What do people know about the heritability of sleep?

Running title: Heritability of sleep

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Informed consent: Participants read information about the study, including their rights as participants, and provided informed consent.

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Abstract:

Study Objectives: Twin studies have provided data about the relative weight of genetic and environmental factors on sleep variables over the last few decades. However, heritability is a non-intuitive concept and it is often misunderstood even amongst the scientific community. This study aimed to analyze: 1) understanding of the meaning of heritability of insomnia; 2) the accuracy of estimations of heritability in the general population regarding three sleep traits (sleep duration, sleep quality and insomnia); 3) perceptions of the effectiveness of different treatments for insomnia depending on how the disorder is presented (i.e. having an environmental or genetic etiology) and whether the subject's estimate of genetic influence on sleep traits impacted beliefs about the effectiveness of different treatments.

Methods: Participants (N=3658) completed a survey which included: questions about general genetic knowledge; a specific question about the meaning of heritability; estimates of heritability of three different sleep traits; and the effectiveness of different treatments for insomnia depending on how the etiology of this condition was presented.

Results: Less than 25% of the participants selected the correct description of the heritability of insomnia. Almost half of the sample incorrectly believed that heritability refers to the chance of passing a disorder onto their children. We also found that participants provided different estimates for the effectiveness of different treatments depending on the presumed etiology of the disorder.

Conclusion: Most people do not have accurate knowledge about the concept of heritability. People's assumptions about the etiology of a disorder may influence which treatments they consider most effective.

Keywords: Genetic knowledge, insomnia, heritability, sleep

1. INTRODUCTION

Over the past few decades twin studies have provided useful information about the relative weight of genetic factors for almost every trait/behaviour (Polderman et al. 2015). In line with this, there are a plethora of papers focusing on the genetics of sleep phenotypes (Barclay and Gregory 2013). This information is sometimes shared with the general public via press releases, news articles and popular science books. However, behavioural genetic research is technical and reports use specific terminology, which could make results difficult for the public to interpret. Incorrect interpretations can have real life consequences for people. For example, beliefs about the genetic vs environmental etiology of a disorder may be related to beliefs about how that disorder should be treated (Lebowitz 2019).

The main goal of twin studies is to disentangle the role of genetic and environmental factors influencing individual differences in a trait or behaviour (known as a phenotype) (Knopik et al. 2017). One key estimate that results from this research is *'heritability'*. This estimate expresses the proportion of phenotypic variance in a trait that is due to genetic factors. This is a population statistic, which means that it is specific to the population being assessed at a specific time (Knopik et al. 2017; Visscher et al. 2008). Despite this concept being key in the field of behavioural genetics, it is often misunderstood by non-behavioural genetic experts.

In a review, Visscher et al (2008) addressed the conceptions and misconceptions of heritability. For example, heritability is often misunderstood as the likelihood of a phenotype being passed to the next generation. Therefore, if someone is suffering from insomnia and knows that the heritability of insomnia is high, they may think that their children will unfailingly suffer from insomnia as well, regardless of environmental

influences. In relation to this point, a high heritability is often misunderstood as genetic determinism. These misconceptions are concerning and could potentially influence perceptions of treatment. Indeed, if patients think that a disorder is purely genetic in origin, they may think that treatments are not able to change that condition. This is not correct, as environmental interventions can be useful when considering genetic illnesses. Even in the case of monogenic disorders, with a known and measurable risk of a parent passing this disorder to their children, environmental interventions can prevent the development of symptoms. One such monogenic disorder, Phenylketonuria (PKU), leads to intellectual disability and behaviour problems if untreated. However, these symptoms can be fully prevented by an environmental intervention (a diet low in foods that contain phenylalanine) (Kelly et al. 2016).

Previous studies, from our research group, have found that genetic knowledge in the general population is low (Chapman et al. 2019). To the best of our knowledge, there are no studies that have tested the understanding of heritability specifically in relation to sleep in the general population. Therefore, this study aimed to analyze: 1) understanding of the meaning of heritability of insomnia; 2) the accuracy of estimations of heritability in the general population regarding three sleep traits (sleep duration, sleep quality and insomnia); 3) perceptions of the effectiveness of different treatments for insomnia depending on how the disorder is presented (i.e. having an environmental or genetic etiology) and whether the subject's estimate of genetic influence on sleep traits impacted beliefs about the effectiveness of different treatments.

2. METHOD

2.1.Participants and Materials

The International Genetic Literacy and Attitudes Survey – iGLAS (Chapman et al. 2019; Chapman et al. 2017) was used for data collection. iGLAS is an on-line instrument that consists of questions about genetic knowledge and opinions as well as several vignettes and demographic items. iGLAS has received approval from the ethics departments at both Goldsmiths, University of London and the Ethics Committee for Interdisciplinary Research of Tomsk State University, Russia. Data presented for the analyses reported here were collected between 16th May 2018 and 2nd April 2019, at which time iGLAS was available in Albanian, English, French, Italian, Romanian, Russian and Spanish. Participants were required to be at least 18 years of age; no other restrictions were applied. iGLAS was available for completion on The Accessible Genetics Consortium website (tagc.world). The survey was promoted using several channels of distribution such as internet forums, University webpages, Twitter accounts and Facebook groups in order to obtain a maximum number of participants. In addition, the authors of the current study conducted targeted collections, including the recruitment of students at several institutions (e.g. emails were sent out via distribution lists from Universities in Nigeria, Spain and the United Kingdom). This report included data from 3658 participants. An additional question about heritability and sleep was added on 19-June-2018, so data for this item were only available for a subsample of these participants (n = 1606). For the entire sample, the mean age was 27.6 (SD=11.9; Range: 18-80). The sample was 60.9% female (N = 2226); 38.2% male (N = 1396); 0.5% were non-binary (N = 17); and 0.5% preferred not to say (N = 19). Participants were mainly from Nigeria (29.1%), Russian Federation (25.8%), USA (8.5%), Spain (7.7%), Italy (7%), United Kingdom (6.6%) and from other countries (15.3%).

Participants read information about the study, including their rights as participants, and provided informed consent. The iGLAS items analyzed in this study

are: sex, age, country of secondary education; country of current residency; and 19 genetic knowledge questions (with a 20th item specifically related to knowledge of heritability added to latter versions of data collection; see item 6, Table 1 [added on 19-June-2018]). For the purposes of this study, iGLAS was supplemented with additional items focusing on sleep variables. See Table 1 for full item descriptions.

Participants were also asked to estimate the heritability of the following sleep traits: sleep quality; sleep length; and insomnia (Items 1, 2, 3 in Table 1). For these items, the term 'heritability' was not used as it was thought to be too technical. Instead, participants were asked: *"On a scale of 0-100 how important are genetic differences between people in explaining individual differences in the following traits"*. To assess the accuracy of a response, we drew upon recent data. Although heritability estimates vary depending on the specific population under investigation, a recent meta-analysis of twin studies focusing on sleep quality and sleep length showed that the mean heritabilities are 31% for sleep quality and 38% and for sleep duration respectively (Madrid-Valero et al. 2020). Regarding insomnia, genetic influences typically explain around 20-50% of the variance (Hublin et al. 2011; Barclay et al. 2015; Drake et al. 2011; Gregory et al. 2016).

The question concerning the heritability of insomnia (Item 6, Table 1) asked: *"If a report states 'the heritability of insomnia is approximately 30%' what would that mean?"* with four response options to choose from: *A= If someone has insomnia this is approximately 30% due to their genes; B=Approximately 30% of people will experience insomnia at some point in their lives; C=Genetic influences account for approximately 30% of the differences between people in insomnia; D=There is an approximately 30% chance that someone will pass insomnia onto their children*. [C is the correct answer].

This item was presented after participants had been asked to estimate the heritability of the 3 sleep traits and so could not have influenced their answers to these items. In two other items (Items 4 and 5, Table 1), participants were asked to estimate how effective they considered four different treatments for insomnia to be (i.e. medication, talking therapies, gene therapy and a change in lifestyle) with five categories (i.e. 1- not effective at all; 2-slightly effective; 3- moderately effective; 4-very effective; 5-extremely effective). The two items differed just in terms of the background information presented: 1) genetic etiology —where participants were informed "Peter is suffering from insomnia. He thinks it is probably because of his genes" and 2) environmental etiology — where participants were informed "Robert is suffering from insomnia. He thinks it is probably because his job is so stressful, and he has a lot else going on in his life". Each participant was given both items and the presentation order of each scenario was randomized.

2.2.Data treatment

Participants who attempted less than 70% of the iGLAS items were considered to be disengaged from the collection and so their data were excluded from analyses. Data from participants who did not attempt at least 75% of the genetic knowledge items were also removed as it was felt that their summed genetic knowledge scores would not be reliable. All the analyses were performed using SPSS and R.

3. RESULTS

3.1.What do people understand when scientific literature states that 'the heritability of insomnia is approximately 30%'?

Table 2 presents the percentage of each response option for the heritability question (*"If a report states 'the heritability of insomnia is approximately 30%' what*

would that mean?"). The correct option is C ("Genetic influences account for approximately 30% of the differences between people in insomnia"). For the total sample, only 24% endorsed the correct option. The most widely endorsed answer (47.2% of the sample) was D ("There is an approximately 30% chance that someone will pass insomnia onto their children"). We re-ran the analyses, splitting the sample into tertiles based on the genetic knowledge score (the sum of 19 genetic knowledge items), forming 3 approximately equally sized groups: poor, medium and high genetic knowledge. Table 2 shows that 18.1, 20.7 and 33.3% chose the correct response option in the poor, medium and high genetic knowledge groups respectively. Option D was the most endorsed response, even for people with a good genetic knowledge (44.3%).

Regarding demographic variables we found differences for sex and country of residency. Women selected the correct answer [option C] slightly more often (n=259; 25.8%) than men (n=97; 19.3%). This difference was statistically significant ($\chi^2(3)=9.19.$; p=0.027). There were also statistically significant differences in the proportion of correct responses provided by countries ($\chi^2(3)=12.59$; p=0.006). The correct answer was selected in 38.3%, 24.5%, 23.1% and 13% of the cases when the sample was divided into participants from North America (n=60), Europe (n=664), Africa (n=717) and South America (n=89) [please note that this question was not asked to the majority of Russian participants, who had taken part before this item was included in the testing battery].We further compared, by means of a Chi square test of independence, the accuracy of response to the heritability question for participants with no genetic training (n = 1062, 66%) and those who reported some training (n = 544, 34%). There were no significant differences ($\chi^2(1)=3.54$; p= .060) in the selection of the correct answer between people who studied genetics as part of their university degree (N = 544, 26.8% provided the correct response) and people who did not (N = 1062,

22.6% provided the correct response). Similarly, no difference ($\chi^2(1)=.781;p= .377$) was found between participants who have worked in genetics (N =78, 28.2% provide the correct response) and those who have not (N = 1528, 23.8% provided the correct response).

3.2. How precise are estimates of the heritability of sleep traits?

Similar values were found for the heritability estimates for the three sleep traits. The mean values were 40.1% for sleep quality (SD= 24.1), 40.3% for insomnia (SD= 24.9) and 40.9% for sleep length (SD= 24.8). Figure 1 presents the histograms for the distribution of these estimates. The means are approximately 40% for each of the three traits, which is remarkably close to the best empirical estimates of the phenotypes (Madrid-Valero et al. 2020; Hublin et al. 2011; Drake et al. 2011). Nonetheless, there was a wide variation of responses to each item. Indeed, only around one third of the participants (33.5% for sleep quality; 31.6% for insomnia; and 30.8% for sleep duration) estimated the heritability within 30-50% - the range that captures heritability estimates from most of the previous scientific studies and a recent meta-analysis (Madrid-Valero et al. 2020; Hublin et al. 2011; Barclay et al. 2015; Drake et al. 2011; Gregory et al. 2016). Furthermore, a substantial proportion of the sample selected "extreme" heritability estimates, defined as estimates between 0 to 15% or 85 to 100% (22% for sleep quality, 23.9% for insomnia and 23.5% for sleep duration). Nonetheless, overall, the 'wisdom of the crowd' shone through, where the collective voice of our sample provided accurate estimates, which should not be ignored.

3.3. Does perception of the effectiveness of a treatment depend on how the etiology of the disorder is presented?

Figure 2 presents information about how effective people think four different treatments are (i.e. medication, talking therapies, gene therapy, lifestyle change) for insomnia, with the etiology presented as either environmental or genetic. Regarding the different treatments, 40.8% of the sample selected *medication* as very or extremely effective when the disorder was presented as environmental in origin, and 44.9% - when the etiology was presented as genetic. Larger differences were found for the other three treatment types. For *talking therapies*, 51.0% of the sample selected this treatment as very or extremely effective when the etiology was presented as environmental, while only 37.0% when the etiology was presented as genetic. Similarly, *change in lifestyle* was viewed as effective by more participants in the environmental etiology condition (70.8%) than in the genetic etiology condition (53.1%). In contrast, *gene therapy* was considered effective by fewer participants in the environmental etiology condition (23.5%) than in the genetic etiology condition (42.7%). T tests for paired samples were used to check if these differences are statistically significant. Our result showed that all the differences were significant: medication effectiveness ($\bar{x}_{\text{genetic etiology}}$=3.28; $\bar{x}_{\text{environmental etiology}}$=3.18; t[1475]=3.987; p<0.001); talking therapies effectiveness ($\bar{x}_{\text{genetic etiology}}$=3.10; $\bar{x}_{\text{environmental etiology}}$=3.41; t[1284]=10.806; p<0.001); change in lifestyle effectiveness ($\bar{x}_{\text{genetic etiology}}$=3.48; $\bar{x}_{\text{environmental etiology}}$=3.88; t[1256]=13.926; p<0.001) and gene therapy effectiveness ($\bar{x}_{\text{genetic etiology}}$=3.07; $\bar{x}_{\text{environmental etiology}}$=2.46; t[1238]=17.935; p<0.001).

Further, the sample was divided into participants who believe that insomnia is strongly influenced by genetic factors (i.e. they estimated the heritability of insomnia between 85% and 100%) and participants who believe that insomnia is weakly influenced by genetic factors (i.e. they estimated the heritability of insomnia between 0% and 15%). Interestingly we did not find differences for “medication” or “Talking

therapies" effectiveness between the high and the low h^2 estimate groups in the "genetic" nor in the "environmental" scenario. However, T-tests yielded statistical differences for the other two proposed treatments (i.e. "change in life style" and "gene therapy" (Table 3)).

4. DISCUSSION

Heritability is a key concept in behavioural genetics and is a term used regularly in both common and scientific speech (Visscher et al. 2008). Our first aim was to check what people understand when a scientific publication or press release states that a trait (i.e. insomnia) has a specific heritability value (i.e. 30%). Our results reveal that most of the population that we sampled misunderstood what heritability means; with most participants thinking that heritability is the probability of passing a trait onto their children. These results are perhaps unsurprising since heritability is often misunderstood as "the quality of being heritable" (Visscher et al. 2008). More surprising is the finding that this misunderstanding is common even amongst those with otherwise good genetic knowledge. Although, those with the greatest score on genetic knowledge endorsed the correct option to a greater extent than people with a medium or poor score on genetic knowledge, these knowledgeable participants still most frequently endorsed the option that someone will pass insomnia onto their children rather than the other options. Our results therefore suggest that even people with otherwise good genetic knowledge struggled to identify the correct definition of heritability. Those that identified themselves as studying or working in the field of genetics were no more accurate than others at answering this item. This may indicate that concepts common to behavioral geneticists (heritability in this case) are not well understood either by the public or those engaged with certain aspects of genetics research. Indeed, genetics is a broad area and there are multiple specialities within this field. Whereas twin researchers are familiar

with the concept of heritability, those focusing on molecular genetics may be less so. We also found differences regarding sex and country of origin. A previous publication from this research group reported sex differences, where men showed higher scores for genetic knowledge (Chapman et al. 2019). However, with regard to the concept of heritability, we report here that women endorsed the right answer more often than men. Differences among participants from varying countries were also reported in this sample. People from North America selected the correct answer most often and people from South America selected the correct answer least often. However, care must be taken in interpreting these data as the participants were not necessarily representative of the wider population. Overall, it seems that a wide range of people misunderstand results from scientific articles and press releases focusing on genetic findings.

We also asked participants to estimate the heritability of three different traits related to sleep (i.e. insomnia, sleep length and sleep quality). At a first glance, the mean estimations for the heritability of these three traits match the values from previous research and meta-analyses (Barclay et al. 2015; Madrid-Valero et al. 2019), and therefore give an impression of accurate knowledge Our results are similar to some extent to those from a previous publication where mean lay estimates for different traits were close to the published heritability estimates (Willoughby et al. 2019). However, further analyses demonstrated considerable variability in the responses, with only around one third of the sample estimating the heritability of these traits in the ranges established by previous research. Of note, the results demonstrate that a substantial proportion of the population believe these phenotypes are not heritable at all (e.g. 19.2% for insomnia). To a lesser extent, there are also some who believe them to be 100% heritable (e.g. 4.7% for insomnia). Therefore, while there was heterogeneity in

heritability estimates most of the sample was inaccurate in estimating the relative influence of genetic factors on sleep traits.

These results can be considered alongside beliefs about the meaning of heritability. For example, some participants may believe that if someone has insomnia their offspring will suffer from insomnia almost unavoidably. On the other hand, if someone suffers from insomnia and they believe this is due to their stressful environment, they might think that their offspring will not suffer from insomnia. In summary, these results seem to point to considerable misunderstanding about the relative influences of genes and environments on sleep phenotypes.

This study also explored differences in the perception of the effectiveness of treatments depending on how the origin of insomnia is presented (i.e. genetic or environmental). Note that the aim of this part of the study was not to investigate how accurate the participants' estimates were for the effectiveness of each treatment. Instead, we are interested in how these estimates could change across different conditions. The most and the least valuated treatments were "lifestyle change" and "gene therapy" respectively, regardless of the context (i.e., the presented scenario). There were however differences in the perceived effectiveness of treatments depending on how the condition was presented. For example, as might be expected, "talking therapies" were perceived as being more effective in the environmental scenario while "gene therapy" was considered more valuable in the genetic context. "Medication", however, was perceived to have similar credibility in both scenarios, even though the large sample size revealed a significant difference (albeit of small magnitude). To investigate this further, subsamples of participants who believe that insomnia is strongly or weekly genetically influenced were extracted. We found that for those estimating high heritability, changing lifestyle was considered the worst alternative in the genetic scenario and the

best one in the environmental scenario. Conversely, for those estimating low heritability for insomnia, lifestyle change was the best option regardless of the scenario. Finally, "medication" and "talking therapies" did not show differences among heritability estimates groups. This may indicate that beliefs about the origin of a disorder could have a significant impact on the perception of the effectiveness of treatments. As a knock-on consequence, this could mean that the effectiveness and adherence to treatments might be influenced by patients' beliefs and preferences about these treatments (Morin et al. 2002; Vincent and Lionberg 2001). For example, if a disorder such as insomnia is perceived as "genetic in origin", because the patient has family members affected as well, then the disorder could be viewed as unavoidable and these attitudes might undermine the effectiveness of certain treatments (Lebowitz 2019). For example, Cognitive Behavioral Therapy for Insomnia (CBT-I) is the first line treatment of choice for chronic insomnia (Morin et al. 2015; Qaseem et al. 2016) and beliefs and attitudes play a key role for the effectiveness of this treatment. Indeed, CBT-I can also have an impact on beliefs and attitudes which are related to better maintenance of sleep improvements after the treatment (Morin et al. 2002). This issue is not limited to sleep traits nor restricted to patients' beliefs, but extends to many other relevant traits and to the beliefs of clinicians and practitioners. Indeed, previous research has demonstrated that biological explanations of mental disorders could exacerbate stigma and reduce clinicians' empathy, which is fundamental for the therapeutic alliance (Lebowitz and Ahn 2014).

Our results point to a differential perception of the effectiveness of the treatments based on the described etiology. For example, when a disorder is perceived as genetic in origin, those who believe that there is a high genetic influence on insomnia, tend to see treatment alternatives such as changing lifestyle or talking

therapies as less effective and gene therapy is considered the best treatment. Moreover, when the disorder is perceived as environmental in origin all participants, regardless of their heritability estimate classify changing lifestyle as the best option. However, those who estimate a high genetic influence, consider it significantly less efficacious than those estimating a low genetic influence. It is also important to note that effectiveness estimates for "medication" did not change substantially across scenarios or as a function of beliefs about the origin of insomnia. These findings must be interpreted with caution. Our results support a differential perception of the effectiveness of each treatment depending on how the etiology of the condition is presented as well as beliefs about genetic influences on a trait. However, this does not necessarily mean that participants' responses are accurate or inaccurate. Indeed, when participants selected "change in lifestyle" as effective in the environmental scenario this might make sense (if your job is giving you sleepless nights, changing it might cause them to cease). Nevertheless, the purpose of our "experimental manipulation" was to check if the subjective assessment and beliefs about the etiology of the trait had a significant impact on the perception of the effectiveness of different treatment options.

Altogether our results strongly suggest that perception of the effectiveness of a treatment could be influenced by previous conceptions of the etiology of a disorder and contextual information about it. This could potentially interfere with people's selection and perception of the credibility of treatment alternatives, intervention involvement and adherence, and, finally, treatment outcomes and success. Further research should investigate these important issues, consider intervening variables and conceivable courses of action to address it.

Strengths and limitations

This study has several strengths such as a large sample from different countries. Participants were able to complete collection in 7 languages. A large number of genetic questions were used which allowed the assessment of variance in genetic knowledge among participants. This is important because genetics is a complex field and previous research showed that people may have good knowledge in some areas but not in others (Selita, Smereczynska, Chapman, Toivainen, & Kovas, 2020). This study also has limitations. For example, the participants may not be representative of the general population. Indeed, most (68.2%) participants in this study were University students. Moreover, the survey was disseminated online meaning that it could only be completed by those with internet access. Given these factors, it is possible that the participants included in this study had greater genetic literacy and understanding than the wider public. Regarding the effectiveness of the treatments, our results could be biased by preexisting knowledge and previous experiences (e.g. it is likely that most of the participants did not have first-hand experience of gene therapy and did not appear to understand what it is). Finally, although several countries are represented in the dataset, the number of participants in some of them was small.

Conclusions

This study is the first to have investigated sleep-related genetic knowledge. Our main findings are: 1) most participants misunderstand the meaning of heritability; 2) estimates regarding the heritability of sleep quality, sleep length and insomnia are on average, remarkably accurate – but responses were diverse; and only about one third of participants estimate heritability in the correct range; 3) the perception of the origin of insomnia is associated with perceptions of the effectiveness of different treatments. These findings highlight the challenge of presenting knowledge stemming from genetic

research in ways that have potential to empower rather than confuse and benefit rather than harm.

In summary, genetic knowledge among the population appears to be poor, especially with regard to the concept of heritability, and this may have implications for how individuals subjectively evaluate family risks and assess the effectiveness of treatment options. As such, researchers need to think carefully about how they discuss and disseminate behavioral genetics research findings. Steps should be taken to work collaboratively with journalists when results are presented to the general public – and to correct misunderstandings where they occur. Furthermore, initiatives are needed to improve general levels of genetic knowledge amongst the public and to promote specific training in behavior genetics within basic science education courses, at least for key disciplines with human behavior at their core.

Compliance with ethical standards

Disclosure statement:

Declarations: AMG is an advisor for a project sponsored by Johnson's Baby. She has written two books, Nodding Off (Bloomsbury, 2018); The Sleepy Pebble (Flying Eye Books, 2019). She is a regular contributor to BBC Focus magazine and has contributed to other outlets (such as The Conversation, The Guardian and Balance Magazine). She occasionally receives sample products related to sleep (e.g. blue light blocking glasses) and has given a paid talk to a business.

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Figure Legend

Figure 1: Heritability estimates for sleep quality, sleep length and insomnia
Figure 2: Perception of the effectiveness for each treatment

Figure 2 bottom legend: Items were: 1) Robert is suffering from insomnia. He thinks it is probably because his job is so stressful and he has a lot else going on in his life. Robert is keen to seek help for his disturbed sleep. Estimate how effective you think the following treatments might be (from not at all effective, to very effective) (Medication, Talking therapies, Gene therapy and Life style change).
2) Peter is suffering from insomnia. He thinks it is probably because of his genes – after all multiple family members suffer terribly with sleep too. Peter is keen to seek help for his disturbed sleep. Estimate how effective you think the following treatments might be (from not at all effective, to very effective) (Medication, Talking therapies, Gene therapy and Life style change).

Table 1. Items added to iGLAS for the present study

	Description	N
1.	Heritability of Sleep Quality	**3420**
2.	Heritability of Insomnia	**3229**
3.	Heritability of Sleep Length	**3228**
4.	Robert is suffering from insomnia. He thinks it is probably because his job is so stressful and he has a lot else going on in his life. Robert is keen to seek help for his disturbed sleep. Estimate how effective you think the following treatments might be [from (1) not at all effective, to (5) very effective]	**1544**
•	Pharmacological	*1510*
•	Talking therapies	*1351*
•	Therapy	*1294*
•	Change in lifestyle	*1308*
5.	Peter is suffering from insomnia. He thinks it is probably because of his genes – after all, multiple family members suffer terribly with sleep too. Peter is keen to seek help for his disturbed sleep. Estimate how effective you think the following treatments might be [from (1) not at all effective, to (5) very effective]	**1546**
•	Pharmacological	*1513*
•	Talking therapies	*1352*
•	Therapy	*1304*
•	Change in lifestyle	*1309*
6.	If a report states that 'insomnia is approximately 30% heritable' what would that mean?	**1606**
1)	If someone has insomnia this is approximately 30% due to their genes	
2)	Approximately 30% of people will experience insomnia at some point in their lives	
3)	Genetic influences account for approximately 30% of the differences between people in insomnia	
4)	There is an approximately 30% chance that someone will pass insomnia onto their children	

Numbers in bold represent total number of participants who provided responses to the item. *Numbers in Italics* represent the number of participants who selected the particular response option. Participants could select multiple responses to these items. Items 4 to 6 have smaller Ns as these items were added after the data collection had commenced (19-June-2018)

Table 2: Responses to heritability item (by genetic knowledge)

	A N (%)	B N (%)	**C** **N (%)**	D N (%)
Total Sample (N = 1606)	274 (17.1)	188 (11.7)	**386 (24)**	758 (47.2)
Poor genetic knowledge score (N = 530)	114 (21.5)	94 (17.7)	**96 (18.1)**	226 (42.6)
Medium genetic knowledge score (N = 545)	82 (15.0)	53 (9.7)	**113 (20.7)**	297 (54.5)
High genetic knowledge score (N = 531)	78 (14.7)	41 (7.7)	**177 (33.3)**	235 (44.3)

Note: C is the correct Answer [in bold font]

A= If someone has insomnia this is approximately 30% due to their genes

B=Approximately 30% of people will experience insomnia at some point in their lives

C=Genetic influences account for approximately 30% of the differences between people in insomnia

D=There is an approximately 30% chance that someone will pass insomnia onto their children

The sample was split in three tertiles (i.e. Poor, Medium and High genetic knowledge respectively). The genetic knowledge score was a composite of 19 items. The questionnaire did not include an item about the definition of heritability.

Table 3: Mean (SD) comparison between low and high heritability groups for treatment effectiveness

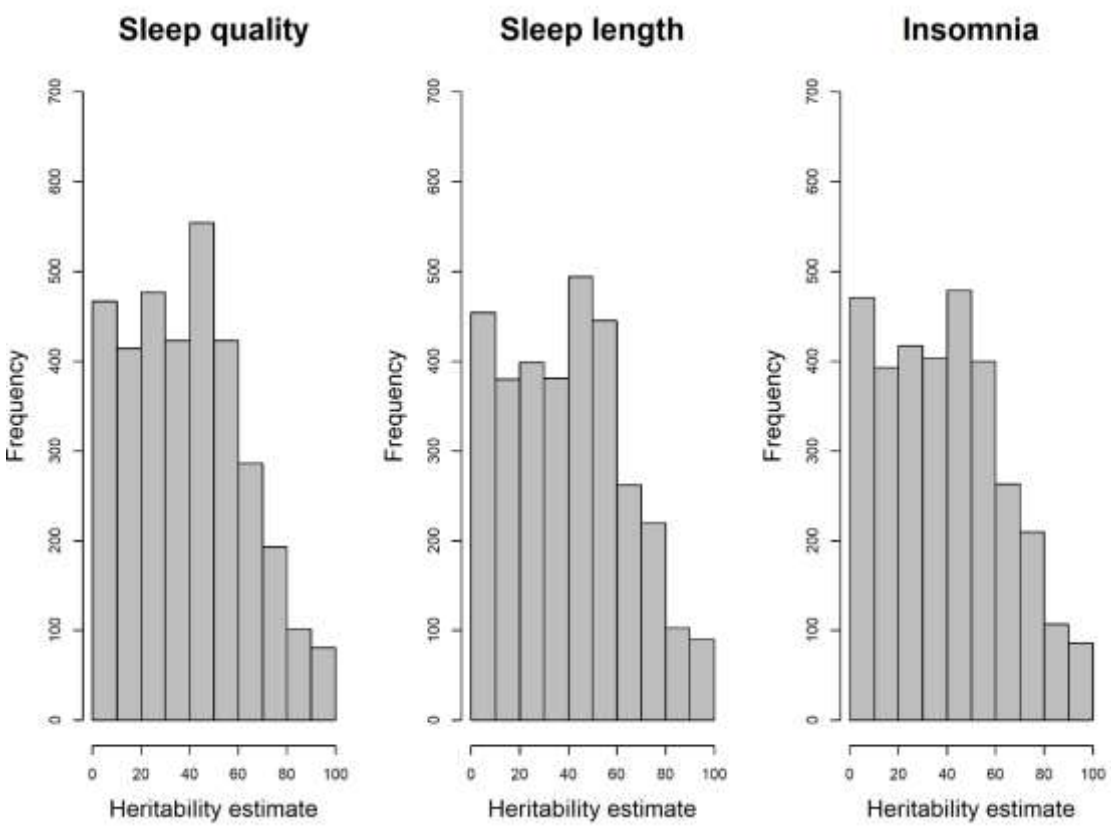
	Medication		Talking therapies		Change in lif	
	Low h^2 estimates	High h^2 estimates	Low h^2 estimates	High h^2 estimates	Low h^2 estimates	H e
				Treatment means effectiveness perception esti		
Genetic scenario	3.15 (1.2)	3.36 (1.0)	3.14 (1.2)	3.28 (1.1)	3.65 (1.0)*	3
Environmental scenario	3.23 (1.0)	3.27 (1.1)	3.61 (1.0)	3.39 (1.0)	4.08 (0.9)**	3

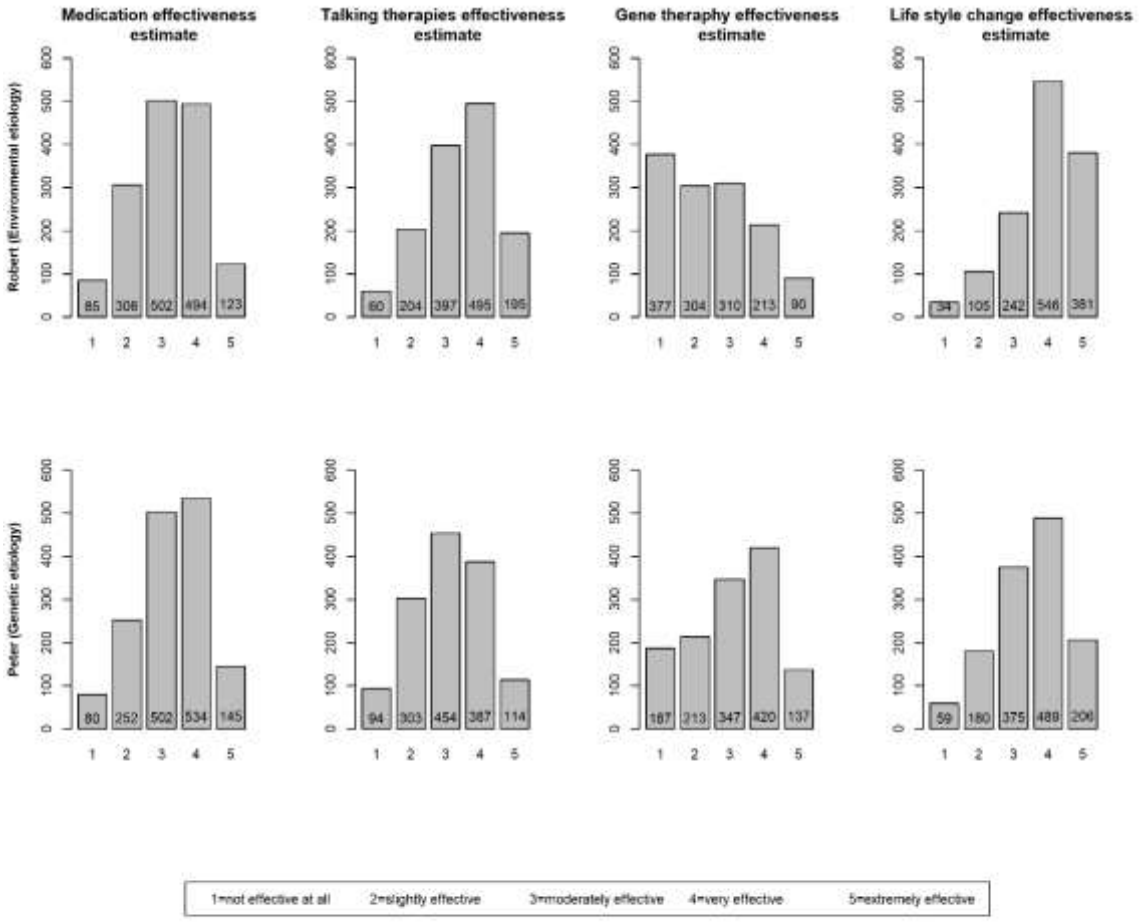
Low h^2 estimates represent participants who estimated the heritability of insomnia between 0% and 15%

High h^2 estimates represent participants who estimated the heritability of insomnia between 85% and 100%

Statistical differences between the low h^2 estimates group and the high h^2 estimates group: *p<.05; **p<.01.

Note: scores range from 1: not effective at all to 5: extremely effective


Sleep quality
Sleep length
Insomnia
Frequency
Heritability estimate
0
100
200
300
400
500
600
700
0
20
40
60
80
100


Medication effectiveness estimate
Talking therapies effectiveness estimate
Gene theraphy effectiveness estimate
Life style change effectiveness estimate
Robert (Environmental etiology)
Peter (Genetic etiology)
85 308 502 494 123
60 204 397 495 195
377 304 310 213 90
34 105 242 546 381
80 252 502 534 145
94 303 454 387 114
187 213 347 420 137
59 180 375 489 206
1=not effective at all
2=slightly effective
3=moderately effective
4=very effective
5=extremely effective