“Good Night, Sleep Tight”: Do we have an “Evolutionary Preference” for Placing Beds in Sleeping Rooms? A Replication and Extension of Spörrle and Stich (2010)

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• Authors' contributions (All authors must be mentioned)

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Abstract

In the distant past, hunter-gatherers had to manage the risk of attacks from other human beings and dangerous animals not only when awake, but also when asleep—a time during which humans are particularly vulnerable. Thus, one hypothesis is that humans evolved to choose "safe spaces" to sleep. Spörrle and Stich (2010) provided evidence for this hypothesis using 2D-floor plans and by asking participants to arrange pieces of furniture in a bedroom (bed, chair, table, closet). The aim of the present research was to replicate and extend Spörrle and Stich's (2010) findings. In two studies, participants had to position furniture in a sleeping room in the way they liked it best. Study 1 conducted with French participants was a quasi-replication of Spörrle and Stich (2010) using 2D-floor plans of a bedroom that differed in the opening direction of the door (left versus right) and the presence (versus absence) of a window. Study 2 with Slovak participants used the same design but this time with 3D-room plans. Finally, in Study 3 involving both French and Slovak participants, we examined the hypothesis that when participants are asked to imagine sleeping in a particular bedroom, a bed position that increases the risk of attack or predation ("unsafe position") will elicit greater feelings of discomfort than a bed position that reduces such risks. Taken overall, the findings provide further evidence that the positioning of beds in modern sleeping rooms has been shaped by the ancestral requirement of being protected during the night.

Keywords: sleeping places, bedroom, predation, safe places, fear

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In Nature, predation occurs all the time, and is therefore a strong selective pressure (Barrett, 2016). It is only recently that in modern environments animal attacks have ceased to be a major threat for our species (Kenrick & Lundberg-Kenrick, 2022). Indeed, in urban environments, humans have managed to keep most dangerous animals at bay. The fear of animals, in particular of snakes and spiders, may be perceived as irrational and unrealistic (Öhman & Mineka, 2001), but this was not the case for early *Homo sapiens*. Indeed, our hunter-gatherer ancestors were hunted by dangerous animals, such as lions or saber-toothed tigers, and they therefore had to manage to protect themselves from predators (Hart & Sussman, 2009; Henrich, 2019; Røskaft et al., 2003; Treves & Naughton-Treves, 1999). One hypothesis is that our brains bear the imprints of this selective pressure (Barrett, 2016; Bonin & Méot, 2019). In line with this view, a number of studies have suggested that our perceptual-attentional processes were shaped by predation (Isbell, 2009). Likewise, it has been found that adults detect dangerous animals—like snakes or lions—more quickly than non-dangerous animals (LoBue & DeLoache, 2008; Öhman et al., 2001; Prokop, 2018; Yorzinski et al., 2014; Yorzinski, Tovar, & Coss, 2018). For instance, in a study conducted by LoBue and DeLoache (2008), preschool children and adults were asked to find and then touch "threatening" target pictures on a screen (e.g., snakes) among matrices of "nonthreatening" distractors (e.g., mushrooms) or to do the reverse. The findings showed that both adults and children detected snakes more quickly than nonthreatening targets (e.g., caterpillars, flowers, frogs) (for similar findings with spiders, see LoBue, 2010). Even babies exhibit a perceptual-attentional bias towards snakes and spiders (Hoehl et al., 2017; Hoehl & Pauen, 2017; LoBue, 2010; Rakison, 2009). Hoehl et al. (2017) found greater pupillary dilatation—which indicates

activation of the noradrenergic system linked to stress responses—in infants aged 6 months when they viewed pictures of spiders and snakes compared to matched pictures of fish or flowers. In addition, Rakison and Derringer (2008) reported that 5-month-old babies preferred to look at schematic representations of spiders longer than at reconfigured features of the same spiders or at completely scrambled versions, suggesting the existence of a perceptual template present at birth. More recently, the same findings were observed with schematic snakes (Rakison, 2018).

In addition to the threat posed by predators, threats that come from congeners also exerted considerable selective pressure in the distant past and continue to do so today, even though the incidence of violence in human-to-human conflicts has decreased over time (see Pinker [2012] for a review on human violence). Anthropologists have documented that modern hunter-gatherers are extremely prone to intergroup warfare and everyday violence (e.g., Lee, 1979 cited in Kenrick & Lundberg-Kenrick, 2022). As in the case of (animal) predators, the human mind has evolved to process information about people who might more readily pose a potential threat of violence (e.g., a strange man) (Kenrick, 2011). Interestingly, Becker et al. (2007) showed that angry faces are visualized as male whereas happy faces are visualized as female and also that neutral male faces were more likely to be misidentified as angry (and less likely to be identified as happy) than neutral female faces. Several studies have shown that the emotion of anger plays a crucial role in this regard as the rapid detection of this emotion potentially avoids harmful conflicts (e.g., Calvo, Avero, & Lundqvist, 2006; Krems et al., 2015).

Our ancestors were certainly aware of how to protect themselves from congeners/(animal) predators, for instance by choosing places where they felt safe not only by day, but also during the night, and especially when sleeping (see Wichlinski [2022] for a review on how humans have tried to solve the problem of vulnerability during sleep). Humans

spend about one third of their lives sleeping (Zimbardo & Gerrig, 2004) and, when asleep, their sensory responsiveness is diminished. Understandably, individuals are therefore more vulnerable to predators, enemies and also hostile forces of nature (e.g., storms, fire) (Wichlinski, 2022). As claimed by Kanazawa and Li (2018): "*Any human in the ancestral environment up and about during the night would have been at risk of predation by nocturnal predators.*" Also, night is the time when most attacks on humans occur (Cohn & Rotton, 1997; Hamilton, 1982). Darkness leads to fear (Gordon et al., 2007) and it may be this fear of the dark that accounts for the fear of intrusion that is prominent in children (Gordon et al., 2007). Because individuals are more vulnerable to both predators and attackers during the night, when their spatial orientation is visually impaired, it has been hypothesized that the preference for certain types of landscape has been shaped by these selective pressures: for example, the savanna landscape (Balling & Falk, 1982; Falk & Balling, 2010; Gullone, 2000; Orians & Heerwagen, 1992, but see Moura et al., 2018), or landscapes offering an unobstructed view (Stamps, 2014, citing Appleton, 1975). This preference "to see without being seen" has been explored in non-human animals. It has also been observed that baboons prefer elevated locations that are safe from predators (Hamilton, 1982) and that capuchin monkeys choose their sleeping site to protect themselves from predators, and this even more so than from parasites (Di Bitetti et al., 2000). Chimpanzees also choose tall, strong trees to build platforms that keep them safe from predators and improve stability during sleeping (Samson & Hunt, 2014). Furthermore, night nests of hominids that are placed on branches farther from the trunk may be advantageous in terms of protection from predation because the greater vibrations effectively warn the sleeping animal of approaching predators (Altmann & Altmann, 1970). Another study exploring sleeping sites in wild saddleback and mustached tamarins suggests that choosing a safe place to sleep would have been even more important

than choosing places to find food (Smith et al., 2007)[1]. Indeed, mothers and young orangutans who are more vulnerable to predation prefer trees with less food as places for their night nests in order to avoid predation (Sugardjito, 1983). Taken overall, the findings of animal studies provide evidence that animals reduce the risk of predation by selecting safe sleeping places. As far as humans are concerned, Spörrle and Stich (2010) investigated whether—as hunter-gatherers certainly did—adults place beds in sleeping rooms in a way that allow them to detect the presence of a predator and/or an attacker and to react quickly if necessary. In their study, the participants were presented with 2D-floor plans of a sleeping room that differed through the presence (versus absence) of a window and the opening direction of the door (left to right versus right to left). They were asked to position furniture in a bedroom (bed, chair, table, closet) in the way they liked best. Unbeknownst to the participants, only the positioning of the bed was investigated. The main findings were as follows. First of all, a large majority of participants preferred to position the head of the bed in a way that gave them a view of the door, although this preference decreased slightly in the bedrooms with a window. Second, the participants placed the bed at a maximum distance from the entrance door. Thus, the bed was closer to the wall than to the door. However, the distance between the bed and the wall opposite the door varied depending on whether or not a window was present: When a window was present, 59% of the participants left no distance between the bed and the (opposite) wall and this percentage amounted to 81% when there was none. Third, the participants preferred to position the bed on the side of the room toward which the door opened, permitting them to see a potential intruder without being immediately seen.

Spörrle and Stich's (2010) study is original and interesting and has important theoretical implications for how humans organize their everyday space. However, we are not

[1] In this study that explored the sleep ecology of wild saddleback and mustached tamarins, the places chosen for sleeping were mainly high trees that were climbed depending on the altitude of the sun. Both species reached their sleep sites when the light was significantly higher than when they left them in the morning. However, no evidence was found that sleeping locations were selected to be closer to past than to future feeding sites.

aware of any study that has attempted to replicate Spörrle and Stich's (2010) findings. Given the replicability crisis in psychology (Asendorpf et al., 2013; Pashler & Harris, 2012), it is critical to identify robust, replicable, and generalizable evidence. The aim of Study 1 was therefore to assess the replicability of Spörrle and Stich's (2010) findings in French adults. Moreover, it is important to determine whether such findings can be extended to other situations and populations. Likewise, in Study 2, we investigated whether these findings can be observed with 3D-floor plans of sleeping rooms and also explored potential cultural differences by studying participants from Slovakia, a country still under threat of predation (e.g., bear attacks) (Prokop & Fančovičová, 2010). Successful replications in samples of participants from various countries adds to the universality of the investigated phenomenon (Apicella & Barrett, 2016; Barrett, 2020a, 2020b). Finally, in a third study conducted with both French and Slovak participants, we examined the hypothesis—which was put forward by Spörrle and Stich (2010) even though they did not test it—that when people are asked to imagine sleeping in a particular bedroom, an unsafe (versus a safe) bed position should elicit greater feelings of discomfort.

Study 1. Replication of Spörrle and Stich's (2010) study

Method

Participants. The participants were 154 volunteers from France, aged from 17 to 63 (*M* = 20.8 years; *SD* = 5.06; 128 females). Most of them (96%) were students at the University of xxxxx and received course credits for their participation. All were native speakers of French. Sample size was planned to be similar to that of Spörrle and Stich (2010) (N = 138) in which a between-subject design was used to test the positioning of the bed depending on the opening direction of the door and the presence of a window. Written informed consent was obtained

from all of the participants before the beginning of the study. All the study procedures were approved by the Statutory Ethics Committee of the University of xxxxx.

Design. A between-subject design was used with Window (presence versus absence) and Direction of the door (left versus right) as independent variables. The participants were randomly assigned to one of four conditions (n = 38 participants per condition, except for the "without window, right to left" condition, for which n = 40).

Materials. Since we intended to replicate Spörrle and Stich's (2010) findings, we closely followed the design of their study and the instructions given to the participants. The participants were presented with one of four different 2D-floor plans of a bedroom (see Figure 1A in the Supplemental Material for an illustration of the furnished bedroom with a window). The plans differed on two main aspects: (1) The presence versus absence of a window in the wall opposite the door, and (2) The opening direction of the door (left to right versus right to left).

Procedure. The participants were tested individually in a quiet room. At the beginning of the experiment, demographic information was collected: gender, age, and native language. Then, an empty 2D-floor plan of a bedroom (12 cm x 22 cm) was presented with several pictorial symbols representing furniture: a bed (12.7 x 5 cm), a table (2.8 x 3.6 cm), a chair (2.2 x 2.4 cm), and a closet (6.2 x 2.2 cm). The participants were instructed to organize the bedroom as they liked it best. They were told that no element should protrude from the plan. In order to avoid any effect of the experimenter's expectations, the participants performed the bed arrangement task without the experimenter being present (Klein et al., 2012). As in Spörrle and Stich's (2010) study, the length of the bed (12.7 cm) was deliberately larger than the width of the room (12 cm) with the result that it could only be positioned horizontally or diagonally. The other furniture was used to distract the participants from the fact that only the

placement of the bed was of interest. Finally, the participants were debriefed and thanked for their participation and the experimenter took a picture of the plan.

Data analyses. Three binary outcome variables (with the event of interest coded 1 and otherwise 0) were analyzed by means of logistic regressions: the direction of the bed (i.e., head side towards the door [1] versus head side towards the wall opposite the door [0]); placing the head of the bed in a way to see without being seen (1) or the reverse (0); placing the head of the bed with any space between the bed and the wall opposite to the door (1) or not (0). First of all, an empty model was used to test the overall probability of the event of interest. The experimental design was then taken into account by introducing predictive variables coding for contrasts. Main effects were coded 1 for the presence of a window and left-to-right opening direction and -1 for the other modalities. The interaction contrast predictor was equal to the product of the variables coding for main effects. This term was, however, never significant and was therefore excluded from the models in order to simplify the presentations (it should be noted that the same patterns of significant effects were found whether this term was included or not). In addition, distance (in cm) between the bed and the wall opposite the door was analyzed using a two-way between-subjects analysis of variance with the presence of a window and the opening direction of the door included as independent variables. However, since most of the participants did not leave any distance between the bed and the wall, neither the assumptions of normality nor of homoscedasticity were met. The results of this analysis must therefore be treated with care.

Results of Study 1

Head of the bed

In the empty model, the intercept was significant ($\chi^2(1) = 67.64$, $p < .001$, *Odd* = 10.85): A very high proportion of the participants (91.6%) placed the head of the bed in a way such to have a view of the door. In the model including the experimental design, no predictor

was significant, thus indicating that the proportion of participants who preferred to position the head of the bed so that they were facing the door did not differ reliably as a function of the presence of a window ($\chi^2(1) = 0.07$, $p > .1$, $OR = 1.15$; presence: 92.1%; absence: 91.0%), or as a function of the opening direction of the door ($\chi^2(1) = 2.14$, $p > .1$, $OR = 0.40$; left to the right: 88.2%; right to the left: 94.9%).

Position of the bed as a function of the opening direction of the door

147 (95.5%) of the participants positioned the bed along one of the two longer room walls. Given that seven of the remaining participants never placed the bed exactly half-way along a wall, the center of the bedhead was used to determine whether the bed position permitted their positioning of the bed as enabling or not to see without being seen (1 if it was behind the door, 0 if this was not the case)[2]. 61.0% of the participants positioned the bed in a way that enabled them to see without being seen, a proportion that differs reliably from chance ($\chi^2(1) = 7.38$, $p < .01$, $Odd = 1.57$). This way of positioning the bed did not vary reliably as a function of the door opening direction ($\chi^2(1) = 2.07$, $p > .1$, $OR = 0.62$; left to right: 55.3%; right to left: 66.7%), nor did it differ as a function of the presence of a window ($\chi^2(1) = 0.60$, $p > .1$, $OR = 0.77$; presence: 57.9% and absence: 64.1%).

Distance between the bed and the wall opposite the door

Across conditions, most of the participants (78.6%) did not leave any space between the bed and the wall opposite the door, a percentage which was reliably higher than 50% ($\chi^2(1) = 43.77$, $p < .001$, $Odd = 3.67$). There was a main effect of the presence of a window ($\chi^2(1) = 8.57$, $p < .01$, $OR = 0.28$): The preference for positioning the bed without any space between it and the wall opposite the door was greater when there was no window (88.5%) than when there was one (68.4%). The difference between the two door opening directions was not significant ($\chi^2(1) = 0.02$, $p > .1$, $OR = 1.07$; left to right: 78.9%; right to left: 78.2 %).

[2] Note that the same pattern of results was obtained when these participants were excluded from the analyses.

The analysis using distance (in cm) as the dependent variable and the presence of a window and the opening direction of the door as independent variables revealed a trend toward significance for the window factor, $F(1, 150) = 3.31$, $p < .1$, such that the distance between the wall opposite the door and the bed was higher when the bedroom had a window ($M = 0.67$ cm, $SD = 1.38$) than when it had none ($M = 0.30$ cm, $SD = 1.12$). This latter trend is interesting to note because Spörrle and Stich (2010) found the same pattern. The main effect of the opening direction of the door and the interaction were not significant, $F(1,150) = 0.31$ and $F(1, 150) = 1.93$, respectively; both $p > .1$. In addition, as in Spörrle and Stich's (2010) study, we compared the mean distance between the bed and the wall opposite the door with 2.15 cm which—as the exact midpoint of the practically feasible maximum distance between the wall and the door (4.3 cm)—can be taken as revealing no preference. The difference was significant, $t(153) = -16.35$, $p < .001$, $M = 0.49$, $SD = 1.26$, $d = -1.32$, suggesting a strong preference for sleeping away from the door, as was also observed in the Spörrle and Stich (2010) study.

Discussion of Study 1

Using a 2D-floor plan of a sleeping room to investigate the placement of the bed, we replicated most of the findings reported by Spörrle and Stich (2010). First of all, there was a strong preference for positioning the bed in a way that made it possible to see if the door was opened (but contrary to Spörrle and Stich (2010), this preference was not altered by the presence of a window). Second, there was a strong preference to maximize the distance between the bed and the door, and this preference varied as a function of the presence of a window in the room. Finally, there was an above chance preference to position the bed in such a way as to see without being seen. These findings are therefore consistent with the prospect and refuge theory (Appleton, 1975; Stamps, 2014), according to which there is a preference for safe sleeping sites, that is to say those making it possible to "see without being

seen". As far as prospect is concerned, lighted spaces, open panoramas and vistas improve safety by making it easier to detect potential threats (Appleton, 1975). Refuge traits correspond to aspects of the space such as the possibility of hiding, accessibility (e.g., risk of intrusion), and physical properties (e.g., artificial space such as building, natural spaces such as caves or trees). Because bedrooms are closed spaces mostly used in the dark during the night, the possibility of escape is limited. Also in line with prospect and refuge theory, we found a preference to position the bed in order to minimize reaction time in case of intrusion (e.g., see before being visible to the intruder, bed far away from the door). In Study 2, we sought to extend these findings using 3D-floor plans of a sleeping room. We hypothesized that the use of 3D plans would be more consistent with the participants' habitual perception of their own bedrooms (and perhaps that they would also be more immersed in the task). This is because 3D plans more closely depict how individuals experience visual space and better represent relative object size. We also thought it was important to investigate another cultural context, namely Slovakia. Interestingly, Slovakia is a country where the fear of dangerous animals is still present because bear attacks are relatively frequent (Prokop & Fančovičová, 2010).

Study 2. Extending Spörrle and Stich's (2010) study using a 3D model

Method

Participants. The participants were 160 volunteers from Slovakia, aged from 14 to 76 (M = 27.1 years; SD = 14.5; 97 females). 42.5% of the participants had a high school degree, 41.3% had a basic school degree, and 16.3% were university students. All were native speakers of Slovak. Sample size was planned to be similar to Study 1 (N = 154), in which a between-subject design was used to test the placement of the bed in the light of the opening direction

of the door and the presence of a window. Written informed consent was obtained from all of the participants before the beginning of the study.

Design. A between-subject design was used with Window (presence versus absence) and the Direction of the door (left versus right) as independent variables. The participants were randomly assigned to one of the four conditions (n = 40 participants per condition).

Materials. At the beginning of the study, demographic information was collected: gender, age, and native language. As in Study 1, the stimuli were presented in the form of paper printouts. An empty 3D-floor plan of a bedroom (12.5 × 29 × 10.5 cm) was presented upright on the table with several piece of furniture: a bed (12.5 × 5 × 2 cm), a table (2.7 × 3.5 × 4.7 cm), a chair (2 × 2.4 × 2.9 cm), and a closet (6.2 × 2.2 × 8.4 cm) (see Figure 1B in the Supplemental Material for an illustration of the furnished bedroom with a window.)

Procedure. The participants were tested individually in a quiet room. The same instructions as in Study 1 were given to the participants regarding the need to organize the bedroom furniture—the experimenter was not present while they performed the bed arrangement task—and they were debriefed in the same way after completing the task. The participants were finally thanked for their participation, and a picture of the plan was taken by the experimenter.

Results of Study 2

The data were analyzed in the same way as described in Study 1.

Head of the bed

As found in Study 1, the great majority of the participants (83.1%) positioned the head of the bed in a way which allowed them to view the door and this proportion differed from chance level ($\chi^2(1) = 57.06$, $p < .001$, $Odd = 4.93$). In contrast to Study 1, the main effect of the presence of a window was significant ($\chi^2(1) = 6.97$, $p < .01$, $OR = 0.29$), with a larger proportion of participants positioning the head of the bed in the direction of the door in the absence of a window (91.3 %) than when there was one (75.0%). The preferred bedhead

position did not differ between the two door opening directions ($\chi^2(1) = 0.42$, $p > .1$, $OR = 0.75$).

Position of the bed as a function of the door opening direction

As in Study 1, a large majority of the participants (151 [94.4%]) positioned the bed along one of the two longer room walls. For the remaining nine participants, who did not proceed in this way, the positioning of the bed was judged as enabling them to see without being seen, or vice versa, on the basis of the position of the center of the bedhead (in these cases, the bed was never placed exactly half-way along the two longer room walls)[3]. 60% of the participants positioned the bed in a way that allowed them to see without being seen and this trend was reliably above chance ($\chi^2(1) = 6.31$, $p < .05$, $Odd = 1.50$). As found in Study 1, this percentage did not vary reliably as a function of the door opening direction ($\chi^2(1) = 0.42$, $p > .1$, $OR = 0.81$, left to right: 57.5% and right to left: 62.5%), or as a function of the presence of a window ($\chi^2(1) = 0.94$, $p > .1$, $OR = 1.37$, presence: 63.8% and absence: 56.3%).

Distance between the bed and the wall opposite the door

Across conditions, most of the participants (74.3%) did not leave any space between the bed and the wall opposite the door ($\chi^2(1) = 34.62$, $p < .001$, $Odd = 2.90$). As found in Study 1, there was a stronger preference to leave no space between the bed and the wall opposite the door when there was no window in the room (82.5% versus 66.3%, $\chi^2(1) = 5.40$, $p < .05$, $OR = 0.42$). There was no main effect of the door opening direction ($\chi^2(1) = 0.31$, $p > .1$, $OR = 0.82$; left to right: 72.5% and right to left: 76.3%). In the analysis of variance using the distance between the bed and the wall opposite the door (in cm) as the dependent variable and the presence of a window and the opening direction of the door as independent variables, only a trend towards significance was found for the window factor, $F(1, 156) = 3.32$, $p < .1$: The distance between the wall opposite the door and the bed was greater when the room had a

[3] As in Study 1, the same pattern of results was obtained when these participants were excluded from the analyses.

window (*M* = 2.91 cm ; *SD* = 4.65) than when it had none (*M* = 1.68 cm ; *SD* = 3.89) (this trend was observed also in Study 1). In addition, the mean distance between the bed and the wall opposite the door (*M* = 2.29 cm; *SD* = 4.32) was reliably lower than 5.85 cm, $t(159) = -10.43$, $p < .001$, $d = -0.82$, the value corresponding to the mid-point between the wall and the door and indicating "no preference". This reveals a strong preference for sleeping away from the door.[4]

Combined analyses

In order to investigate differences between the two nationalities, the analyses that were run in Studies 1 and 2 were performed again with Study added as an independent variable. A backward selection approach was used: The three-way interaction terms were first discarded, followed by the two-way interaction effects. To do this, we took higher from lower *p*-values above .05 into account.

As far the position of the bedhead is concerned, the main effect of the Study factor reached significance ($\chi^2(1) = 4.86$, $p < .05$, $OR = 2.2$), with a larger proportion of French (91.6%) than Slovak (83.1%) participants positioning the bedhead in the direction of the door. The percentage of participants who positioned the bedhead in the direction of the door was also significantly lower ($\chi^2(1) = 4.19$, $p < .05$, $OR = 0.49$) when a window was present (83.3%) than when there was none (91.1 %). In the analysis that took the position of the bed as a function of the opening direction of the door into account, there were no reliable interaction or main effects.

As far as the distance between the bed and the wall opposite the door is concerned, there were a main effect of the window factor ($\chi^2(1) = 14.19$, $p < .001$, $OR = 0.35$), with less

[4] As participants were not predominantly students, we ran supplementary exploratory analyses for each DV including the student variable in addition to the significant predictors. A significant difference between student and non-student participants was observed only for the position of the bed as a function of the door opening direction, with a lower percentage of students (42.3%) than non-students (63.4%) positioning the bedhead in a way that allowed them to see without being seen. The effects observed without the student status variable were still significant.

participants choosing to place the bed without any space between it and the wall opposite the door when a window was present (67.3 %) than when there was none (85.4%). There was also a significant interaction between the window factor and the opening direction of the door ($\chi^2(1) = 5.53$, $p < .05$, *OR left to right / OR right to left* = 4.05), with the difference in the no window/window percentages being higher for the right-to-left door opening direction. The distance between the bed and the wall opposite the door (in cm) was standardized within nationalities in order to study the effects of the window and door factors, while also taking account of the two nationalities. In the resulting between-subjects ANOVA using Window (presence versus absence) and Direction of the door (left versus right) as independent variables, only the main effect of the Window factor was significant ($F(1,310) = 6.7$, $p < .05$), with a greater distance being left between the wall and the bed when there was a window ($M = 0.15$, $SD = 1.08$) than when there was none ($M = -0.14$, $SD = 0.89$).

Discussion of Study 2

Study 2 with Slovak participants provided a successful replication of Study 1 with a sample of French adults. Importantly, the participants in this second study were not primarily students, as well as of the original research of Spörrle and Stich (2010) with a German sample of participants. Using 3D-floor plans of a sleeping room with Slovak participants, the predictions regarding the preference for safe sleeping places were confirmed. A large majority of participants positioned the head of the bed in a way that gave them a view on the door and a larger proportion of them positioned the head of the bed to face the door when no window was present. It seems that the positioning of the head of the bed is universal across cultures and that the preference is strong regardless of whether the study is conducted with 2D (Spörrle and Stich 2010; the current Study 1) or with a 3D-floor plan of a bedroom (the present study). As in Study 1, the majority of adults chose to position the bed in a way that allowed them to see without being seen. Finally, as revealed in Study 1 with 2D plans, a high

number of adults did not leave any space between the bed and the wall opposite the door and this preference was more pronounced when there was no window. We suggest that the impact of doors is more straightforward than that of windows because doors are always risky in terms of intruder access. Indeed, windows are extremely safe, in particular for people who live on upper floors since floors above ground level represent a greater barrier for entry by malicious intruders. Interestingly, it is common in Slovakia for ground floor windows to have a grille.

The findings from the combined analysis were mostly in line with those reported separately in the two studies. Interestingly, this analysis indicated that French participants positioned the bedhead in the direction of the door reliably more often than Slovak participants and that the presence of a window had the effect of (1) reducing this trend and (2) increasing the distance left between the wall and the bed.

Study 3. Safe versus unsafe bed position and (dis)comfort ratings

In Study 3, we used a different methodology to further test the hypothesis that the way beds are positioned in sleeping rooms has been shaped by the requirement to be protected during the night. Indeed, Spörrle and Stich (2010) made the interesting suggestion that when people are asked to imagine sleeping in a bedroom, an unsafe bed position should elicit a greater level of discomfort than a safe bed position. In Study 3, we used 3D plans of two bedrooms in which the bed was positioned in a way that either increases potential risks, such as being killed by an intruder (“unsafe position”) or reduces potential risks (“safe position”). The participants’ comfort ratings when imagining sleeping in the bedrooms were collected. The safe and unsafe bedrooms were designed using the “Sweet Home 3D” software. As illustrated in Figure 1, one room had the bed positioned with the head facing the wall opposite the entrance and was located on the side of the room that would permit a potential intruder to immediately see the person lying in the bed: an “unsafe bedroom”. By contrast, the other

room had the bed with the head facing the entrance and located on the side of the room toward which the door opened, thus making it possible to detect a potential intruder without being immediately seen oneself: a “safe bedroom”. In line with the findings of Study 1 and 2, we predicted that the “unsafe bedroom” should elicit a greater level of discomfort than the “safe bedroom”. Participants from both France and Slovakia were involved in this study. In order to study whether potential differences between nations could be explained (at least in part) by differences related to fear of sleeping, we also explored this dimension using the Fear of Sleep Inventory-Short Form (Pruiksma et al., 2014).

Method

Participants. Participants were 160 volunteers from Slovakia (n = 80, M = 35.11 years; SD = 10.15; 62 females) and France (n = 80, M = 22.16 years; SD = 4.98; 67 females). As in the previous studies, the participants from France were mostly university psychology students (56.25%), whereas the participants from Slovakia were more diverse (15% of the participants had a high school degree and 18.7% were university students). All were native speakers of Slovak or French, respectively, and were tested online. Written informed consent was obtained from all the participants before the beginning of the study.

Design. A between-subject design was used, with Safety of the room (safe versus unsafe) and Country (Slovakia versus France) as independent variables. The participants were randomly assigned to one of the two conditions of the Safety factor.

Materials. Demographic information was collected at the start of the study: gender, age, and native language. The two bedrooms were designed with “Sweet Home 3D” (https://www.sweethome3d.com), a software program used to create housing designs. The same proportions as in the bedroom used in Study 1 were used (see Figure 1). The participants were instructed to imagine that they had to sleep in the bedroom presented to them and to evaluate how comfortable they would feel sleeping in this room on a 7-point

Likert scale (1 = very uncomfortable vs. 7 = absolutely comfortable). Finally, the participants completed the Fear of Sleep Inventory-Short Form (FoSI-SF) (Pruiksma et al., 2014). The FoSI-SF consists of two subscales. The first subscale, "fear of loss of control", includes 11 items such as "I was fearful of letting my guard down while sleeping" or "I stayed up late to avoid sleeping". The second subscale, "fear of darkness" includes two items, namely "being in the dark scared me" and "I slept with a light on to feel safer". Participants were required to rate how often the event corresponding to each item had occurred in the past month on a 5-point Likert scale (0 = not at all; 1 = a few times per month; 2 = once or twice per week; 3 = several times per week; 4 = nearly every night). Finally, the participants were debriefed regarding the research goals. The survey took about five minutes to complete.

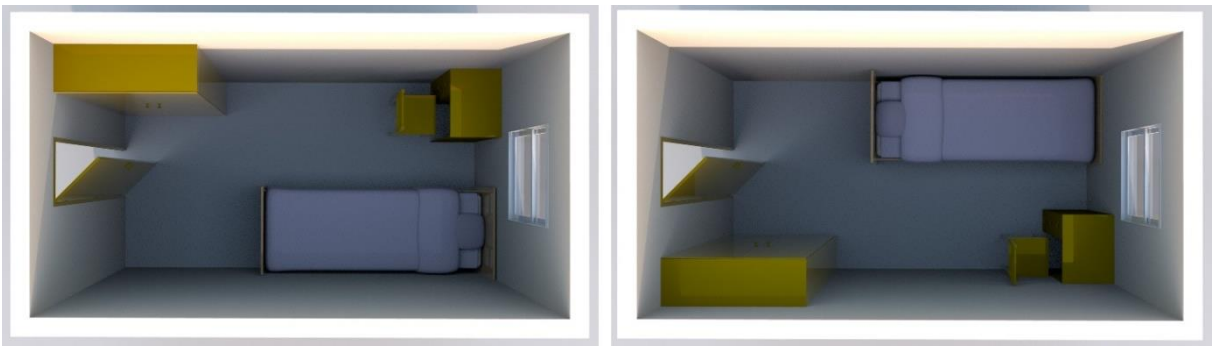

Figure 1. Examples of the bedrooms used in Study 3 (on the left: safe arrangement; on the right: unsafe arrangement).

Results of Study 3

Comfort ratings

The main effect of Safety was significant, $F(1, 156) = 25.45$, $p < .001$, $\eta_p^2 = .14$, with a higher level of comfort being expressed for the safe ($M = 3.95$) than for the unsafe room ($M = 2.61$). Neither the main effect of Country, $F(1,156) = 0.80$, $p = .37$, nor the interaction between the two factors, $F(1,156) = 0.002$, $p = .96$, was significant. Given that the participants in Slovakia were older than the participants in France, we ran an additional analysis with age

introduced as a covariate factor. However, introducing this factor into the analysis did not change the pattern of findings (main effect of Safety: $F(1, 156) = 14.32$, $p < .001$, $\eta_P^2 = .08$).[5]

Fear of Sleep Inventory-Short Form

The reliabilities of the "loss of control" ($\omega = .91$)[6] and "fear of darkness" subscales (Spearman-Brown $\rho = .86$) were acceptable. According to Welch's t-tests, the French participants expressed both a higher level of loss of control, $t(117.45) = 4.22$, $p < .001$, ($M = 0.55$ and $M = 0.19$) and more fear of darkness than the Slovak participants, $t(102.97) = 2.76$, $p < .01$, ($M = .54$ and $M = .18$). Additional analyses revealed no reliable correlations between the loss of control and fear of darkness scores and comfort ratings either in the French ($r = .08$, $p = .44$ and $r = .10$, $p = .36$) or in the Slovak ($r = -.13$, $p = .24$ and $r = -.08$, $p = .49$) participants.

Discussion of Study 3

Following Spörrle and Stich's (2010) suggestion, we measured feelings of comfort in order to compare two different bed positions in a sleeping room. We hypothesized that the safer bedroom would be rated as being more comfortable than the bedroom in which there was a greater risk of being attacked during the night and the findings turned out to be exactly as we predicted in both the French and Slovak participants. We additionally explored sleeping habits. We found that French participants expressed a higher level of loss of control than Slovak participants as well as a greater fear of darkness. We would like to stress, however, that the scores on both subscales of the Fear of Sleep Inventory-Short Form questionnaire were very low. Therefore, the inferential results reported above should be considered with caution. Importantly, neither the darkness scores nor the loss of control scores were related to

[5] There was no significant difference between student and non-student Slovakian participants. Given that, with the exception of the psychology students, the student status was not recorded for the French sample, it was not possible to test for such a difference.

[6] The computation was performed using the SPSS OMEGA macro (ML option) provided by Hayes and Coutts (2020).

ratings of comfort in either country. In line with the findings from Studies 1 and 2, we were able to provide further evidence for the hypothesis that the way bedrooms are arranged has been shaped by the issue of being protected during the night which has been faced throughout hominid evolutionary history.

General Discussion

Our Pleistocene ancestors had to protect themselves from both predators (Hagen, 2022) and potentially dangerous congeners (Kenrick & Lundberg-Kenrick, 2022) and our minds still bear the imprints of these evolutionary pressures. Nights are periods of particular vulnerability for most animals, including humans (Wichlinski, 2022). It is therefore reasonable to hypothesize that a range of psychological mechanisms have evolved to reduce the consequence of an attack while sleeping. Previous research has investigated the type of sleeping places that are occupied by animals and it has been found that safe locations are generally preferred, i.e., locations that make it possible to hide and/or to escape quickly (e.g., Caine, Potter, & Mayer, 1992). However, only a few studies have examined such preferences in humans. Indeed, we are aware of only one study of this kind, namely the research designed by Spörrle and Stich (2010). The present work therefore built on Spörrle and Stich's (2010) study and—in view of the replicability crisis in psychology (Asendorpf et al., 2013; Pashler & Harris, 2012)—was designed to examine anew whether there is evidence that humans have an evolved preference for positioning their bed in a sleeping room in way that maximizes safety from possible predators/aggressors. We investigated these issues in two different samples of participants (French and Slovak). Study 1 was a quasi-replication of Spörrle and Stich (2010) with 2D-floor plans in French adults, whereas Study 2 was an extension with 3D-floor plans in Slovak and did not predominantly involve student participants. In a third study, we opted for a different methodology and collected comfort ratings for a safe and an unsafe bed

position in a preorganized bedroom from both French and Slovak participants.

Taken overall, the findings of the three studies are consistent with an evolutionary approach to the organization of sleeping spaces which minimizes the cost of potential nighttime aggression. In the first two studies, we found a strong preference to position the head of the bed in the sleeping room in order to be able to see if the door was opened. This makes it possible to detect potential intruders quickly. In Study 2, but not in Study 1, the head of the bed was positioned less frequently in the door opening direction when a window was another point of access to the bedroom. Also, the bed was placed opposite to the direction of the door opening. This preference is also consistent with an evolutionary account of the choice of sleeping places because facing the entrance to the room afforded by the open door makes it possible to react quickly in case of intrusion, while also providing the possibility to see without being seen. As discussed above, this finding is in line with the prospect and refuge theory (Appleton, 1975; Stamps, 2014), according to which there is a preference for spaces that provide large fields of view and afford protection from threat. Vision has been shaped by issues related to survival (Isbell, 2009; LoBue & DeLoache, 2008) and, in particular, the ability to visually detect an attacker quickly greatly increases the chance of survival. In line with this account are the findings of Fisher and Nasar (1992), who examined the relationship between exterior site features (i.e., prospect, refuge, escape) and fear of crime. In this study, participants evaluated (using 5-point Likert scales) different areas for prospect, refuge, and entrapment on a campus. Higher levels of fear were found when places offered limited vision, refuges for potential criminals, and poor escape opportunities for potential victims. Interestingly, a previous work (Tiffany & Ketchel, 1979) revealed that robbers also preferred to use paths and banks that permitted them to remain unseen, while simultaneously given them maximum visibility. It therefore seems advantageous to “see without being seen”, whether you are a robber or a simple citizen.

We found that adults exhibited a strong preference to maximize the distance between the bed and the door, and that the preference to leave no space between the bed and the wall opposite the door was greater when there was no window in the room. In addition, in the combined analysis, a significant interaction between the window factor and the opening direction of the door was found.

However, this interaction was clearly not anticipated and we have no explanation at present. Positioning the bed at a maximum distance from the door gives the room occupant more time to react in the case of an intrusion. It is interesting to note that this latter finding is consistent with a previous animal study that investigated sleeping place preferences in captive tamarins (Caine et al., 1992). Different boxes varying on the degree of concealment (e.g., escape hole, wall strength) were presented to three groups of tamarins over a period of several weeks. The findings indicated a greater preference for sleeping boxes that offered the most concealment, were at the greatest distance from the floor, and were maximally distant from the entrance. Choosing a sleeping place as far as possible from the ground could therefore be an adaptation that makes it possible to manage the threat of predators. A large number of studies conducted on many species have reported a preference for elevated sleeping sites to provide protection from predators (Altmann & Altmann, 1970; Caine et al., 1992; Di Bitetti et al., 2000; Hamilton, 1982; Sugardjito, 1983). Importantly, such a preference is reduced in areas where predators are uncommon. For instance, chimpanzees and mountain gorillas use sleeping places on the ground or just above it (Schaller, 1963). As far as humans are concerned, we are too heavy and less agile than non-human primates to sleep in trees (except tree houses). This is why caves were used by our ancestors to protect themselves during sleep and, indeed, certain archaeological findings suggest that burned grass bedding was used in the caves of South Africa 200,000 years ago (Wadley et al., 2020). Even modern hunter-gatherers dig shelters in the ground to protect themselves from predators (Samson & Nunn, 2015).

In Study 3, we tested a hypothesis that was put forward by Spörrle and Stich (2010), but which to our knowledge has never been examined. More specifically, their hypothesis suggests that a safer bedroom will be rated as being more comfortable than a bedroom that is less safe in terms of the potential risk of being harmed by an attacker or by a dangerous animal. The findings were in line with this prediction in both the French and Slovak participants. The findings of Study 3 allow us to conjecture that evolved psychological processes involved in safety-related behaviors like those investigated here are triggered by affective states. However, future research is needed to investigate this hypothesis more thoroughly.

As suggested by Spörrle and Stich (2010), a different explanation of the findings from Study 1 and 2 is that they are the result of the transmission of cultural norms. It could be that participants are simply reproducing the typical arrangement of a German, French or Slovakian bedroom. This account is not necessarily inconsistent with an evolutionary view of human sleeping place preferences. If such norms do exist, they may be rooted in the remote past and be related to survival issues in the same way that culinary traditions can be linked to survival issues such as pathogen avoidance, as illustrated by the use of spices to cook meals (Sherman & Billing, 1999; Prokop & Fančovičová, 2011) or the adherence to traditional norms in nations with greater parasite stress (Tybur et al., 2016). In the present work, we found findings similar to those initially reported by Spörrle and Stich (2010) in a German sample using two new samples of participants whose cultures and traditions are somewhat different. One potential important difference between Slovakia and France is that Slovakia is a country still faced with predation in the form of bear attacks (Prokop & Fančovičová, 2010). However, the Slovak participants involved in Study 2 were not specifically selected from areas where bears are prevalent and the beds in the sleeping rooms of the Slovakian participants were arranged in the same way as those of the French and the German

participants. Also, in Study 3, the comfort ratings given to the safe (versus unsafe) bedroom were nearly the same in the two countries. The Fear of Sleep Inventory-Short Form revealed that French participants expressed higher levels of both loss of control and fear of darkness than Slovak participants, but it should be noted that the scores were overall very low on these two measures. This suggests that fear of predators does not disappear even in conditions with a longer period of relaxed selection (Coss, 1991). In future research, it would be interesting to investigate where people sleep and how they organize their sleeping places in areas of the world where attacks from predators and humans are frequent. We therefore encourage future research to investigate preferences for sleeping places in a range of different situations, and in particular in situations that are more realistic than the ones investigated here, which we acknowledge, are somewhat artificial. Selbst, Baker, and Shames (1990) have shown that bunk beds are commonly used for children, even though they are responsible for injuries due to falls and even collapses. It would be interesting to explore if, given the choice, children prefer to sleep up or down, and whether any such preference is guided by safety issues. Furthermore, in heterosexual couples, anecdotal evidence suggests that women prefer to sleep away from the window: Is this preference due to the fact that a potential attacker coming from this location will first assault the man? And as a result, does his wife/girlfriend benefit from greater protection? Future research should also consider investigating safety in other private or public spaces (i.e., theaters or public transport): When given the choice, do people choose to sit in a particular place in a theater to feel safe, for instance next to the exit doors? In the same way, do individuals in a train sit near the exit doors when the train is empty? And do these choices vary as a function of individual characteristics such as personality traits and/or as a function of contextual characteristics such being alone, accompanied by a friend, a spouse, or a child? Finally, the findings may have practical implications for the way beds are

organized, not only in private life but also for hotel managers who want their guests to feel at ease during the night.

It is important to acknowledge some limitations of the present work in order to help and guide future research. First, although we compared two different countries (France and Slovakia), both are European and therefore not very distanced from one another culturally. Future studies could investigate more distant cultures, for instance Asian or African cultures. From a general standpoint, it is critical to investigate psychological differences and similarities between individuals of different cultures if we wish to achieve a better and deeper understanding of human nature (Barrett, 2020a, 2020b). Although the cross-cultural approach is not new in evolutionary psychology (Buss, 1989), it has been taken increasingly seriously in recent years and, indeed, certain researchers have advocated the need to embrace cultural and environmental variation in order to test evolutionary hypotheses (e.g., Apicella & Barrett, 2016). At present, growing numbers of studies are including more cultural diversities in the samples of participants studied. To illustrate, a team of international researchers recently collected data on fundamental social motivations (e.g., self-protection, mate acquisition, kin care) across 42 societies (Pick et al., 2022). Another recent illustration takes the form of the research conducted by van Leeuwen et al. (2022), which investigated disgust sensitivity and prejudice toward gay men and lesbian women in 31 different nations (van Leeuwen et al., 2022). Nevertheless, as several researchers have pointed out, psychology studies face a representativeness problem because most of them have been conducted using samples of people living in ‘WEIRD’ (Western, Educated, Industrialized, Rich, and Democratic) societies (Barrett, 2020a, 2020b; Henrich et al., 2010; Kurzban, 2013; Rad et al., 2018; Tindle, 2021; but see also Kanazawa, 2020). For instance, in their analysis of empirical papers published in the Journal *Psychological science* in 2014, Rad et al. (2018) noted that 94.15% of the studies used WEIRD samples. However, it should be noted that even though most of

the samples used in studies in the field of evolutionary psychology use WEIRD student samples, they do so less heavily than in some other fields (e.g., social, developmental psychology) (Pollet & Saxton, 2019). To return to the issue at hand, it is already clear that future research will need to go beyond the specific cultural samples of participants studied here to investigate whether there are any cultural specificities in the way sleeping places are organized and, importantly, such an approach should help determine the generality of the current findings.

As far as our specific samples of European participants are concerned, we acknowledge that we did not control for certain potential confounding variables that may affect bed placement decisions such as, for instance, risk propensity (and personality traits that might underlie such a propensity, e.g., Nicholson et al., 2005; Joseph & Zhang, 2021). Thus, examining how risk propensity influences the placement of beds in sleeping places could provide important information and one might conjecture that people who are more prone to engaging in risky behaviors would be less inclined to organize their sleeping spaces in ways that minimize the cost of potential nighttime aggression. Another important aspect related to individual differences is participants' previous experiences of burglary or crime. In the literature, it has been shown that the fear of crime in women predicts mate selection preference, in particular the extent to which they value formidability in a male long-term mate (Snyder et al., 2011), or in (non-romantic) friends (Meskelyte & Lyons, 2022). We did not assess individual differences related to previous experiences of physical aggression among the participants in our studies but such differences may play a role in how participants decide to organize sleeping places in relation to safety. For instance, a previous study investigated the psychological effects of street robbery on victims and reported that even 9 months after the aggression, one third of the participants still experienced anxiety, severe depression, and insomnia (Gale & Coupe, 2005). Furthermore, they were more likely to engage in safe

behaviors such as not going out alone or locking valuables in the car boot. It is possible to conjecture that participants who have experienced a burglary or have faced physical threats, either by witnessing physical attacks with knives or firearms or by suffering such attacks themselves, will be even more anxious to protect themselves at night than participants who have not been confronted with such threats.

Second, because we wanted to replicate Spörrle and Stich's (2010) findings, we followed the approach adopted by these authors and used floor plans which deliberately restricted the possible positions of the bed inside the room. Spörrle and Stich's (2010) rationale was that this approach limited the degrees of freedom available for positioning the bed to diagnostic location. In future studies, the use of floor plans with more options could be considered. Third, we asked participants to imagine furnishing a bedroom in the way they liked best, but it might be more ecological to study the positioning of the bed in real sleeping rooms, for instance by asking participants to take a photograph of their bedroom. Fourth, where exactly the bedroom is located in a house or in a building, and in which context, may be of importance. In our study, there was no indication about where the bedroom was located. For instance, it is possible to imagine that the bed may be positioned differently depending on whether the bedroom is on the third floor or the ground floor of a building. Also, two identical rooms could be in houses located in a quiet or in a dangerous neighborhood.

To conclude, the present findings provide further evidence that sleeping preferences have been shaped by our deep-rooted fear of being attacked. Such behaviors are in line with our basic need to protect ourselves from dangerous animals or threatening congeners. Indeed, self-protection is a fundamental motivation for human behavior (Kenrick & Lundberg-Kenrich, 2022). Although the topic of self-protection during moments of great vulnerability such as sleep has been relatively well-documented in animals (Altmann & Altmann, 1970; Caine et al., 1992; Di Bitetti et al., 2000; Hamilton, 1982; Sugardjito, 1983), to our

knowledge, only Spörrle and Stich (2010) have addressed this issue in humans in the case of the arrangement of bedrooms. Thus, in the light of the replication crisis in psychology (Asendorpf et al., 2013), our research makes a valuable contribution by replicating the findings of Spörrle and Stich (2010). Importantly, we were able to extend these findings to a 3D-floor plan in different populations (French and Slovak participants), and we also obtained novel findings showing that comfort ratings are impacted by the level of safety provided by the placement of the bed in a sleeping space. In both humans and animal species, choosing a safe place to sleep seems to be a kind of universal need that is rooted in the distant past.

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