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RESEARCH ARTICLE

Previous Experiences and Regularity of Occurrence in Evolutionary Time Affect the Recall of Ancestral and Modern Diseases

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Abstract

Human beings have an adaptive memory that adjusts to different threats in the environment; however, we know little about the factors that modulate this plasticity in memory. Using challenges related to disease threats as a research model, we investigated whether the regularity of occurrence and previous experience with diseases would be factors responsible for predicting memory performance. To test the hypothesis that information regarding diseases that affect with regularity over evolutionary time is better remembered, we grouped diseases into chronic and acute. To investigate the hypothesis that information about diseases that affect regularly in the current environment is better remembered, we grouped diseases into high- and low-incidence. Furthermore, to test the hypothesis that information about illnesses from previous experiences is better remembered, we grouped illnesses into experienced and unexperienced by the participants in this study. As an alternative hypothesis, we investigated whether the recall could be influenced by diseases that originated in ancestral environments or are simply explained by regularity and previous experience with diseases. For this purpose, we grouped the acute and chronic diseases into ancestral and modern. Information about illnesses was presented to university students through fictional stories, followed by an unexpected memory test to identify the best-remembered information. We found that information about diseases that affect regularly over evolutionary time (acute) and from previous experiences was remembered more, whereas ancestral and regular diseases in the current environment (high incidence) were remembered less. This was possibly because diseases that affect humans regularly over evolutionary time spawned greater earlier experiences, increasing people's perception of risk and facilitating its evocation in memory. In addition, regular diseases in human evolutionary history may have generated greater selective pressure on memory, contributing to a better retention of information. Human beings have developed an adaptability to deal with different environmental adversities, favoring those challenges in memory that affect them regularly and from previous experiences and not necessarily those challenges that refer only to threats from ancestral environments.

Keywords Adaptive memory plasticity · Regular illnesses · Evolutionary psychology · Evolutionary ethnobiology

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Introduction

Human beings have inherited and share several psychological adaptations as a result of selective pressures faced by hominids in ancestral environments (see Tooby & Cosmides, 2005, 2015). Fear of snakes and the prevention of incest, for example, are considered universal psychological adaptations present in the human species (see Schmitt & Pilcher, 2004). A human memory adapted to especially remember information of importance to survival and reproduction represents another important psychological adaptation, known as adaptive memory (see Aslan & Bauml, 2012; Nairne et al., 2007; Nairne & Pandeirada, 2008; Otgaar et al., 2010).

Modern human beings have a memory that privileges important information for survival, such as information related to dangerous animals (Barrett et al., 2016), toxic plants (Prokop & Fančovičová, 2014, 2018), and pathogens (Fernandes et al., 2017, 2021; Gretz & Huff, 2019; Prokop et al., 2014; Thiebaut et al., 2021), to the detriment of other types of information of lesser adaptive value, such as nontoxic plants and harmless animals. These human cognitive mechanisms have been observed in people of different ages (Broesch et al., 2014; Nouchi, 2012; Prokop & Fančovičová, 2014) and who live in different environments and cultural contexts (Barrett & Broesch, 2012; Barrett et al., 2016).

However, there are controversies as to whether human memory is adjusted only to remember challenges that refer to threats from ancestral environments (see Nairne & Pandeirada, 2010; Weinstein et al., 2008) or those challenges that have recently emerged in our evolutionary history (Soderstrom & McCabe, 2011; Yang et al., 2014). Young et al. (2012) observed that attention to ancestral threats (snakes and spiders) and modern threats (cars and firearms) is guided by the environmental context where these threats are found, which suggests the existence of a detection mechanism of more general threats in humans.

Such evidence differs from those reported in other studies, which suggest the existence of an innate bias aimed at the faster detection of threats that were common in ancestral environments (see Öhman & Mineka, 2001; Öhman et al., 2001). For example, Schaller et al. (2010) showed that the mere perception regarding signs of infectious diseases was responsible for promoting a more aggressive immune response compared with other conditions that involved threatening stimuli such as firearms, evidencing targeting of the human immune system toward ancestral threats.

In addition to this evidence, it was observed that information involving a situation of contamination by infectious disease was recalled in a similar way in ancient and modern settings (see Bonin et al., 2019a) and that fictional modern threats and ancient threats are similarly remembered (Bonin et al., 2019b), evidencing a more general functioning for human memory.

In addition, human adaptive memory seems to present plasticity, where some information important for survival is better remembered than others (see Sandry et al., 2013; Silva et al., 2019). Less serious diseases are favored in memory over more serious ones (see Silva et al., 2019). Finally, dangerous animals are remembered and learned first, followed by dangerous food and objects (see Barrett et al., 2016).

However, little is known about the factors that modulate this plasticity in memory, leading some information of importance to survival to be better evoked than others. Evidence shows that the regularity with which environmental challenges affect people (see Prokop et al., 2014; Sachs et al., 2017; Silva et al., 2019) and previous experience with a given event in the environment (Gibbons & Groarke, 2016; Miceli et al., 2008; Prokop et al., 2015; Scheideler et al., 2017; Wachinger et al., 2013) directly interfere with the perception of human risk. Thus, people can direct strategies to address recurring challenges, causing some information to be remembered in a different way. Tooby and Cosmides (2015) also argued that regular challenges over evolutionary time have shaped most human psychological adaptations to face frequent threats in the environment. However, it is unclear whether the regularity of threats throughout human evolutionary history or just in their current environment is involved in memory performance.

Thus, assuming that human beings have a memory adapted to remember survival information and that this memory works in general by remembering different threats in the environment, this study aimed to investigate which factors are responsible for modulating human adaptive memory. To test our assumptions, we used information of importance to human survival (e.g., causes, symptoms and treatments) associated with different types of diseases as a research model. Throughout human evolutionary history, diseases have represented an enormous challenge to our survival and reproduction (see Tooby, 1982). To prevent disease, humans have developed adaptations, such as a behavioral immune system, to deal with pathogens in the environment (see Ackerman et al., 2018; Murray & Schaller, 2016; Schaller & Park, 2011; Thiebaut et al., 2021). In this case, it is likely that once in contact with diseases, this behavioral immune system strengthens memory to remember certain information about illnesses, something that would be analogous to what happens with the physiological immune system. Thus, we investigated whether the regularity with which diseases affect people and previous experiences with illnesses are responsible for improving information recall.

To investigate whether diseases that affect regularly over evolutionary time boosted the recall, we selected information related to acute and chronic diseases. Evidence shows that acute and chronic diseases have coexisted with our ancestors, affecting humans since ancient times (see Lee et al., 2015; Weyrich et al., 2017). Therefore, these diseases influence humans over time and between generations. Considering that acute diseases have a shorter duration in the body than chronic diseases, which last longer (Marcano-Reik, 2013; Mendes, 2012), acute diseases have a higher potential for reinfection than chronic diseases, resulting in diseases that affect people more regularly in their populations. Thus, based on the characteristics that these diseases present, we consider acute conditions as diseases that affect individuals more regularly than chronic diseases, which tend to affect them less regularly throughout evolutionary history.

To investigate whether the regularity of the disease in the current environment would influence the recall, we grouped acute and chronic diseases into diseases of high and low incidence in the Brazilian population, the country where this study was carried out. Incident diseases can fluctuate in time and space, being more regular at one time in the environment but not at a second time (see Bierrenbach et al., 2007). However, acute diseases affect people on a continuous basis regardless of the time and space in which they occur. Thus, high- and low-incidence diseases constitute excellent models for investigating the effects of regularity of threats in the current environment on memory. To investigate the effect of previous disease experience on recall, we grouped illnesses into experienced and unexperienced by the participants in this study.

Furthermore, considering the controversy that human memory would especially retain information regarding ancestral threats, we investigated whether disease ancestry or only diseases that affect regularly and that were previously experienced by individuals could influence recall. To this end, we grouped acute and chronic diseases into ancestral (e.g., diarrhea) and modern (e.g., stroke) groups. We tested the following hypothesis:

H1: Diseases that affect humans more regularly over evolutionary time are prioritized in memory. We predict that information related to acute illnesses will be better remembered than information related to chronic illnesses.
H2: Illnesses that affect humans more regularly in the current environment are prioritized in memory. We predict that information about high-incidence diseases will be better remembered than that about low-incidence diseases.
H3: Previously experienced diseases are favored in memory. We predict that information about diseases from previous experiences will be better remembered than information about diseases for which there is no previous experience.
H4: Diseases that originated in ancestral environments are prioritized in memory. We predict that information about ancient diseases will be better remembered than that about modern diseases.

Therefore, this study aims to contribute to the understanding of the factors that modulate human memory adapted for survival.

Material and Methods

Participants

Two hundred forty undergraduate students from the Federal University of Pernambuco, Brazil (162 women and 78 men), aged 18 to 52 years (average = 21.6; standard deviation = 3.9) were recruited. Recruitment was carried out through a direct approach with the student at the educational institution and included volunteers from twenty-six different undergraduate courses (archeology, library science, biology, biomedicine, computer science, law, physical education, nursing, civil engineering, graphic expression, pharmacy, philosophy, physics, physiotherapy, speech therapy, geography, information management, history, journalism, letters, medicine, nutrition, dentistry, pedagogy, psychology, and chemistry). All those who agreed to participate in the study signed a free and informed consent form as instructed in resolution No. 466/12 of the National Health Council. The study was approved by the ethics committee on human research at the University of Pernambuco-Opinion No. 3,015,401. To compose our experimental design, we used information related to disease challenges as a research model.

Disease Selection and Classification

The selection of diseases was carried out through a bibliographic survey in the Scopus database (https://www.scopus.com/home.uri) using a search engine with keywords. The objective was to identify two distinct types of disease: ancestral and modern. The following inclusion criteria were used: (i) we categorized as ancestral diseases those that the studies referred to as present in African Pleistocene environments, where the first human beings probably lived (see Cockburn, 1971; Houldcroft & Underdown, 2016; McmichaeL, 2004; Omran, 2005; Polgar, 1964; Stepanov, 2016); and (ii) we categorized as modern diseases those that originated as a result of the lifestyle adopted by contemporary human beings after the advent of agriculture and the establishment of a sedentary life (see Jew et al., 2009; McmichaeL, 2004; O'keefe Jr & Cordain, 2004; Sudano & Gregorio, 2011; Stepanov, 2016). For example, type II diabetes represents a modern disease that has recently emerged due to the excessive consumption of sugar by humanity (see Sudano & Gregorio, 2011), while diarrhea represents an ancestral disease usually caused by pathogens (e.g., bacteria) that have been present since the beginning of human life on earth (see Houldcroft & Underdown, 2016; Omran, 2005; Weyrich et al., 2017).

We identified nineteen diseases in total, of which 12 were ancestors (measles, flu, smallpox, mumps, tuberculosis, chicken pox, pneumonia, diarrhea, hepatitis, leprosy, arthrosis, and malaria) and 7 were modern ones (diabetes, hypertension, asthma, lupus, cancer, stroke, and tetanus). We selected the names of eight of the nineteen diseases, four ancestors (tuberculosis, arthrosis, diarrhea, and mumps) and four modern ones (hypertension, asthma, stroke, and tetanus), which fit the criteria established in this study to compose the experimental design. Ancestral and modern diseases were organized into two groups—acute and chronic (see Fig. 1). The grouping of ancestral and modern diseases into chronic and acute diseases was carried out considering the duration of the disease (see Brazil, 2013a, b). Acute conditions in general have a short course, less than three months in duration, and tend to self-limit, while chronic conditions have a fairly long duration, exceeding three months, and in some cases, they tend to present themselves permanently (Mendes, 2012).

In this study, due to the short duration of acute conditions, we considered these diseases to have a greater potential to reinfect people than chronic conditions, and therefore, diseases capable of affecting people more regularly. Thus, we considered acute diseases to be more regular and chronic diseases to be less regular.

Chronic and acute diseases were grouped into four subgroups: chronic of high and low incidence and acute of high and low incidence (see Fig. 1). Incidence constitutes new cases of disease in a population (Indrayan, 2013). Thus, when we refer to high-incidence diseases, we refer to diseases that generate a greater number of new cases among individuals in a given population, and low-incidence diseases are those that generate a small number of new cases. The grouping of high- and low-incidence diseases was performed based on disease incidence data in the Brazilian adult population provided by the Ministry of Health (2017).

Stimulus

Fictional stories that referred to a person affected by an illness constituted the stimuli used in the study. Each fictional story was associated with one of the eight diseases previously selected (see Fig. 1). To compose the fictional stories, we previously selected information about the causes, symptoms, and forms of treatment for each disease using data from the Ministry of Health (see Brazil, 2009, 2011, 2013a, b, c, 2016, 2019). Specific information on each disease was incorporated into its corresponding fictional history. Thus, each of the fictional stories corresponded to a health risk scenario. All stories had the same standard structure and approximate number of words (see Box 6). Information on the name of the disease, causes, symptoms, and treatments varied between the fictional stories. A brief description of the disease (e.g., hypertension is a disease that causes an increase in blood pressure) also varied between stories and was intended only to contextualize the type of disease used. Below is a fictional story model applied in the study.

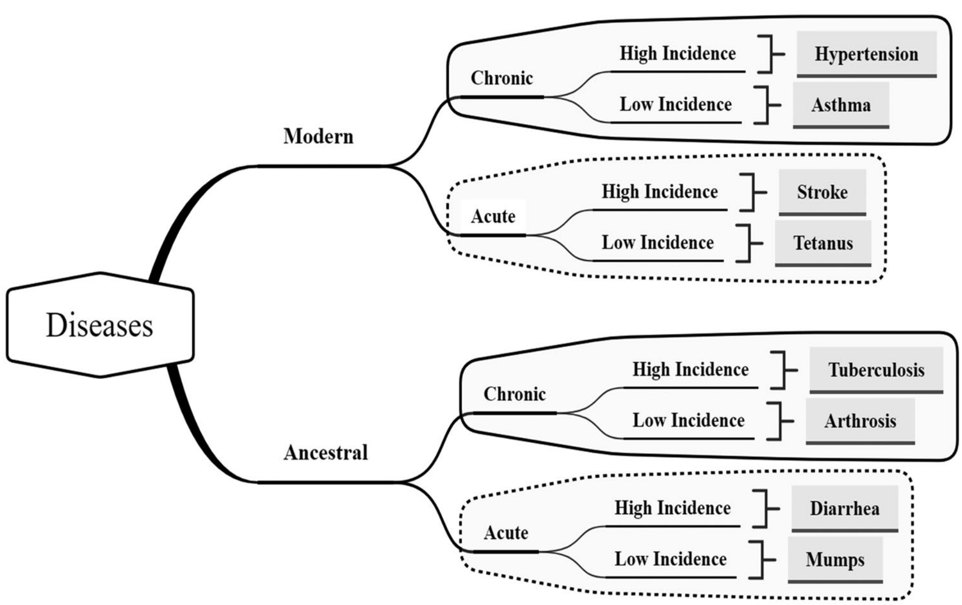

Fig. 1 Classification of diseases into ancestors and moderns categories and divided into two groups (chronic and acute) and categorized into four subgroups (chronic of high or low incidence and acute of high and low incidence)

The number of participants recruited was equal for each of the eight fictional stories, totaling 30 volunteers per story.

Box 1 Fictitious history model presented to students at the Federal University of Pernambuco, Brazil

Fictional story model

A person suffers from **[disease x],** a disease that causes **(brief description).** Some of the factors responsible for causing the disease were found to be **[cause x]** and **[cause y].** Among the main symptoms observed, **[symptom x]** and **[symptom y]** stand out. To be treated, medications such as **[treatment x]** and **[treatment y]** were used.

Procedure

The protocol used was adapted from the work of Jiménez et al. (2018). First, the fictional stories were randomized (see boxed model 1). Posteriorly, the volunteers were informed that they were participating in a study on human behavior in relation to diseases. For this, they would need to pay attention to the story presented to them regarding a health risk situation. The volunteers were informed that this procedure was important because they would be asked about the disease later. However, no additional information about the type of questioning to be carried out was provided. All participants received the same instructions. Then, the volunteers individually and in a controlled environment—free from noise and movement of people—received a single fictional story written on paper (A4 size) and were instructed to read it carefully.

After this procedure, the text was taken from the volunteers, and they were instructed to fill out a form with their personal data (age, sex, course, etc.). Filling out the form worked as a 2-min distraction activity. The distraction interval avoids the primacy or recency effect, which involves remembering mainly the first or last words read.

Subsequently, the volunteers performed a surprise recall test, where they were instructed to recall the story presented as accurately as possible. The researcher gave the following instructions: “Write down what you can remember about the text previously presented. Be as accurate as possible. Do not worry if you cannot remember all the information. You have up to 10 min to complete this activity”.

At the end of the recall test, the volunteers were asked to complete a form with the following questions: (i) Were you or are you affected by this disease? (ii) Has any relative been or is affected by this disease? The purpose of these questions was to assess whether information related to diseases with previous experiences would be favored in the participants’ memory. In this study, we considered a previous experience the individual being or having been affected by the disease. In addition, the questioning about the previous experience of illnesses in the family aimed to investigate a possible influence of the family history in remembering the information contained in the stories.

Data Analysis

To evaluate the recall of the fictional stories corresponding to each disease, we considered the propositions remembered by the volunteers. The propositions constitute the central information in a narrative (Stubbersfield et al., 2014). We considered the name of the disease, causes, symptoms, and treatments as propositions.

To investigate which factors best explained the recall of propositions associated with diseases in each fictional story, we applied a multilevel logistic regression with binomial distribution. We created a data matrix in which we recorded the volunteers’ recall of each of the propositions for each disease. A column of presence and absence of memory was generated, where “0” symbolized an unremembered proposition and “1” a remembered proposition. The sum of the propositions remembered by each participant for the disease was used as the response variable in our analysis.

To test the hypotheses that more regular diseases over evolutionary time are prioritized in memory (H1), more regular diseases in the current environment are prioritized in memory (H2), previously experienced diseases are favored in memory (H3), and ancestral diseases are prioritized in memory (H4), we used the following predictive variables: regularity of disease occurrence in evolutionary time (acute or chronic), regularity of disease occurrence in the current environment (high or low incidence), period of origin of the disease (ancestral or modern), previous experience (yes or no), and family experience (yes or no) (see Table 1).

To test the validity of our complete model that included our predictive and explanatory variables, it was compared with the null model, which considered only the effect of random participants on recall. We used the X^2 test to adjust the models using the ANOVA function and the maximum likelihood estimate (Finch et al., 2014). To determine which predictive variables best explained the recall of the propositions, we successively removed the predictive variables included in our complete model and compared their fit values using the AIC (Akaike information criteria) to identify the best-fit model. All analyses were performed using the software R version 3.4.1 (R Core Team, 2015) with the support of the lme4 packages (Bates et al., 2015) and lmerTest (Kuznetsova et al., 2017).

Table 1 Multilevel logistic regression models generated to understand whether the variables period of origin of the disease (ancestral or modern), regularity of the disease in evolutionary time (chronic or acute), regularity of the disease in the current environment (high incidence or low incidence), previous experience (yes or no), and family experience (yes or no) predicted the recall of propositions

Fixed effect	**Null model** Coefficient (standard error)	**Model 1** Coefficient (standard error)	**Model 2** Coefficient (standard error)	**Model 3** Coefficient (standard error)	**Model 4** Coefficient (standard error)	**Model 5** Coefficient (standard error)	**Model 6** Coefficient (standard error)
Intercept	0.57 (0.06)*	0.72 (0.08)*	0.74 (0.08)*	0.67 (0.08)*	0.48 (0.06)*	0.62 (0.09)*	0.58 (0.10)*
Period of origin	-	−0.29 (0.12)	-	-	-	-	-
Regularity in evolutionary time	-	-	−0.34 (0.12)*	-	-	−0.24 (0.12)*	−0.26 (0.12)*
Regularity in the current environment	-	-	-	−0.19 (0.12)	-	-	-
Previous Experience	-	-	-	-	0.61 (0.17)*	0.52 (0.17)*	0.45 (0.18)*
Family Experience	-	-	-	-	-	-	0.12 (0.12)
Random effect	Variance (standard deviation)	Variance (standard deviation)	Variance (standard deviation)	Variance (standard deviation)	Variance (standard deviation)	Variance (standard deviation)	Variance (standard deviation)
Level 2							
Participants	0.19 (0.43)	0.17 (0.41)	0.16 (0.40)	0.18 (0.42)	0.15 (0.38)	0.14 (0.37)	0.13 (0.36)
Adjusted							
AIC	2203.4	2199.4	2197.0	2202.8	2192.1	2189.8	2190.8

Model 1−evaluates the effect of the period of origin of the disease (ancestral or modern) on recall; Model 2−assesses the effect of disease regularity in evolutionary time (acute or chronic) on recall; Model 3−evaluates the effect of disease regularity in the current environment (high or low incidence) on recall; Model 4−evaluates the effect of previous experience with the disease on recall (yes or no); Model 5−assesses the combined effect of disease regularity on evolutionary time and previous experience on recall; Model 6−assesses the combined effect of disease regularity on evolutionary time, prior experience, and family experience on recall

*$p < 0.05$

Results

The results supported our H1 hypothesis, which states that more regular diseases over evolutionary time (acute) would be prioritized in memory. Our results also support H3, which claims that diseases from previous experiences would be favored in memory. The generated models showed that the combined effect of the regularity of the disease in the evolutionary time and previous experience with the disease were the factors that best explained the recall of the propositions (Model 5: AIC = 2189.8; Regularity in the evolutionary time (acute/chronic): [chronic]- $Z = -2.067$, $p = 0.038$, previous experience (Yes/No): [Yes]- $Z = 2.987$, $p = 0.002$) (see Table 1).

The results showed that chronic diseases negatively influenced the recall of propositions, indicating that people remembered fewer propositions associated with chronic diseases than those related to acute diseases (see Tables 1 and 2). However, illnesses from previous experiences had a

Table 2 Mean and standard deviation of the proportion of propositions remembered by the participants for each disease condition

Period of origin	**Regularity in evolutionary time**	**Regularity in the current environment (incidence)**	**Disease**	**Proportion**	
				M	**SD**
Modern	Chronic	High	Hypertension	0.58	0.49
	Chronic	Low	Asthma	0.58	0.49
	Acute	High	Stroke	0.65	0.48
	Acute	Low	Tetanus	0.60	0.49
Ancestral	Chronic	High	Tuberculosis	0.60	0.49
	Chronic	Low	Arthrosis	0.62	0.49
	Acute	High	Diarrhea	0.78	0.41
	Acute	Low	Mumps	0.66	0.48

M mean, *SD* standard deviation

positive influence on the recall, indicating that propositions associated with illnesses from previous experiences were better remembered than those associated with illnesses not experienced.

In contrast, our hypothesis that more regular diseases in the current environment would be prioritized in memory (H2) and that ancestral diseases would be favored over modern diseases in memory (H4) was not supported. The models generated with the period of origin of the disease (Model 1: AIC = 2199.4) and regular diseases in the current environment (Model 3: AIC = 2202.8) did not significantly increase the prediction of recall. When evaluating the combined effect of the regularity of the disease in evolutionary time, previous experience, and family experiences, we found that diseases from previous experiences in the family did not influence the information recalled, reducing the explanatory potential of the model (Model 6: AIC = 2190.8; Family Experience (Yes/No): [Yes] $Z = 1.022$, $p = 0.31$). These results reinforce the finding that acute illnesses and those previously experienced received better recall scores.

Discussion

This study provides a new contribution to the theoretical field of adaptive memory, revealing that this memory can be modulated by the regularity of occurrence in evolutionary time and previous experience with the challenge in the environment, regardless of whether it involves an ancestral or recent disease. The recall of information about these diseases can be explained because in the modern human mind, psychological traits coexist to deal with ancient and recent threats (Barrett, 2012). It is possible that any of these traits can be activated in memory. The activation of the trait would be due to the greater regularity with which the disease affects people over time and their previous experiences with the threat in the environment. We suppose that this is because the regularity of disease over time generates previous experience and influences the increase in the perception of risk, making information about diseases that present these characteristics better evoked in memory.

Studies have observed that the most regular environmental challenges (Ruin et al., 2007; Sachs et al., 2017) and previous experience (see Grothmann & Reusswig, 2006; Halpern-Felsher et al., 2001; Öhman, 2017; Prokop et al., 2015; Siegrist & Gutscher, 2006; Wachinger et al., 2013) influence human risk perception. For example, it has been observed that rare environmental events of great magnitude and serious consequences are perceived as having a lower risk owing to their low occurrence in the population (see Ruin et al., 2007). In addition, people who have previous experiences with illnesses have a higher perception of risk in relation to these illnesses (see Gibbons & Groarke, 2016). Such evidence indicates that greater regularity with which environmental challenges affect people and previous experience with these threats can influence the perception of risk in relation to threats in the environment.

Another interesting issue that arises from this discussion is that diseases experienced directly were found to be better recalled in relation to those that had been experienced in the family. These results are consistent with other studies that investigated the effect of self-reference on human memory (see Sui et al., 2012; Symons & Johnson, 1997). Therefore, people who have had direct experience with the illness are more likely to remember information about the illness than those who have not had any direct experience with the illness.

In addition, evidence suggests that acute illnesses such as diarrhea were present among our ancestors (see Weyrich et al., 2017). As acute diseases have a shorter duration in the body (Mendes, 2012), presenting a greater potential for reinfection than chronic diseases, this leads us to suppose that the greater regularity of acute diseases over evolutionary time exerts greater selective pressure on human memory. In addition to this evidence, studies show that information about objects contaminated by infectious diseases tends to be better remembered than uncontaminated objects (see Fernandes et al., 2017, 2021). This evidence suggests a role for the infectious characteristic of diseases in memory performance, indicating that information about acute diseases was better remembered because they were more infectious.

In contrast, we observed that more regular diseases in the current environment (high incidence) were not better remembered. This can be explained by the fact that high-incidence diseases vary in time and space, being more regular at one time in the environment but not at a second time (see Bierrenbach et al., 2007). This fact reinforces our findings that greater regularity of diseases over evolutionary time is more important for the fixation of information in memory.

Throughout our evolutionary history, we have faced a variety of environmental challenges. An adapted memory capable of adjusting to threats that varied in time and space, recovering especially information about threats that affected more regularly, may have been advantageous for the first hominids. According to Anderson and Schooler (1991), human memory is adapted to respond to the structure of the environment, privileging in memory that information is most likely to be useful in the future. Thus, information that individuals constantly access, for example, words read daily in a newspaper, is more easily retrieved from memory (Anderson & Schooler, 1991). Thus, human beings may have developed an effective cognitive and behavioral apparatus to solve the challenges that most often affect nature (Ferreira Júnior et al., 2019).

How does an adapted memory that is not solely tied to solving ancient challenges affect modern human behavior? Studies have observed different attitudes of people toward diseases that occur more regularly, which may involve both preventive behaviors (see Lavielle & Wacher, 2014; Prokop et al., 2014; Wu et al., 2019) and those related to the selection of natural resources to treat diseases (see Nascimento et al., 2016; Santoro et al., 2015, 2016).

For example, Schaller and Murray (2008) found that people living in regions with a high occurrence of infectious diseases have lower levels of sociosexuality, extraversion, and openness to new experiences, which is a possible disease avoidance behavior. People also select more natural resources to treat recurrent diseases (Nascimento et al., 2016; Santoro et al., 2015, 2016; Sherman & Billing, 1999). For example, it has already been observed that people concentrate a greater wealth of plants and animals in their pharmacopoeia for the treatment of diseases perceived as more frequent (Nascimento et al., 2016; Santoro et al., 2015).

This evidence shows that diseases that affect more regularly influence human cognition and, consequently, may interfere with human behavior to deal with diseases. This study indicates that the same can occur when human beings are exposed to other types of challenges they are regularly affected by and to previous experiences in nature. We suggest that future studies investigate the existence of other possible factors responsible for intensifying certain information of importance to survival in human memory. This understanding will allow us to more clearly comprehend the link between cognition and human behavior in the face of different environmental challenges.

Limitations

One of the acute diseases selected for this study (stroke) does not have an infectious character, something that we argue to be important for memory performance. Therefore, we suggest that future studies intending to replicate these findings or test new hypotheses should include acute diseases caused by pathogens in their design. In addition, five of the diseases used in this study were not directly experienced by the participants. Therefore, this fact may have led us to not adequately measure the effect of the variable "prior experience" on memory performance.

Final Considerations

Our results showed that information about more regular diseases in evolutionary time and from previous experiences was better evoked in memory. This occurred irrespective of whether the disease was ancestral or modern. We argue that the increase in risk perception in relation to diseases is more regular in evolutionary time and previously experienced boosted differential recall. Another important factor that may have driven the recall was the greater regularity of acute illnesses throughout human evolutionary history, which may have exerted a greater selective pressure on memory. We suggest that this was only possible because humans inherited an adapted memory capable of adjusting to the fluctuating threats in the environment, better fixing those challenges that affect nature more regularly. Thus, this study provides a new contribution to the understanding of the cognitive bases that structure the relationship between people and diseases, revealing some factors responsible for modulating human memory adapted for survival.

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Author contribution RHS, JMBM, ABN, WSFJ, and UPA conceived of and designed the study. RHS conducted data collection, and RHS and ABN performed analysis. RHS wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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Code Availability Not applicable.

Declarations

Ethics Approval The study was approved by the ethics committee on human research at the University of Pernambuco-Opinion No. 3,015,401.

Consent to Participate All those who agreed to participate in the study signed a free and informed consent term as instructed in resolution No. 466/12, of the National Health Council.

Consent for Publication Not applicable.

Conflict of Interest The authors declare no competing interests.

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