0) = 65.37$, $p < 0.001$; for effects on individual variables see below). Secondly, we predicted (P2, P2’) interactions between group and condition. In the omnibus model, there was a three-way interaction between condition (human, animal), group (AS, NT) and variable rated (innateness, in the genes, biological; $F(2, 380) = 5.56$, $p = 0.004$). This suggests that group interacted with condition, but differentially across the three variables rated.

To break down the omnibus effect, we fitted three separate linear mixed models with each of the three dependent variables as outcomes (table 3). The main effects of condition were significant in all three cases: in the animal condition, ratings of innateness, in the genes, and biological were substantially higher than in the human condition (figure 4A). The interaction between condition and group was significant only for innateness. As figure 4A shows, capacities of animals were judged less innate in the AS group compared to the NT group, whilst capacities of humans were judged fractionally more innate in the AS group compared to the NT group. Put differently, the difference in mean innateness rating between the human and animal condition was 27.6 for the NT group, but only 13.4 for the AS group.

Table 3. Summaries of linear mixed models predicting each dependent variable in turn, study 4.

Effect	Dependent variable		
	Innate	In the genes	Biological
Condition (ref Human)	F(1, 190) = 38.69, p < 0.001 B = 27.58, se 4.69	F(1, 180.9) = 69.62, p < 0.001, B = 31.07, se 4.79	F(1, 189.4) = 21.93, p < 0.001 B = 10.66, se 4.88,
Group (ref NT)	F(1, 190) = 1.04, p = 0.308 B = 3.69, se 4.64	F(1, 188.8) = 0.52, p = 0.475, B = 0.51, se 4.74	F(1, 189.3) = 0.22, p = 0.636 B = -7.19, se 4.84,
Condition * Group	F(1, 190) = 4.58, p = 0.033 B = -14.21, se 6.60	F(1, 189.2) = 0.75, p = 0.386, B = -5.85, se 6.73	F(1, 187.7) = 2.65, p = 0.105, B = 11.11, se 6.82

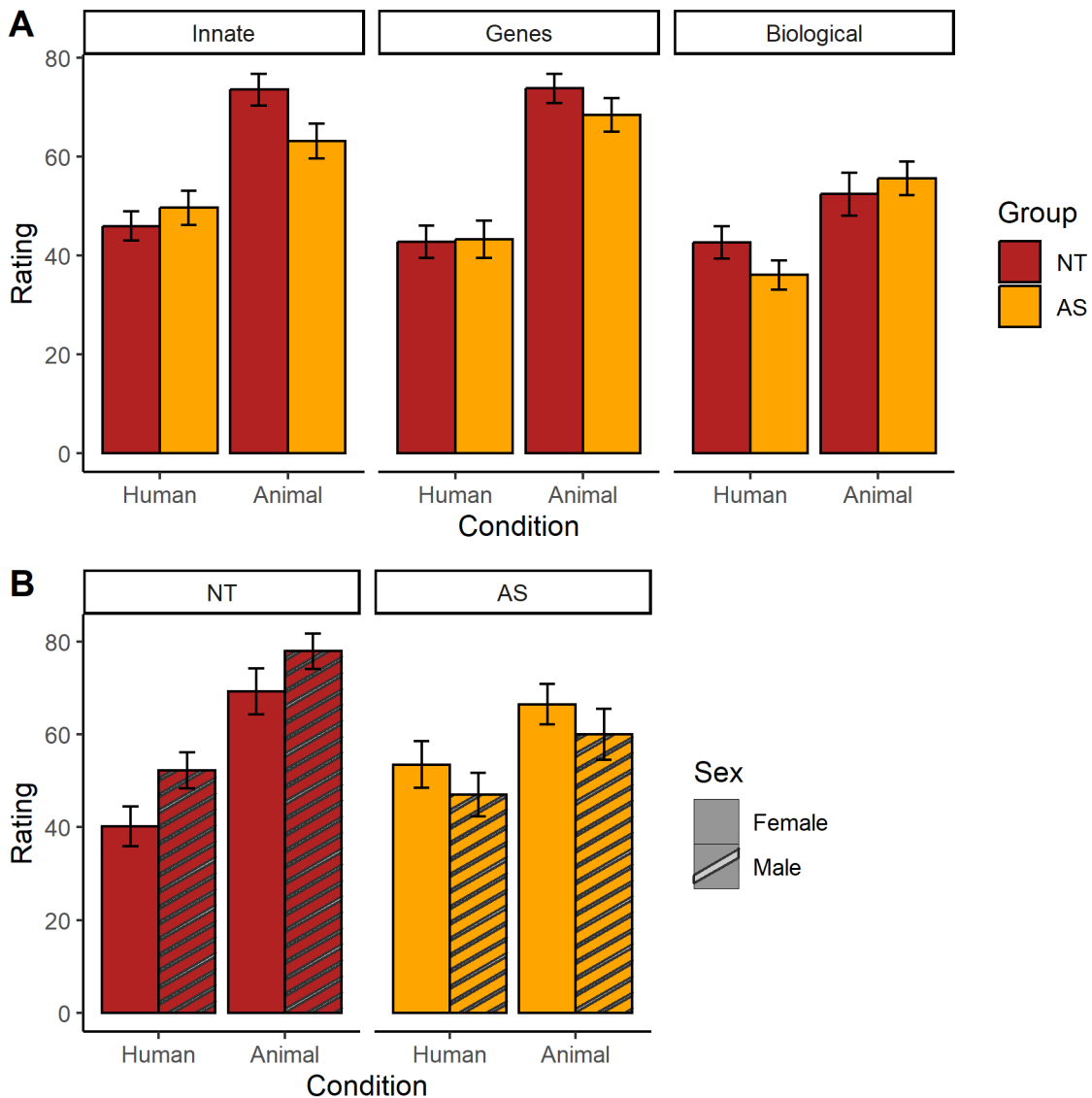


Figure 4. A. Mean ratings of innateness, in the genes and biological, by condition and participant group, study 4. Sexes are combined. AS: Autism spectrum; NT: non-autism spectrum. Error bars represent ± 1 standard error. B. Mean ratings of innateness by sex for the NT and AS groups. Error bars represent ± 1 standard error.

Analysis involving sex differences. For innateness ratings, there was a significant sex by group interaction ($F(1, 186) = 6.59, p = 0.011$), as well as the condition by group interaction and main effect of condition reported in table 3. Breaking down the data into men and women, men made significantly higher ratings than women in the NT group (collapsing across conditions; $F(1, 92) = 6.14, p = 0.015; B_{\text{male}} = 12.01, \text{s.e. } 5.76$; figure 4B). This difference was abolished in the AS group ($F(1, 94) = 1.70, p = 0.196; B_{\text{male}} = -6.51, \text{s.e. } 7.33$; figure 4B).

Discussion

In study 4, confirming prediction P1, there was a clear main effect of condition across all three dependent variables. We thus replicated the central finding of earlier studies: capacities of animals are judged more innate, in the genes, and biological than corresponding capacities in humans. There was some evidence for P2, the prediction that AS status would affect ratings. AS status was important to differing extents according to the combination of which variable participants were rating and whether they were doing so for humans or animals. Participants in the AS group judged capacities of animals to be less innate than participants in the NT group did; and judged capacities of humans to be fractionally more innate than the participants in the NT group did. There was no significant patterning with AS status for the other two dependent variables.

The conceptual replication of the findings of Berent et al. (2022b) was partial. The innateness dependent variable is the one most similar to what they measured, and for this variable we did find a significant interaction between group and condition, albeit that it was absent for the other dependent variables. However, Berent et al.'s observation was higher ratings of innateness for human traits in the AS than the NT group. In our data, the group difference for the human stimuli was indeed in this direction, but very small. Our interaction between group and condition was substantially driven by *lower* ratings of innateness for *animal* traits in the AS group. Previous studies have shown that AS/NT group differences in social cognitive tasks, observed when the stimuli are human, are abolished when the stimuli are animals or non-human avatars (Atherton & Cross, 2019). Only one study to our knowledge has previously shown a full crossover interaction of the kind observed here. This study (Brosnan et al., 2015) did not use animals, but rather compared animations to realistic human stimuli. The authors of that study suggest that the AS participants use atypical explicit strategies to solve social cognitive tasks, and these strategies transfer better to the animated stimuli. In any event, one way of characterizing our finding for the innateness variable is that the difference between the animal and human case is blunted for the AS group compared to the NT group.

In Berent et al.'s (2022b) study, the group difference in innateness judgement was driven specifically by the subset of traits they dubbed 'epistemic', that are thought to involve extensive thinking. It is possible our vignette capacities (navigating, finding wild fruits, hiding at noises, avoiding sunlight) were insufficiently epistemic for a strong comparison to their study. We address this possibility in study 5. We also note that although there was a clear group difference in the S-ASQ in study 4, it was not as great as in the validation data for that scale, which were from a large UK clinical sample and general population controls. S-ASQ scores were not as high as the validation sample for our AS group, and substantially higher for the NT group. The method of recruitment here was the same as Berent et al. (2022b) (although they did not restrict participation to the UK), so this is unlikely to be the source of any difference in results, but it is a reason to expect group effects to be modest.

There was a sex difference in innateness ratings in study 4, but only in the NT group. In the AS group, the sex difference was abolished. The abolition of typical sex differences in social cognition in autism

spectrum populations has been observed elsewhere (Baron-Cohen et al., 2015). In the NT group, the higher male ratings of innateness applied equally across the human and animal conditions.

Study 5

In study 5, we repeated the AS/NT comparison, but with a method closer to that of Berent et al. (2022a). Participants were told about 10 capacities. As before, we varied (between subjects) whether they were described as capacities of humans or animals, and obtained ratings of innateness, in the genes and biological. We selected 5 capacities that received very high ratings for involving thinking in study 3 (and hence are epistemic); and 5 that received very low ratings for involving thinking (hence, non-epistemic). The epistemic capacities are inevitably (given the findings of study 3) rather less typical of animals than humans. Nonetheless, we chose capacities where animal cognition research has claimed the capacity to be present in at least some non-human species. The broad prediction of study 5 was that group (AS or NT) will interact with condition (animal or human) in predicting innateness/in the genes/biological ratings. The narrower prediction was for a three-way interaction between group, condition and capacity type (epistemic or non-epistemic), with AS group participants rating human epistemic capacities in particular as more innate (in the genes, biological).

Methods

Preregistration. The study was pre-registered at: <https://osf.io/mgfqz>. We pre-registered no predictions concerning sex differences. We present a brief post-hoc analysis of sex differences in innateness ratings for after the main analysis.

Participants. We created AS ($n = 99$) and NT ($n = 100$) groups from Prolific in the same way as in study 4 (96 men, 102 women, 1 preferred not to say; mean age 36.1 (s.d. 12.2); 46 current student status, 143 not, 10 not specified). Men and women were balanced within each group. In study 5, we did not include the Short Autism Spectrum Quotient questionnaire (Allison et al., 2012). As we sampled from the same population, it is reasonable to assume that the group difference in autism experience was comparable with study 4. Participants were recompensed £1.

Design. A 2 (participant group: AS, NT) by 2 (condition: animal, human, between-subjects) by 2 (capacity type: epistemic, non-epistemic, within-subjects) study. Participants read a list of 10 capacities (see SI, section 3) and rated each one for innateness, being 'in the genes', and being biological as opposed to psychological on 100-pt sliders.

Procedure and materials. Participants were either told 'You are going to see a list of capacities that people have' or 'You are going to see a list of capacities that some animals have been shown to have', and asked to rate the extent to which they thought the capacity was innate, in the genes, and biological as opposed to psychological.

Data analysis. We used a very similar analytical strategy to study 4, with an omnibus model for all three dependent variables together, prior to running separate models for each dependent variable.

Results

Main analysis. The dependent variables were moderately correlated with one another (innateness/genes: $r = 0.45$; innateness/bio: $r = 0.33$; bio/genes: $r = 0.60$; all $ps < 0.001$). In the omnibus model, there was a marginally significant four-way interaction between condition (human/animal), group (AS/NT), capacity type (epistemic/non-epistemic) and variable rated (innate/in the genes/biological; $F(2, 5563.9) = 3.35$, $p = 0.035$). This suggests that NT and AS participants might be responding differently to the human/animal condition, but differentially for

different combinations of capacity types and dependent variables. As our pre-registered prediction (P3) concerned epistemic capacities in particular, we simplified the interaction by subsequently focusing on the epistemic capacities alone.

Considering the epistemic capacities alone, there was a significant three-way interaction between condition, group and variable rated ($F(2, 2686.6) = 4.02, p = 0.018$). Further decomposing this effect, group and variable interacted significantly in the human condition ($F(2, 1373.31) = 7.09, p < 0.001$). This was driven by the AS group rating human epistemic capacities *less* innate but *more* biological than the NT group did (figure 5). There was no corresponding interaction for the animal epistemic capacities ($F(2,1309.35) = 0.57, p = 0.568$). Neither the lower innateness ratings or the higher biological ratings of the AS group for the human epistemic capacities would be significant if considered in isolation (innateness: $F(1, 100.1) = 1.77, B_{AS} = -5.69, t = -1.33, p = 0.186$; biological: $F(1, 98.9) = 1.71, B_{AS} = 5.58, t = 1.31, p = 0.194$).

As well as the predictions concerning group, we also predicted (P1) higher ratings of innateness, in the genes, and biological for animals than humans. There was a main effect of condition (omnibus model: $F(1, 194.9) = 5.00, p = 0.027$). However, this was driven by *lower* ratings of innateness for animals for the epistemic traits ($F(1,195.59) = 25.87, B_{animal} = -13.63, t = 3.00, p < 0.001$; figure 5), coupled with non-significant effects of condition for all other combinations of variable and capacity type. Finally, we predicted (P2) that ratings of innateness, in the genes and biological would be lower for the epistemic traits than the non-epistemic. This prediction was confirmed in the omnibus model ($F(1, 8) = 30.11, p < 0.001$), and in each dependent variable considered separately (innateness: $F(1, 8) = 37.91, B_{epistemic} = -26.86, t = -6.95, p < 0.001$; in the genes: $F(1, 8) = 19.05, B_{epistemic} = -24.85, t = -5.18, p = 0.002$; biological: $F(1, 8) = 26.94, B_{epistemic} = -33.35, t = -5.70, p < 0.001$; figure 5).

Sex differences. Considering the innateness ratings alone, male and female mean ratings were very similar (men: mean 63.0, s.d. 31.4; women: mean 63.2, s.d. 32.3). There was no significant main effect of sex ($F(1, 190.3) = 0.02, p = 0.893$); interaction between condition and sex ($F(1, 190.3) = 0.06, p = 0.802$); interaction between group and sex ($F(1, 190.3) = 0.02, p = 0.883$); nor three-way interaction between condition, sex and group ($F(1, 190.3) = 0.00, p = 1.000$).

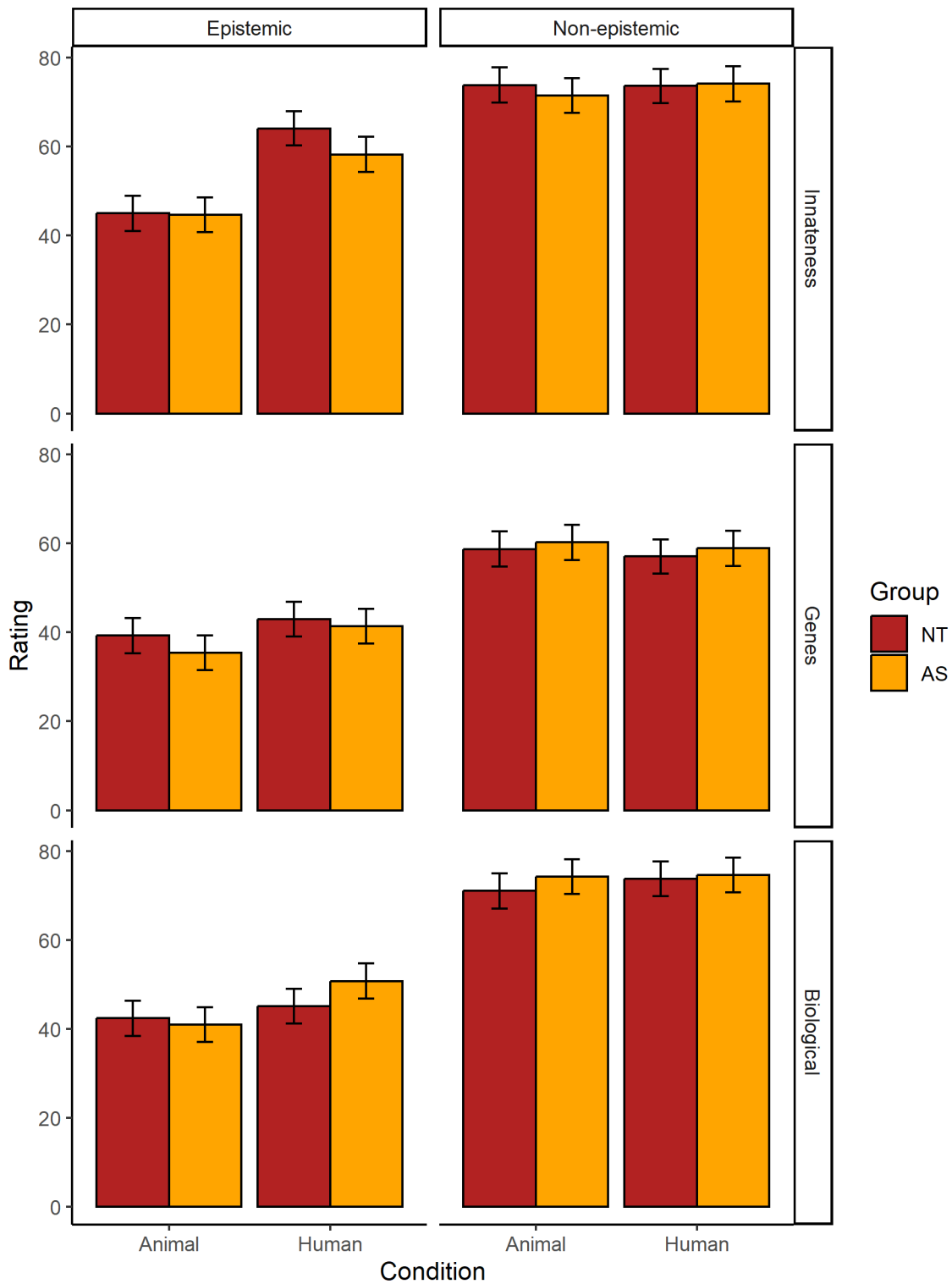


Figure 5. Mean ratings by condition (animal/human), group (NT/AS), capacity type (epistemic/non-epistemic) and variable rated (innateness/in the genes/biological), study 5. Bars show estimated marginal means and error bars one standard error.

Study 5 discussion

Study 5 attempted more closely to replicate study 3 of Berent et al. (2022a). Unlike their study, we also had a condition where the capacities were attributed to animals, and hence we predicted an

interaction: higher innateness judgements for the AS group in the human condition, but not in the animal condition. We did find some evidence that AS and NT participants might differ in the ratings they gave, but the differences varied by whether the target was human or animal, the capacity was epistemic or not, and exactly which variable was being rated. However, there was no tendency for AS participants to rate human capacities more innate than NT participants did, either for all capacities or just the epistemic ones. For the human epistemic capacities, the AS group tended to rate them as *less* innate, albeit slightly more biological. Thus, the key findings of Berent et al. (2022a) with respect to AS diagnosis were not replicated here.

It is possible that our AS and NT groups, based on participant self-declaration of diagnostic history, were not well enough separated on the autism spectrum (see study 4 discussion). We note, however, that the recruitment source was the same as in Berent et al. (2022a). Moreover, whilst this would plausibly affect the magnitude of effect observed, it should not affect the direction. Another possibility is that higher innateness judgements amongst people with autism diagnoses is not a broadly generalizable finding. For one thing, autism spectrum diagnoses do not constitute a clean ‘manipulation’ of the availability of intuitive psychology. Though few would argue that social difficulties are a typical feature of autism, impairment on intuitive psychology tasks is neither specific to autism, nor characteristic of all individuals on the autism spectrum (Gernsbacher & Yergeau, 2019). Thus, observing autism/neurotypicality differences may not be a strong methodology for testing the effects of the activation of intuitive psychology on judgements of innateness. More pertinently, our study 3 suggested that it is not the level of activation of intuitive psychology that drives judgements of innateness. Rather, it is the level of activation of intuitive *biology* that matters most directly. We return to the observed AS/NT differences, and their implications, in the General Discussion.

Study 5 also provided us with another chance to examine sex differences in innateness judgements, although it was not originally designed for this. There was no evidence of any sex difference, either overall, for the human capacities, or for the human epistemic capacities in particular. Again, we return to this in the General Discussion.

The hypothesis that human epistemic capacities (those that are appraised as involving thinking) are judged less innate than non-epistemic capacities was strongly supported in study 5, reinforcing the results of study 3. This concurs with Berent et al.’s (2019) findings, and study 3, that capacities that involve more thinking are seen as less innate. However, our interpretation of this effect is somewhat different, an issue we return to in the General Discussion.

In study 5, and unlike all of the previous four studies, we did not observe higher ratings of innateness, in the genes and biological for the same capacities in animals as compared to humans. Although this was contrary to prediction, in retrospect, it was an artifact of the scenarios used. The non-epistemic capacities used in study 5 were exactly those kinds of capacities that would be processed using intuitive biology both in humans and in animals, and indeed they were rated highly innate in both cases. As for the epistemic capacities, we chose these for the purposes of replicating Berent et al. (2022a), as those which would be seen as thought-intensive. Given the findings of study 3, this necessarily meant capacities considered uncharacteristic of animals. Thus, given that a central component of innateness is typicality (see studies 1 and 2), and our epistemic capacities were by design rather typical of humans rather and untypical of most animals, it is no surprise that innateness ratings were in fact higher for humans. This was exacerbated by the fact that, to make the scenario plausible in the animal condition, we felt it necessary to say ‘*some* animals have been shown to have....’. We intended this to mean some *species* of animals, but it could also have been understood as some (but not other) individual animals. This strongly cues non-typicality, and hence should be

expected to lead to lower innateness ratings. Thus, we do not view this finding in study 5 as an important counterexample to the pattern, very consistent across the other studies, of the presumption of greater innateness in animals than humans overall.

General discussion

Summary and interpretation of findings

Across five studies, we found clear evidence for several contentions proposed in the Introduction. In our study population, the concept of innateness is strongly associated with inferences of fixity (the capacity develops the same way regardless of circumstances) and typicality (all individuals show it; studies 1 and 2). These findings concur with previous work on the folk concept of innateness (Linguist et al., 2011; Machery et al., 2019). We also showed that the notions ‘in the genes’ and ‘biological’, when applied to capacities, covary with the judgement of innateness and have similar associations with fixity and typicality (studies 1 and 2). Centrally, the concept of innateness is strongly tied to non-human animals. People assented to innateness much more readily when the bearer of the same capacity was a human rather than an animal (studies 1 and 4), and rated human capacities more likely to be innate the more those capacities are also characteristic of non-human animals (study 3). Even describing an imaginary alien being as having an innate (vs. non-innate) capacity made that alien seem less human-like (study 3). The perceived involvement of thinking is negatively related to the judgement that a capacity is innate (studies 3 and 5). Thus, in the minds of our participants, capacities can be ranged from, at one end, those that are innate, fixed, typical, thoughtless, and characteristic of animals; to, at the other end, those that are non-innate, not fixed, idiosyncratic, thoughtful, and distinctive to humans.

We interpret these results in the following way, though we accept that this involves inference beyond the data, and may not be the only possible interpretation. Intuitive biology and intuitive psychology are two systems that can process the capacities of living beings. Broadly speaking, the more active the one system is on a set of inputs, the less active the other one is (study 3). This negative correlation could arise either because their tunings are negatively correlated across a range of stimulus features, or because they mutually inhibit each other once activated. Intuitive biology is, plausibly for good functional reasons, concerned with making computationally efficient generalizations about whole classes (species) from limited experience with one or a few individuals. It thus generates a characteristic schema of fixedness and typicality. This schema is what gets referred to in everyday talk as ‘innateness’. When intuitive biology is less strongly activated, this schema is less present. To the extent to which intuitive psychology is more active instead, one sees the hallmarks of mind schema: an inner, dynamic, personal, contextually-dependent world of thought underlying behaviour. It is mind schema that is, presumably, usually active when one is thinking about the capacities of an agent and intuitive biology is *not* strongly activated. When people say that a capacity is ‘learned’, ‘acquired’ or ‘not biological’, what they mean is presumably that they think about that capacity primarily using mind schema; intuitive psychology dominates intuitive biology in their intuitions about that capacity.

The optimally exciting stimulus for intuitive biology is an animal. Describing a being as an animal engages innateness schema. This explains the large effects of the animal/human manipulation in studies 1 and 4 and the strong correlation, across capacities, between presence in animals and innateness in study 3. However, the picture is not quite as simple as ‘animals innate/humans thoughtful’. For example, some capacities such as seeing, walking and sleeping were rated as highly innate *in humans* in study 3, as well as largely thoughtless. Humans can clearly excite both systems.

Specifically, those aspects of humans related to their somatic constraints, and immediate sensory and motor behaviour are shared with other animals and are handled by intuitive biology. This gives humans a special, dual-aspect status: beings whose dynamics can be handled by two different cognitive systems, depending on how exactly they are considered or framed. We return to this in the discussion of intuitive dualism, below. It implies an interesting asymmetry between the domains of intuitive psychology and intuitive biology. The proper domain of intuitive psychology is human agents; occasional extension to animals in cases such as pets probably do not represent the system's evolved function (Atran, 1998). On the other hand, the proper domain of intuitive biology may include non-human animals *and also* human agents when computing their basic somatic, sensory and motoric aspects. Thus, thinking of some aspects of human beings as belonging distinctively to their material embodiment would not represent a misfiring of a cognitive system, but its fulfillment of one of that system's evolved functions.

Our studies come from adults in just one population. This limits the strength of the present evidence for the account given above. It is possible what we are picking up is simply the semantics of certain words in one language; or the discursive and educational practices found widely in one particular country. However, whilst we can triangulate our account against multiple sources of other argumentation, including, importantly evidence from non-Western cultures and from young children. Specifically, there are rich developmental and non-Western-based literatures supporting the claims that thinking about animals is supported by a distinct cognitive system, and that key signatures of this system include assumption that capacities are likely to be typical of the kind, and are fixed (see Atran, 1998; Medin & Atran, 2004 for reviews). The key cognitive signatures of this system emerge early in childhood, in ways that are, in the regards discussed here, very similar in extremely different cultural contexts (Atran et al., 2001; Gelman & Wellman, 1991; Sousa et al., 2002). Likewise, the claim that humans are a 'dual-aspect' category, intuitively processed as owing some of their capacities to an inner mental world, and others to the animal-like body, is based on an extensive evidence base that is cross-cultural, developmental, and in many cases both (Astuti, 2001; Bering & Bjorklund, 2004; Cohen et al., 2011; Weisman et al., 2021). The critical role of the soma in determining which system is most activated, for human capacities, is demonstrated causally in experiments where a bodily basis for a human capacity is either cued or not. People think of the capacity as more innate and more 'biological' when the capacity is described in terms of a somatic basis (Berent & Platt, 2021b, 2021a; Nettle et al., 2022). The soma is what humans share with other animals; and the inferences unleashed where cues to a bodily basis are provided are fixity and typicality, the core of the innateness schema.

Intuitive dualism

The idea that humans are processed by two different cognitive mechanisms, one dealing with their embodied properties and another with their minds originates in the literature on *intuitive dualism* that traces back to the work of Paul Bloom (Barlev & Shtulman, 2021; Bloom, 2004; Cohen et al., 2011). In particular, Iris Berent has recently linked innateness judgements to intuitive dualism, arguing that innateness is the intuitive judgement we make about the embodied capacities of humans, whilst non-innateness is the intuitive judgement we make about their mind capacities (Berent, 2023; Berent et al., 2022b). This has much in common with the present account, and indeed influenced it, but there are some key differences.

Berent draws on the argument that has been made from the outset of the literature on intuitive dualism (Bloom, 2004), that people thinking about other people can either use intuitive psychology

(for mind-properties) or intuitive physics (for body properties, e.g. Berent, 2023, p. 1). On this account, we judge human capacities as innate when we are thinking about people as physical objects, and as non-innate when we are thinking about their minds. On our account, by contrast, innateness judgements are the characteristic outputs of intuitive *biology*, not intuitive physics. We believe this makes more sense both of the present data, and the data from Berent's experiments (Berent, 2023; Berent et al., 2022b). If the concept of innateness represents the activation of intuitive physics, why would innateness judgements be so strongly triggered by describing *animals* (as in the present study 1)? Animals are not typical cases of physical objects. Indeed, a large body of work (mentioned above) suggests that animals are processed in different ways from other kinds of objects. The core elements of the innateness schema, (developmental) fixedness and (species-) typicality, are the hallmarks of intuitive reasoning about animals, not reasoning about objects in general. They are good design features for rapidly categorizing and learning about potential predators or prey, not good design features for thinking about water or earth. In study 3, the predictor driving the judgement of innateness of a capacity in humans was how present *in animals* that capacity was taken to be. Presence in animals seems like a face-valid measure of the engagement of intuitive biology, not the engagement of intuitive physics. Moreover, the various experimental cues that have been shown to increase judgements of innateness for human capacities are reminders of humans' *animal* natures, not their status as physical objects (Berent & Platt, 2021b, 2021a; Dar-Nimrod & Heine, 2011; Nettle et al., 2022). We consider it an odd quirk that the literature on intuitive dualism pits the cognition about humans that comes from intuitive physics against the cognition that comes from intuitive psychology. Humans are physical objects too, of course, but the cognition that comes from intuitive biology, whose proper domain is living beings, seems much more relevant.

Autism spectrum and male-female differences

Studies 4 and 5 gave us the pre-planned opportunity to replicate Berent et al.'s (2022b) findings in relation to innateness in AS conditions, whilst post-hoc analysis of studies 1, 3, 4 and 5 allowed us to replicate their findings in relation to sex differences in innateness judgements (Berent, 2023). The replication picture is mixed at best. Studies 4 and 5 both found statistically significant interaction effects involving AS diagnosis status. However, the nature of the AS/NT differences depended on exactly which variable was being rated, whether the target was a human or animal, and, in study 5, what kind of capacity it was. We can't summarize these effects as AS participants judging capacities as more innate, either in general or for humans specifically, and so we did not replicate the main claim of Berent et al. (2022b) regarding innateness judgements. Possibly the results hint at people with AS diagnoses showing reduced or altered differences in processing between human targets and animal targets, as has been suggested in previous literature (Atherton & Cross, 2019). However, the effects involving AS status were marginally significant in both studies, and the effect sizes small.

The results involving sex differences perhaps fared better, though here too the results were mixed. Most positively, in study 3, the closest in methodology to Berent (2023), men made higher ratings of innateness than women, though the effect size varied across capacities. In study 4, NT men made higher ratings of innateness than women, both when the target was a human and when it was an animal. The difference was abolished in the AS group. In study 1, men made more judgements of innateness than women, but only for animal targets. Finally, in study 5, no sex differences were observed. Taken together, these results do suggest a greater willingness of men to make the judgement of innateness, that is not restricted to judgements about humans, and has either a modest effect size, or moderators in terms of the capacity being rated or other contextual features.

Our interpretation of study 3 was that the primary driver of innateness judgements is the level of activation of intuitive biology. If we interpret this as the absolute level, then in fact it is not clear we

would make the prediction made by Berent et al. (2023; 2022b) of greater innateness judgements in men and people with AS diagnoses. Even granting the assumption that intuitive psychology is typically less available in these individuals, we have no reason to believe that intuitive biology is more available. To predict AS or sex differences, we would need to make an additional step: either it is the *relative* activation strengths of activation of intuitive biology and intuitive psychology that matters for innateness judgements; or males and people with AS diagnoses use intuitive biology as a compensatory processing strategy in cases where other people might be using intuitive psychology more. Either of these arguments is reasonable. Thus, our account could be made compatible with AS and sex differences should they be shown to be general, but does not depend on them as a critical prediction.

Scientific implications

We are at pains to stress that our research has no bearing on the debate over whether there is a useful *scientific* concept of innateness to be rescued from the incoherent set of ways the term has been used (Birch, 2009; Griffiths & Linnquist, 2022; Mameli & Bateson, 2011). Our findings concern intuitive or folk conceptions of innateness. But, both scientists and their audiences have to build scientific understanding on top of intuitive theories about the same domains, intuitive theories that continue to exist (Shtulman, 2015; Shtulman & Lombrozo, 2016). Thus, a useful implication of our work for the scientific debate on innateness is to point out that the folk concept of innateness, which is no more absent from the minds of scientists as from any others, may often distort and divert the substantive debate. It is useful to understand it if only to resist its gravitational attraction in theoretical assumptions and interpretations of phenomena.

If we are correct, there is a privileged intuitive connection between non-human animals and an innateness schema consisting of fixedness and species-typicality. This means that the off-diagonal combinations should be surprising to people: namely, cases where animals are individually variable or highly flexible in response to environmental inputs; or where humans rely heavily on innate knowledge. Understanding evolution by natural selection, for example, requires appreciation that members of species are not the same as one another. People tend to replace the actual population account of the evolutionary process with a more intuitive typological one in which species-typicality is preserved at any one time (Shtulman, 2006). Evoking humans as examples can help this, since people have an easier time grasping that individuals differ when they are thinking about humans than when they are thinking about animals (Nettle, 2010). General population also surveys suggest that people fail to appreciate just how early in development human capacities appear, and how much the child must bring to bear in order for those capacities to be able to develop (Wang & Feigenson, 2019).

Perhaps the greatest scientific challenge is to convey that most, in fact possibly all, capacities of adult humans and animals are hybrid. That is to say, they involve the interaction of 'innate' resources that the developing individual brings to the situation, and information and resources in the environment. They often involve, proximally, a great deal of flexible cognition even if, more distally, they scaffold on a lot of innate knowledge. The innateness concept, to the extent that it is scientifically valid, is better not applied to fully developed capacities at all, but to resources that are used in the construction of those capacities, in conjunction with environmental resources and regularities. In effect, understanding contemporary cognitive science requires the listener to bring to bear aspects of innateness schema and access of mind schema at the same time. This seems to be difficult: one or the other schema ends up dominating the other in people's thinking. If the dominant one is innateness schema, the communicator is taken to be bestializing humans, and denying their thoughtfulness, variability and agency. If the dominant one is mind schema, people stop appreciating

that innate knowledge, genes and biology must still play a critical role. To take one example, canonical evolutionary psychology is a hybrid position that attempts to specify what innate resources are available to humans, and how those interact with contextual input (Cosmides & Tooby, 1987; Tooby & Cosmides, 1989). It is often mis-characterized in informal accounts as making the (obviously false) claim that human behaviour is ‘hard-wired’, species typical, and mindless, and unvarying from person to person or group to group (Nettle & Scott-Phillips, 2021). Presumably what happens in such a case is that the reference, in presentations of evolutionary psychology, to evolution, genes, other species etc. activates folk innateness schema. The authors are then taken to have proposed this schema as an account of human behaviour, rather than the hybrid account they actually proposed.

References

- Ahn, W., Proctor, C. C., & Flanagan, E. H. (2009). Mental Health Clinicians’ Beliefs About the Biological, Psychological, and Environmental Bases of Mental Disorders. *Cognitive Science*, 33(2), 147–182. <https://doi.org/10.1111/j.1551-6709.2009.01008.x>
- Allison, C., Auyeung, B., & Baron-Cohen, S. (2012). Toward Brief “Red Flags” for Autism Screening: The Short Autism Spectrum Quotient and the Short Quantitative Checklist in 1,000 Cases and 3,000 Controls. *Journal of the American Academy of Child & Adolescent Psychiatry*, 51(2), 202–212.e7. <https://doi.org/10.1016/j.jaac.2011.11.003>
- Astuti, R. (2001). Are We all Natural Dualists? A Cognitive Developmental Approach. *Journal of the Royal Anthropological Institute*, 7(3), 429–447. <https://doi.org/10.1111/1467-9655.00071>
- Atherton, G., & Cross, L. (2019). Animal Faux Pas: Two Legs Good Four Legs Bad for Theory of Mind, but Not in the Broad Autism Spectrum. *The Journal of Genetic Psychology*, 180(2–3), 81–95. <https://doi.org/10.1080/00221325.2019.1593100>
- Atran, S. (1998). Folk biology and the anthropology of science: Cognitive universals and cultural particulars. *Behavioral and Brain Sciences*, 21, 547–609.
- Atran, S., Medin, D., Lynch, E., Vapnarsky, V., Ek’, E. U., & Sousa, P. (2001). Folkbiology doesn’t Come from Folkpsychology: Evidence from Yukatek Maya in Cross-Cultural Perspective. *Journal of Cognition and Culture*, 1(1), 3–42. <https://doi.org/10.1163/156853701300063561>
- Barlev, M., & Shtulman, A. (2021). Minds, bodies, spirits, and gods: Does widespread belief in disembodied beings imply that we are inherent dualists? *Psychological Review*, 128, 1007–1021. <https://doi.org/10.1037/rev0000298>
- Baron-Cohen, S., Bowen, D. C., Holt, R. J., Allison, C., Auyeung, B., Lombardo, M. V., Smith, P., & Lai, M.-C. (2015). The “Reading the Mind in the Eyes” Test: Complete Absence of Typical Sex Difference in ~400 Men and Women with Autism. *PLOS ONE*, 10(8), e0136521. <https://doi.org/10.1371/journal.pone.0136521>
- Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a “theory of mind” ? *Cognition*, 21(1), 37–46. [https://doi.org/10.1016/0010-0277\(85\)90022-8](https://doi.org/10.1016/0010-0277(85)90022-8)
- Barrett, H. C., & Broesch, J. (2012). Prepared social learning about dangerous animals in children. *Evolution and Human Behavior*, 33(5), 499–508. <https://doi.org/10.1016/j.evolhumbehav.2012.01.003>
- Berent, I. (2023). The illusion of the mind-body divide is attenuated in males. *Scientific Reports*, 13(1), 6653. <https://doi.org/10.1038/s41598-023-33079-1>
- Berent, I., & Platt, M. (2021a). Essentialist Biases Toward Psychiatric Disorders: Brain Disorders Are Presumed Innate. *Cognitive Science*, 45(4), e12970. <https://doi.org/10.1111/cogs.12970>
- Berent, I., & Platt, M. (2021b). Public misconceptions about dyslexia: The role of intuitive psychology. *PLOS ONE*, 16(12), e0259019. <https://doi.org/10.1371/journal.pone.0259019>
- Berent, I., Platt, M., & Sandoboe, G. M. (2019). People’s Intuitions About Innateness. *Open Mind*, 3, 101–114. https://doi.org/10.1162/opmi_a_00029

- Berent, I., Theodore, R. M., & Valencia, E. (2022a). Autism attenuates the perception of the mind-body divide. *Proceedings of the National Academy of Sciences*, *119*(49), e2211628119. <https://doi.org/10.1073/pnas.2211628119>
- Berent, I., Theodore, R. M., & Valencia, E. (2022b). Autism attenuates the perception of the mind-body divide. *Proceedings of the National Academy of Sciences*, *119*(49), e2211628119. <https://doi.org/10.1073/pnas.2211628119>
- Bering, J. M., & Bjorklund, D. F. (2004). The natural emergence of reasoning about the afterlife as a developmental regularity. *Developmental Psychology*, *40*(2), 217–233. <https://doi.org/10.1037/0012-1649.40.2.217>
- Birch, J. (2009). Irretrievably confused? Innateness in explanatory context. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences*, *40*(4), 296–301. <https://doi.org/10.1016/j.shpsc.2009.09.007>
- Bloom, P. (2004). *Descartes' Baby: How the Science of Child Development Explains What Makes us Human*. Basic Books.
- Brosnan, M., Johnson, H., Grawmeyer, B., Chapman, E., & Benton, L. (2015). Emotion Recognition in Animated Compared to Human Stimuli in Adolescents with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *45*(6), 1785–1796. <https://doi.org/10.1007/s10803-014-2338-9>
- Cohen, E., Burdett, E., Knight, N., & Barrett, J. (2011). Cross-Cultural Similarities and Differences in Person-Body Reasoning: Experimental Evidence From the United Kingdom and Brazilian Amazon. *Cognitive Science*, *35*(7), 1282–1304. <https://doi.org/10.1111/j.1551-6709.2011.01172.x>
- Cosmides, L., & Tooby, J. (1987). From Evolution to Behavior: Evolutionary Psychology as the Missing Link. *The Latest on the Best Essays on Evolution and Optimality*, 277–306.
- Dar-Nimrod, I., & Heine, S. J. (2011). Genetic Essentialism: On the Deceptive Determinism of DNA. *Psychological Bulletin*, *137*(5), 800–818. <https://doi.org/10.1037/a0021860>
- Dennett, D. (1987). *The Intentional Stance*. MIT Press.
- Gelman, S. A., & Wellman, H. M. (1991). Insides and essences: Early understandings of the non-obvious. *Cognition*, *38*(3), 213–244. [https://doi.org/10.1016/0010-0277\(91\)90007-Q](https://doi.org/10.1016/0010-0277(91)90007-Q)
- Gernsbacher, M. A., & Yergeau, M. (2019). Empirical Failures of the Claim That Autistic People Lack a Theory of Mind. *Archives of Scientific Psychology*, *7*(1), 102–118. <https://doi.org/10.1037/arc0000067>
- Greenberg, D. M., Warriar, V., Abu-Akel, A., Allison, C., Gajos, K. Z., Reinecke, K., Rentfrow, P. J., Radecki, M. A., & Baron-Cohen, S. (2023). Sex and age differences in “theory of mind” across 57 countries using the English version of the “Reading the Mind in the Eyes” Test. *Proceedings of the National Academy of Sciences*, *120*(1), e2022385119. <https://doi.org/10.1073/pnas.2022385119>
- Griffiths, P., & Linquist, S. (2022). The Distinction Between Innate and Acquired Characteristics. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Spring 2022). Metaphysics Research Lab, Stanford University. <https://plato.stanford.edu/archives/spr2022/entries/innate-acquired/>
- Harden, K. P. (2022). Genetic determinism, essentialism and reductionism: Semantic clarity for contested science. *Nature Reviews Genetics*, 1–8. <https://doi.org/10.1038/s41576-022-00537-x>
- Ho, M. K., Saxe, R., & Cushman, F. (2022). Planning with Theory of Mind. *Trends in Cognitive Sciences*, *26*(11), 959–971. <https://doi.org/10.1016/j.tics.2022.08.003>
- Jara-Ettinger, J., Floyd, S., Tenenbaum, J. B., & Schulz, L. E. (2017). Children understand that agents maximize expected utilities. *Journal of Experimental Psychology. General*, *146*(11), 1574–1585. <https://doi.org/10.1037/xge0000345>
- Jara-Ettinger, J., Gweon, H., Tenenbaum, J. B., & Schulz, L. E. (2015). Children’s understanding of the costs and rewards underlying rational action. *Cognition*, *140*, 14–23. <https://doi.org/10.1016/j.cognition.2015.03.006>

- Jara-Ettinger, J., Schulz, L. E., & Tenenbaum, J. B. (2020). The Naïve Utility Calculus as a unified, quantitative framework for action understanding. *Cognitive Psychology*, *123*, 101334. <https://doi.org/10.1016/j.cogpsych.2020.101334>
- Linguist, S., Machery, E., Griffiths, P. E., & Stotz, K. (2011). Exploring the folkbiological conception of human nature. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1563), 444–453. <https://doi.org/10.1098/rstb.2010.0224>
- Machery, E., Griffiths, P., Linguist, Stefan, & Stotz, K. (2019). Scientists' Concepts of Innateness: Evolution or Attraction? In D. A. Wilkenfeld & R. Samuels (Eds.), *Advances in Experimental Philosophy of Science* (1st ed., pp. 172–201). Bloomsbury Academic; Bloomsbury Collections. <http://www.bloomsburycollections.com/book/advances-in-experimental-philosophy-of-science/ch8-scientists-concepts-of-innateness-evolution-or-attraction/>
- Mameli, M., & Bateson, P. (2006). Innateness and the Sciences. *Biology and Philosophy*, *21*(2), 155–188. <https://doi.org/10.1007/s10539-005-5144-0>
- Mameli, M., & Bateson, P. (2011). An evaluation of the concept of innateness. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1563), 436–443. <https://doi.org/10.1098/rstb.2010.0174>
- Medin, D. L., & Atran, S. (2004). The native mind: Biological categorization and reasoning in development and across cultures. *Psychological Review*, *111*(4), 960–983. <https://doi.org/10.1037/0033-295X.111.4.960>
- Moran, J. M., Young, L. L., Saxe, R., Lee, S. M., O'Young, D., Mavros, P. L., & Gabrieli, J. D. (2011). Impaired theory of mind for moral judgment in high-functioning autism. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(7), 2688–2692. <https://doi.org/10.1073/pnas.1011734108>
- Nettle, D. (2010). Understanding of Evolution May Be Improved by Thinking about People. *Evolutionary Psychology*, *8*(2), 147470491000800200. <https://doi.org/10.1177/147470491000800206>
- Nettle, D., Frankenhuys, W., & Panchanathan, K. (2022). *Biology, society or choice? Non-expert understandings of explanations of behaviour*. <https://doi.org/10.31234/osf.io/2z5h9>
- Nettle, D., & Scott-Phillips, T. (2021). *Is a non-evolutionary psychology possible?* PsyArXiv. <https://doi.org/10.31234/osf.io/wky9h>
- Peer, E., Rothschild, D., Gordon, A., Evernden, Z., & Damer, E. (2022). Data quality of platforms and panels for online behavioral research. *Behavior Research Methods*, *54*(4), 1643–1662. <https://doi.org/10.3758/s13428-021-01694-3>
- Radkani, S., Holton, E., de Courson, B., Saxe, R., & Nettle, D. (2022). *Desperation and inequality increase crime: Evidence from experimental micro-societies*. <https://psyarxiv.com/aqyj9/>
- Sagarin, B. J., Ambler, J. K., & Lee, E. M. (2014). An Ethical Approach to Peeking at Data. *Perspectives on Psychological Science*, *9*(3), 293–304. <https://doi.org/10.1177/1745691614528214>
- Saxe, R., Tzelnic, T., & Carey, S. (2006). Five-month-old infants know humans are solid, like inanimate objects. *Cognition*, *101*(1), B1-8. <https://doi.org/10.1016/j.cognition.2005.10.005>
- Senju, A., Southgate, V., White, S., & Frith, U. (2009). Mindblind eyes: An absence of spontaneous theory of mind in Asperger syndrome. *Science (New York, N.Y.)*, *325*(5942), 883–885. <https://doi.org/10.1126/science.1176170>
- Shtulman, A. (2006). Qualitative differences between naïve and scientific theories of evolution. *Cognitive Psychology*, *52*, 170–194. <https://doi.org/10.1016/j.cogpsych.2005.10.001>
- Shtulman, A. (2015). How Lay Cognition Constrains Scientific Cognition. *Philosophy Compass*, *10*(11), 785–798. <https://doi.org/10.1111/phc3.12260>
- Shtulman, A., & Lombrozo, T. (2016). Bundles of Contradiction: A Coexistence View of Conceptual Change. In D. Barner & A. S. Baron (Eds.), *Core Knowledge and Conceptual Change* (p. 0). Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780190467630.003.0004>
- Sousa, P., Atran, S., & Medin, D. (2002). Essentialism and Folkbiology: Evidence from Brazil. *Journal of Cognition and Culture*, *2*(3), 195–223. <https://doi.org/10.1163/15685370260225099>
- Spelke, E. S., & Kinzler, K. D. (2007). Core knowledge. *Developmental Science*, *10*, 89–96.

- Tingley, D., Yamamoto, T., Hirose, K., Keele, L., & Imai, K. (2014). mediation: R Package for Causal Mediation Analysis. *Journal of Statistical Software*, 59, 1–38.
<https://doi.org/10.18637/jss.v059.i05>
- Tooby, J., & Cosmides, L. (1989). Evolutionary psychology and the generation of culture, part I. Theoretical considerations. *Ethology and Sociobiology*, 10(1–3), 29–49.
[https://doi.org/10.1016/0162-3095\(89\)90012-5](https://doi.org/10.1016/0162-3095(89)90012-5)
- Wang, J. (Jenny), & Feigenson, L. (2019). Is Empiricism Innate? Preference for Nurture Over Nature in People’s Beliefs About the Origins of Human Knowledge. *Open Mind*, 3, 89–100.
https://doi.org/10.1162/opmi_a_00028
- Weisman, K., Legare, C. H., Smith, R. E., Dzokoto, V. A., Aulino, F., Ng, E., Dulin, J. C., Ross-Zehnder, N., Brahinsky, J. D., & Luhrmann, T. M. (2021). Similarities and differences in concepts of mental life among adults and children in five cultures. *Nature Human Behaviour*, 5(10), Article 10. <https://doi.org/10.1038/s41562-021-01184-8>
- Wellman, H. M., & Gelman, S. A. (1992). Cognitive development: Foundational theories of core domains. *Annual Review of Psychology*, 43, 337–375.
<https://doi.org/10.1146/annurev.ps.43.020192.002005>

Supporting information for 'Innateness is for animals'

1. Pilot studies prior to study 1

Two pilot studies were carried out prior the study 1 reported in the paper. The first (pilot study 1, <https://osf.io/f35wm/>; results summarized in the protocol of pilot study 2 at <https://osf.io/p8k2s/>) found evidence that 211 UK adult volunteers from Prolific were more likely to classify the behaviour of a bear-like alien species as innate, in the genes and biological than that of a human-like alien. However, we were concerned that even in the human condition, the creature was not actually human, and was presented in terms of a species and its characteristics, already cueing intuitive biology fairly strongly. Null results for properties like fixity and typicality suggest that the manipulation of intuitive biology/psychology may not have been strong enough.

The second pilot study (<https://osf.io/p8k2s/>; N = 200) instead compared inferences about an unknown person (human condition) and an unknown animal (animal condition), using either a positively valenced behaviour (caregiving) or a negatively valenced behaviour (aggression). The animal condition produced more judgements of innateness, the behaviour being in the genes, and the behaviour being biological. Moreover, the judgement that the behaviour was innate predicted judging it to be fixed and typical. However, direct effects of condition (animal/human) on judgements of fixity and typicality were absent or unclear. An item on subjective utility (did the focal being want to do it?) produced an effect in the predicted direction (higher judgement that the creature wanted to do it in the human condition), but the effect size was small.

There were several issues with the second pilot study. For humans, there were large differences in innateness judgement between the negative (aggression) and the positive (caregiving) behaviour. This may reflect a desire to attribute morally good characteristics of people to the true self and morally bad ones to the surface self (Newman et al., 2015). The interaction effects this produced (there was no valence effect for animals) may obscure main effects of the animal/human manipulation. The wording of the fixity item (that the focal individual will do the presently observed behaviour on other days too) was rather different from fixity as studied in previous work on the folk concept of innateness, which was closer to 'reliably developing across all developmental environments' (Linguist et al., 2011; Machery et al., 2019). Plus, the typicality item did not use the word 'typical'. Moreover, the effect size for the subjective utility item was small, and indeed the subjective utility item was close to ceiling – respondents stated under most circumstances that individuals of whichever species do things because they want to.

The study 1 presented in the paper thus aimed to repeat the human/animal manipulation of the second pilot, but with clearer vignettes and better items for typicality, fixity and subjective utility. We replaced the strongly morally valenced behaviours, aggression and care, with abilities and tendencies that have less moral import, such as being good at finding wild fruits. We changed some response items. We rephrase the fixity and typicality items closer to the sense of these terms in previous literature (Knobe & Samuels, 2013; Linguist et al., 2011; Machery et al., 2019), and came up with vignette-appropriate renderings of subjective utility.

2. List of capacities used in study 3

No.	Capacity	Berent et al. (2019) classification
1	Breathing heavily after exertion	Non-cognitive
2	Walking to move around	Non-cognitive
3	Yawning when tired	Non-cognitive
4	Smelling the scent of food	Non-cognitive
5	Seeing objects with their eyes	Non-cognitive
6	Feeling fear at danger	Non-cognitive
7	Running when in a hurry	Non-cognitive
8	Stretching out their muscles	Non-cognitive
9	Licking with their tongues	Non-cognitive
10	Sleeping to restore energy	Non-cognitive
11	Feeling disgust at feces	Non-cognitive
12	Being surprised at an unexpected event	Non-cognitive
13	Feeling contentment	Non-cognitive
14	Feeling affection towards others	Non-cognitive
15	Dancing to a rhythm	Non-cognitive
16	Recalling past events	Cognitive
17	Judging their options	Cognitive
18	Distinguishing between right and wrong	Cognitive
19	Reflecting on their past and future	Cognitive
20	Having self control	Cognitive
21	Speculating about the causes of events	Cognitive
22	Recognizing relations among kin	Cognitive
23	Forming sentences	Cognitive
24	Abstract reasoning	Cognitive
25	Using metaphors	Cognitive
26	Forming myths	Cognitive
27	Having norms about trade	Cognitive
28	Having classification of plants	Cognitive
29	Having preferences concerning aesthetics	Cognitive
30	Having beliefs about fortune and misfortune	Cognitive

3. List of capacities used in study 5

Capacity	Mean thinking rating, study 3	Classification
Seeing objects with their eyes	18.23	Non-epistemic
Walking to move around	19.70	Non-epistemic
Sleeping to restore energy	17.75	Non-epistemic
Being surprised at an unexpected event	27.75	Non-epistemic
Yawning when tired	10.18	Non-epistemic
Recalling past events	77.85	Epistemic
Judging their options	84.18	Epistemic
Reflecting on their past and future	84.23	Epistemic
Distinguishing between right and wrong	69.70	Epistemic
Abstract reasoning	81.95	Epistemic

References

- Berent, I., Platt, M., & Sandoboe, G. M. (2019). People's Intuitions About Innateness. *Open Mind*, 3, 101–114. https://doi.org/10.1162/opmi_a_00029
- Knobe, J., & Samuels, R. (2013). Thinking like a scientist: Innateness as a case study. *Cognition*, 126(1), 72–86. <https://doi.org/10.1016/j.cognition.2012.09.003>
- Linguist, S., Machery, E., Griffiths, P. E., & Stotz, K. (2011). Exploring the folkbiological conception of human nature. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1563), 444–453. <https://doi.org/10.1098/rstb.2010.0224>
- Machery, E., Griffiths, P., Linguist, Stefan, & Stotz, K. (2019). Scientists' Concepts of Innateness: Evolution or Attraction? In D. A. Wilkenfeld & R. Samuels (Eds.), *Advances in Experimental Philosophy of Science* (1st ed., pp. 172–201). Bloomsbury Academic; Bloomsbury Collections. <http://www.bloomsburycollections.com/book/advances-in-experimental-philosophy-of-science/ch8-scientists-concepts-of-innateness-evolution-or-attraction/>
- Newman, G. E., De Freitas, J., & Knobe, J. (2015). Beliefs About the True Self Explain Asymmetries Based on Moral Judgment. *Cognitive Science*, 39(1), 96–125. <https://doi.org/10.1111/cogs.12134>