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The Linguist's Guide to Human Fallibility and Biases: their Evolution, Cognitive Significance and Impact in Decision Making

Most people, including many scientists, readily assume that human perception depicts reality truthfully, that human thought processes are essentially rational, and that episodic memory aptly stores and recalls factual information about personal experiences. However, these notions are only partially true. Of course, evolutionary pressures have culminated in an overall quite powerful cognitive system that allows humans to adequately cope with the circumstances present within their ecological niche(s), but nevertheless, perception of the outside world is subject to the brain's "motivated" interpretation out of imperfect input, thinking is guided by heuristic shortcuts as well as a plethora of unconscious biases, and memory shows itself to be imperfect as well as malleable to a variety of influences. As a result, intuitive judgments on reality are, in principle, to a certain degree unreliable. Cognitive shortcomings constitute an intrinsic condition of human nature and profoundly impact how people interpret the world and interact with their material and social surroundings. This paper is motivated by the fact that many scholars within linguistics, as well as most students of the field, have little to no awareness of the pertinent literature, even though these biases may directly or indirectly influence their work. The following therefore aims to present a concise introduction to the topic, from the evolutionary background to practical implications within linguistic research.

Keywords: perception, cognitive biases, linguistic theory, linguistic methodology

Des Linguisten Einführung zu menschlicher Fehlbarkeit und kognitiven Verzerrungen: deren Evolution, kognitiver Stellenwert und Einfluss auf die Entscheidungsfindung

Die meisten Menschen, darunter auch viele Wissenschaftler, nehmen bereitwillig an, dass die menschliche perzeptuelle Erfahrungswelt die objektive Realität in einer wahrhaftigen Art und Weise abbildet, dass menschliche Denkprozesse im Grunde rational sind und dass das episodische Gedächtnis faktisch korrekte Informationen über persönliche Erlebnisse dokumentiert sowie abruft. Allerdings sind diese Annahmen nur teilweise korrekt. Natürlich kulminierten evolutionäre Prozesse in einem sehr leistungsfähigen kognitiven System, das Menschen erlaubt, mit den Anforderungen ihrer ökologischen Nische(n) adäquat umzugehen, doch die Wahrnehmung der Umwelt geschieht dennoch unter dem Einfluss der „motivierten" Interpretation des Gehirns aus unvollständigem Input, das Denken ist geprägt von heuristischen Abkürzungen sowie einer Vielzahl kognitiver Verzerrungen und das Gedächtnis zeigt sich als fehlbar und durch eine Fülle von Einflüssen beeinflussbar. Dementsprechend sind intuitive Einschätzungen über die Realität ganz prinzipiell bis zu einem gewissen Grad unzuverlässig. Kognitive Defizite stellen eine intrinsische Eigenschaft der menschlichen Natur dar und haben einen umfangreichen Einfluss darauf, wie Menschen die Welt interpretieren und mit ihrer materiellen respektive sozialen Umwelt verfahren. Der vorliegende Artikel ist durch den Umstand motiviert, dass viele Wissenschaftler innerhalb der Linguistik sowie die meisten Studierenden dieser Disziplin sich bzgl. der Sensibilitäten der einschlägigen Literatur wenig bis nicht bewusst sind, obwohl ihre Arbeit durch jene kognitiven Verzerrungen direkt oder indirekt beeinflusst werden kann. Der nachfolgende Überblick hat daher zum Ziel, eine kompakte Einführung in die Thematik anzubieten, von evolutionären Hintergründen bis zu praktischen Implikationen für die linguistische Forschung.

Schlüsselwörter: Perzeption, kognitive Verzerrungen, linguistische Theoriebildung, linguistische Methoden

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1. Introduction

All people, no matter their age, level of education or group affiliation, typically aim to track reality in their observations and judgments truthfully. This objective is somewhat counteracted by the inner workings of the human mind and its sensory interface with reality, both of which have evolved not to perceive and understand the world as it really is but to maximize human survival within it (e.g. Haselton et al. 2005, McKay/Dennett 2009). Granted, mental representations and thought-processes necessarily correlate with the material world in a rather stable, i.e. reliable, manner, but an at least partial disconnect between human perception and reality cannot be denied. For once, the brain models the outside world indirectly by interpreting sensory input. In the course of this modeling, aspects of experience get filtered out, enhanced, combined or straight-up modified in order to render an agent's interactions with its surroundings efficient and to facilitate its survival within its ecological niche. Further, intuitive judgments, conceptualizations, memory and, building on those, abstract decision making are similarly streamlined for the same purpose. Ultimately, these nonveridical perceptions and judgments serve as a foundation for a whole suit of systematic tendencies to perceptual error and cognitive biases that are built into all of us – hard-wired and seemingly impossible to control for consciously.

Thus, outside of everyday judgements that, by evolutionary design, mostly follow intuitive heuristics, one cannot (or rather should not) naively rely on direct experience or intuitions. While this much is readily accepted by anybody who recognizes that the scientific endeavor constitutes an attempt to leave behind the limitations of human subjectivity through methodological means, the empirical evidence accumulating in disciplines like psychology and neuroscience on the extent of human perceptual and cognitive fallibility is not widely appreciated. These domains have practical implications for any person, including linguists conducting their research, which is impacted in a multitude of areas and dimensions: From hypothesizing and formulation of theory to choice of methodology and interpretation of results; from experimenters and their assistants to test subjects; from study authors to readers of the study; and between competing research groups. In an attempt to offer an accessible introduction to the topic, this paper discusses a range of relevant notions, tying together diverse areas of research.

At the same time, this overview is limited in scope and, therefore, cannot offer an in-depth discussion on fallibility in linguistic research, restricting itself to succinctly presenting and reviewing relevant concepts, and only giving select examples from the linguistic literature along the way. In pursuit of this rather general goal, the next section will begin by introducing how naive data collection is inherently unreliable and how evolution shaped the neuroanatomical substrate of modern human cognition in a way that systematically leads to errors and biases. Further sections will selectively explore the psychological literature, exemplifying key issues and sketching out how common biases manifest themselves. The paper will then culminate in a rough outline of how fallibility and biases may impact linguistic research if those factors are not controlled for – though, as mentioned, this outline ultimately cannot be anything but incomplete.

2. The Inherent Unreliability of Naive Data Collection

On a fundamental level and not yet pertaining to human biology, people's fallibility is rooted in the naive collection of data sets. In daily life, barely ever does anybody explicitly create conditions in which data collection is exhaustive, in which confounding factors are controlled for or in which it is attempted to falsify one's beliefs. Instead, we opportunistically and naively collect data – and along the way, through intuitive heuristics, our opinions simply come to us. Coincidentally, despite this being the most widespread approach to the formation of opinion and decision making, it is a flawed methodology when attempting to seek the truth in a reliable manner. An admittedly comically quaint thought experiment shall exemplify this statement: Two flatmates have a disagreement on if the vegetable drawer of their fridge should, as a default mode, remain open or closed. One of them, named Fritz, declares that it is more hygienic to keep it shut, while the other, Max, objects that it is an unnecessary hassle to open and close the drawer every time one needs to put something in or take something out. However, in order to not escalate the argument, the latter gives in and promises to keep it shut from now on. Despite this promise, he occasionally forgets simply because he is not used to that behavior, and whenever Fritz encounters one of those instances, he gets annoyed at Max's carelessness.

What has to be acknowledged in this scenario is that Fritz, of course, mostly collects data points whenever he finds the vegetable drawer to be open. On those occasions in which Max conscientiously thought of closing it, for Fritz, there is nothing to observe because a shut drawer is a non-event from his perspective. It is disqualified from being a data point for the reason that Fritz does not know if Max closed it or if it was closed to begin with. Therefore, unless having a reason to believe that Max was handling the vegetable drawer beforehand, Fritz will unconsciously discard any instance where he finds it to be closed. Through this naive collection of data, Fritz comes to the subjectively justified conclusion that Max is unreliable and regularly forgets to keep his promise, though in fact this is not the case.

Max, in the meantime, collects an entirely different data set: He only takes notice of his actions whenever he succeeds in adhering to his promise. In those instances where he forgets, trivially, he does not mentally check a data point for **forgetting**. As a result of this inherently biased collection of confirmatory evidence, both parties formulate diametrically opposed opinions that nevertheless, at least subjectively from their respective perspective, appear justified. In other words, opportunistic and naive data collection is, by design, systematically biased and thereby fallible. While the scenario that has been sketched out above merely constitutes a petty dispute within a flat share household, it is nonetheless representative of a deeper problem as the same pattern of problematic data collection and formulation of ill-formed opinions can be found in much more serious contexts.

This general pattern outlines how an individual or a group may successively build prejudices towards other ethnicities, cultures or religions by, once again, forgetting non-events and remembering salient, i.e. emotionally loaded, events as data points. It is also partially responsible for the polarization of political landscapes for the same reason. Even geopolitical conflicts may escalate through a wrongfully formulated conviction rooted in a path of inference that is not unlike the one sketched out above. Hence, from household disagreements to the geopolitical scale, selectively collecting information and basing opinions, actions or policies on an incomplete and thereby inherently biased data set has a potentially negative influence in many contexts. For a linguist, this effect may e.g. manifest itself when apparently seeing a pattern in language data one is working on but without having implemented a sufficiently strict methodology, like in a well-designed corpus study, instead just sifting through data without controlling for potentially ill-founded intuitions. From personal experience, this is a problem in many student theses, but even peer-reviewed technical papers sometimes work with open samples and without proper controls.

However, that is not all there is to say on the subject. Instead, the extent of human fallibility goes far beyond these structural issues due to the fact that people not only inadvertently collect data sets that bias them for confirmation but actively (though unconsciously) seek confirmation of their opinions and expectations, falling victim to perceptual and heuristic errors along the way. This systematically biased and fallible behavior is, to a large extent, grounded in human neuroanatomy, which in turn has been shaped by evolutionary processes. The next sections will elaborate on these issues, i.e. why and how people have an innate propensity to deal with reality in a manner that is, in certain ways, fundamentally error-prone.

3. The Evolution of Fallibility

The following section elaborates on what has been put forward in relation to the evolution of human cognitive shortcomings. Such statements presumably necessitate clarification as for a neuroanatomical structure like the brain to systematically include erroneous perceptions and error-prone pathways of judgment seems to be disadvantageous (though evolutionary psychologists and behavioral biologists are very familiar with this notion;

e.g. Haselton et al. 2005). Instead, intuitively, the most viable evolutionary strategy for an organism seems to be one that builds a truthful mental representation of reality in order to maximize effective interaction with the given material (and, if applicable, social) environment. However, three themes counteract this assumption.

Firstly, strong selective pressure on caloric efficiency naturally leads to limitations in processing. The brain consumes a noteworthy portion of the human body's energy budget, vastly exceeding the average for most other tissues. Keeping calorie expenditure as low as feasible while upholding sufficient function constitutes a highly impactful factor during evolution. As a result, despite the baffling complexity and intricacy of the human neuroanatomical architecture, in many ways, attention, memory and thought are streamlined for a Pareto optimal balance between task effectiveness and energy efficiency, which inherently entails (potential) fallibility for high-demand yet low-payoff tasks (e.g. Arkes 1991). Resulting cognitive limitations lead, for example, to well-documented psychological phenomena like inattentional blindness and change blindness, which will be sketched out alongside other human cognitive shortcomings in a later section.

Secondly, there is no inherent motivation for evolution to favor a perceptual or cognitive adherence to the true nature of the material world. The sole mode of selection in any population of organisms is for statistical survival advantage (or, actually, what is technically driving selection is a statistical reproduction advantage, partly facilitated by survival). As previously mentioned, this entails a stable relationship between perception and reality, but this stability does not guarantee truthfulness in relation to objective reality. For example, there is a clear advantage in perceiving and recognizing objects, events or patterns as distinct, stable and internally consistent entities. Thus, regardless of the context (lighting conditions, time of day or night, weather conditions, personal mood etc.), the brain continuously and unconsciously alters perception in order to offer such an internally consistent account of reality, even if this account stands in conflict with the true nature of reality.

This may be exemplified by the checker shadow illusion (Figure 1) as well as a plethora of other optical, acoustic or tactile illusions and misperceptions, which shall be omitted here for brevity. Further evidence comes from computer simulations, in which nonveridical perceptual systems regularly outcompete those that are pre-designed to truthfully model reality (e.g. Gigerenzer/Goldstein 1996, Hoffman et al. 2015). This means that in addition to the previously discussed factor of caloric efficiency being a limitation on perception and processing, abstracting a nonveridical mental world from perceptual input seems to be a more effective way to deal with reality than a strict adherence to truthfulness. In other words, in real-world situations, nonveridical and biased agents deal with reality more effectively and efficiently than veridical/unbiased agents (e.g. Gigerenzer/Brighton 2009). These biases, however, have their downsides in certain circumstances – and that is where the often counter-intuitive scientific method has to step in.

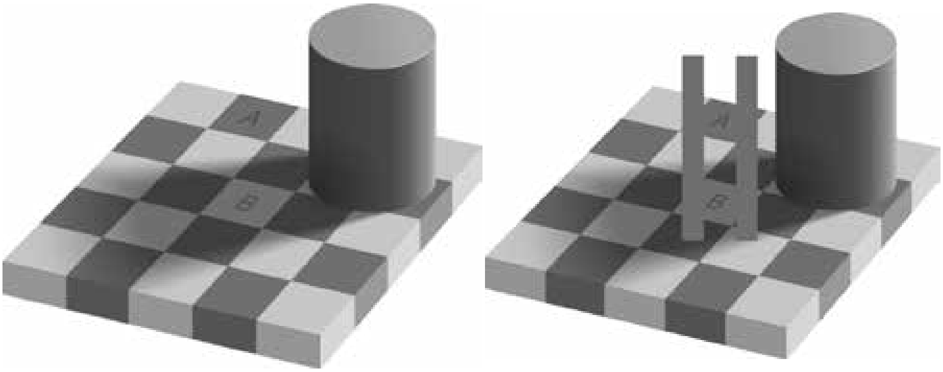

Figure 1. The squares marked A and B are the same shade of grey, but the brain unconsciously corrects to a seemingly more logical brightness scheme. Media license: Copyrighted free use. Copyright by Edward Adelson, MIT

Thirdly, human perception and thinking are finely tuned to a prehistoric ecological context, i.e. the ecological niche that humans and previous chronospecies have evolved in. For example, humans cannot judge temperatures or hardness beyond a narrow range that is of direct relevance to immediate experience, meaning things that are hard or soft and hot or cold to bodily experience, and are incapable of seeing outside a narrow range of the electromagnetic spectrum. This, of course, partly results from bodily limitations (e.g. it is nonsensical to expect accurate judgement of temperatures beyond a threshold of significant bodily injury), but, for example, the perception of color is a direct function from our ancestors being frugivores, which means that evolutionary processes heavily selected for color vision with high sensitivity in ranges that help identify the coloring of ripe fruits in their natural contexts (e.g. Bompas et al. 2013).

Further, human perception is primarily adjusted to dealing with lengths of space between millimeters and a few dozen kilometers as well as lengths of time from milliseconds to some decades. In this sense, because human intuition breaks down when particularly large or small distances and timescales are involved, most pre-scientific, as well as early scientific notions, contended that the earth is a few thousand years old, the universe is limited to the solar system and organisms are macroscopic, remaining ignorant about the existence of microbes. Meanwhile, the true age of the earth, the vastness of space and the unbelievable richness of the microcosm are all insights that stem from scientific efforts throughout roughly the last 150 years, and this exemplifies how judgments on the real world are obscured by the unconscious focus on immediacy. Through language, humans managed to mentally and communicatively leave the natural origo of the speaker (e.g. Leiss 2020: 21, building on Bühler's classic work), but this extension, when based on intuition and not on science, does not travel far from immediate experience.

Similar limitations that directly result from human evolutionary history concern probabilistic judgments. A classic example of this lies in human bias towards type

1 errors, i.e. false positives (e.g. Johnson et al. 2013). A somewhat simplistic scenario may help explain this: When encountering a rustling or crackle in the bushes, a given prehistoric human might have intuitively assumed agency, like an animal or another human, as the source of the sound. From a scientific perspective, this assumption is not necessarily correct as it could have very well been just the wind or another inanimate cause. Yet, a type 2 error (false negative; wrongly assuming that there was nothing of interest) would be a major disadvantage (missing out on prey) or possibly even deadly (predator or other hostile entity), while a type 1 error (false positive; wrongly assuming that there is something of interest) constitutes a mild inconvenience. Consequently, a tendency to type 1 errors and erroneously attributing agency to processes and objects is hard-wired into us. If we feel a draft and a door falls shut, we think nothing of it, but if the windows are closed, and a door falls shut without any apparent physical cause, our intuitions warn us that agency may have been involved – hence the belief in ghosts, demons and the sort in individuals that are especially prone to such judgment calls.

Overall, the perceptual system and the subsequent conceptual processing are finely tuned to the evolutionary niche humans prehistorically resided in. We see the colors that we can see because our ancestors were frugivores, we tend to engage in false positives and overly pronounced agency detection because this constituted a valid risk assessment strategy in the open woodland habitats that our ancestors lived in, and we constantly employ our overactive pattern recognition due to the need to quickly form behavioral patterns in a variable ecological context. Especially the latter is further intensified by our hyper-sociability, which entails a constant necessity to readjust to highly variable and exceptionally rich social contexts. Of course, all of these and more aspects of the human condition need to be executed in the presence of strict processing limitations, which constitute another source of error. Ultimately, a suit of perceptual shortcomings and cognitive biases which conflict with any attempt to adequately explore reality as it is, even extending to the domain of the sciences, stems from these circumstances. The following sections will elaborate on how the human mind is limited and then will discuss concrete examples of how our brain fails us in certain ways or contexts. After that, the ways how these shortcomings may impact linguistic research will be briefly discussed.

4. Inherent Processing Limitations in Human Consciousness

This section is shorter than than the previous one, as much of its contents is relatively well-known within the broader literature. Nevertheless, in order to offer a compelling account, a certain amount of discussion seems appropriate. The previous section mentioned the evolution of processing limitations, and this one will elaborate on resulting issues in an exemplifying manner. Starting off, in a landmark publication, Miller (1956) introduced the notion of a strict limit to how many chunks can be held within working memory at a time, producing results that the "magical" number of maximal capacity may be seven plus/minus two. Further research proposed other such strict limitations (e.g. four in Cowan 2001) and recently opted for the explanation that working memory might be more fittingly described as a limited resource that is put to use rather flexibly and may lead to different capacity limitations depending on the quality of the specific task (e.g. Ma et al. 2014). Independent from the exact interpretation of the data, i.e. no matter if fixed or variable limitations are employed as an explanation, important insights remain. The research unanimously suggests that the processing power of human working memory has an upper limit that defines how much informational chunks may be held and processed at a time while dealing with given experiential input. This, in itself, empirically validates what has been stated before: Human perception and cognitive abilities feature some restrictions on processing power, and from this incomplete informational state follows a risk of fallacious perception and reasoning.

Such limitations are, of course, not confined to working memory but extend to many other domains of the human neuroanatomical system. In other words, human perception and subsequent processing include a series of bottlenecks that have to be successfully dealt with during the execution of cognitive functions. In the Pareto optimal balance between task effectiveness and system efficiency, a flexible redistribution of resources is a constant prime focus of the brain's neuroanatomy. An example of this lies in sensory adaptation, a term that denotes the way the brain reacts and adjusts to continual stimuli. Essentially, though this is not the whole breadth of the phenomenon (see Webster 2012), a novel sensory input leads to the allocation of conscious attention to the stimulus in question – be it somebody suddenly talking in an otherwise silent setting or the distinct pressure of a shoe that has just been put onto a foot. However, if a stimulus remains more or less unchanged in the environment and if it is not deemed important to stay alert to the stimulus, then the neural sensitivity towards the stimulus falls and the individual in question stops paying attention to it. This allows attentional resources to be occupied with more important aspects of the environment, such that even in a crowded room with lots of conversations going on, it is possible to read a book, and people do not have to constantly feel the clothes that they wear.

In this sense, sometimes less is more, as in the case of sensory adaptation being a powerful means of focusing attention to aspects that hold immediate importance in moment-to-moment experience. Additionally, sensory adaptation constitutes an effective way to cope with neuroanatomical processing limitations by conservatively employing attentional resources, rendering behavioral responses practical and energy expenditure efficient. This is the case despite loss of information, once again relating to concepts like inattentional blindness and change blindness that will be discussed later on, building on themes presented up to this point. Overall, the regulation of conscious and unconscious attention is of central importance within the human mental architecture, from infants to adults and beyond being a measure of conserving energy or helping to pay attention to acutely important aspects of experience. For example, only by unconsciously filtering auditive information, young children may learn to focus on speech sounds rather than circumstantial noise in order to learn the set of phonemes that underly a given language, and even adults still profit from this neurocognitive mechanism outside of language acquisition (e.g. Kuhl 2008). Consequently, it should once again be noted that defects or shortcomings that are being discussed in this paper constitute the flipside of otherwise highly important, evolutionarily selected for abilities and mechanisms. Nevertheless, it is of pivotal importance to not forget those limitations, shortcomings and resulting cognitive pitfalls as they also, often negatively, impact thinking and decision making.

5. Artificial "Narratives" Permeating Perception

This section will describe some selected shortcomings in different areas of perception that derive from those principles that have been presented thus far. The common theme will be one of built-in, unconscious bias towards clarity of perceptual input, i.e. the observation that the brain manipulates perceptual input in accordance with a predetermined "narrative". As has been previously stated, the brain constructs a coherent visual picture of the outside world even if this mental picture stands in conflict with actual reality, as is the case in the instructive example of the checker shadow illusion. In other words, instead of being a passive witness to the reality surrounding an individual, the brain actively constructs an individual's experience to build a coherent narrative and moderate behavior. This paper previously pointed out that such a nonveridical perceptual system offers a survival advantage, but examples have been sparse until this point. Similarly, human pattern recognition has been identified as a major factor within human cognition, but further elaboration is still lacking. Both of these aspects shall be discussed in the following.

In relation to these cognitive domains, it has to be stressed that a range of neurological functional circuits, partly learned and partly hard-wired, are responsible for the recognition of shapes and patterns within vision (e.g. Zaidi et al. 2013). The hard-wiring of some of these is evolutionarily sensible because some concepts within perception are so important for survival that the ability to quick-and-easy cognitive availability from birth constitutes a noteworthy advantage. Going into ontogeny, these implicit concepts represent essential building blocks within the subsequent conceptualization of, and therefore effective interaction with, the material world. The possibly most important evolutionary addition to the set of implicit categories within primates and especially humans has been facial recognition circuits (Kanwisher/Yovel 2006), e.g. largely missing in dogs (Bunford et al. 2020). Without inherent recognition of and orientation towards others' faces, human hyper-sociability, as well as derived capabilities, would not be possible in their current form. One of those derived human capabilities can be found in language ontogeny, which, already beginning with the acquisition of phonemes, is heavily supplemented by social interaction (e.g. Kuhl 2007), i.e. humans' implicit orientation towards and fascination with faces. This, however, in turn leads to fallaciously recognizing similar patterns in visual noise, as e.g. was the case during the face on Mars craze (Figure 2) or happens whenever a face supposedly appears on the bottom of pan-fried French toast, once again underscoring the downside to mostly positive features or abilities.

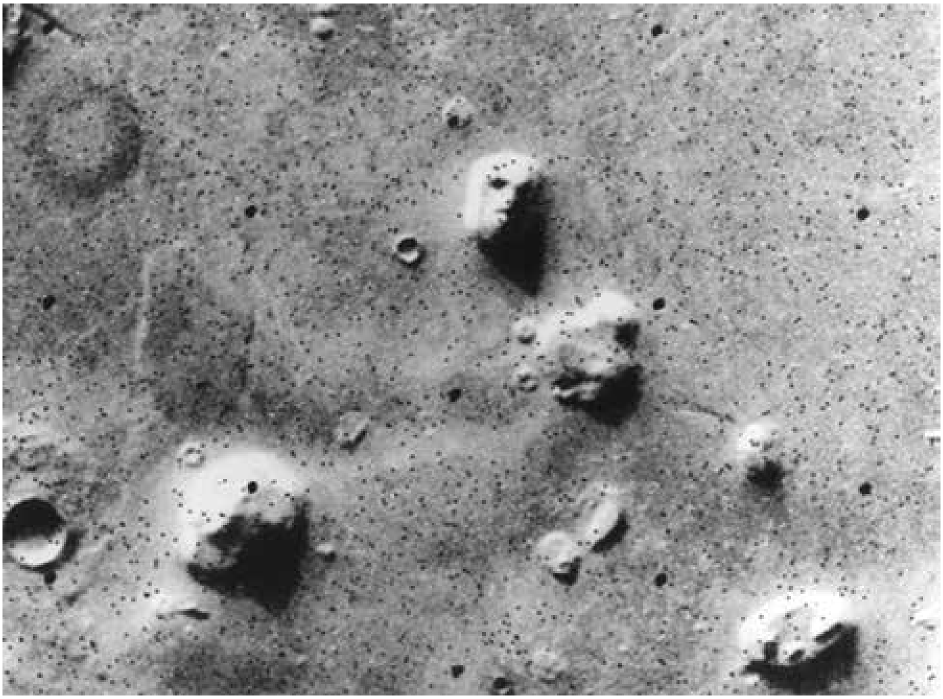

Figure 2. Picture taken by the Viking 1 orbiter in 1976, seemingly depicting a face on the surface of Mars. It is, however, an optical illusion unconsciously created by the brain due to a specific pattern of light and dark patches, resulting in a case of visual pareidolia, i.e. the tendency to incorrectly identify highly salient patterns or objects in perceptual noise. Media license: Public domain. Source: NASA

These notions and observations are not limited to vision but extend to other senses: Similar unconscious modification of experience and comparable fallacious pattern recognition is known in the auditory as well as the haptic/tactile domain. The latter shall be omitted here for the sake of brevity, but the former may be exemplified by the extensive literature on language acquisition. It is well-demonstrated that infants have an astounding capability to learn any language's phoneme system soon after birth, but as they acquire their first language, they become (partially) oblivious to distinctions between phonemes that are not covered by the system they are acquiring. A classic example lies in the phonemes /l/ and /r/, a distinction not realized in Japanese but in English. Native Japanese speakers typically have difficulties perceiving and producing this contrast accurately as, during language ontogeny, they neuroanatomically develop one phoneme category in a certain area of the sound spectrum, whereas English speakers develop two in the same area (e.g. Goto 1971). As such, a Japanese speaker's brain mentally produces one prototype representation no matter if the actual sound class they perceive is English /l/ or /r/, as both of these English phonemes map onto the same Japanese phoneme prototype. In other words, the brain aligns perception, meaning that it unconsciously alters the input to fit preconceived categories (cf. the famous McGurk effect: McGurk/MacDonald 1976).

This process, in itself, once again makes a lot of sense as variation in speech (including age, gender, emotion/mood, amplitude, pitch etc.) are supposed to be irrelevant in speech perception in order to maximize linguistic efficiency. In this fashion, evolutionary pressures have selected for a neuroanatomical system that could disconnect all of this irrelevant acoustic variation from the perception of linguistic prototypes, i.e. phonemes. Recent explanatory proposals, trying to illustrate how neuroanatomy may achieve this feat, explain the way the brain manipulates speech sound perception by the metaphor of "perceptual magnets" pulling individual speech sounds towards the proper prototype during perception (e.g. Kuhl et al. 2008). Unsurprisingly, once again, there are two sides to this phenomenon: On the one hand, this mechanism renders language ontogeny and language use highly efficient and immensely productive, but on the other, it leads to both underproductivity (when trying to learn a second language) and overproductivity (when hearing voices in random acoustic noise, a foundation of the pseudo-science of ghost hunting, for example).

In sum, the visual and auditory senses exhibit "false narratives" in that mental concepts abstract from material reality in an idealizing, nonveridical manner. In the majority of instances, this serves an evolutionarily adaptive purpose and constitutes a highly productive method to deal with reality. However, there are always situations in which these neuroanatomical systems feature detrimental side effects. In other words, despite being functionally important, these nonveridical perceptual/processing systems also show themselves to be fundamentally error-prone in certain contexts and may lead to fallacious judgments.

6. Shortcomings in Attention, Fallibility of Memory and Cognitive Biases

In this section, the level of abstraction from the immediate senses is raised once more. The following will briefly elaborate on the topic of higher-level issues in attention, memory and cognition, following the ultimate goal of building a thematic bridge to the impact of human fallibility in science – i.e. the topic of the next section. To start with, the discourse shall come back to the phenomenon of inattentional blindness as well as the related concept of change blindness, both of which have been mentioned at earlier points. The former term describes how individuals do not notice objects or events, even when directly looking at them, if they are occupied by a task to which these objects or events are not related to. Building on a long experimental literature that demonstrates this surprising psychological finding under controlled settings, Castel et al. (2012) document the phenomenon in a real-world setting by testing the ability of office workers to recall the nearest fire extinguisher. The majority failed to remember despite years of visual exposure and a fire drill happening one week before the test, underscoring how there is "an important distinction between *seeing* and *noticing* objects" (p. 1391). Drew et al. (2013) further demonstrate that even expert medical professionals are vulnerable to inattentional blindness. In standard procedure, they asked radiologists to perform a routine lung-cancer screening involving a "stack" of axial CT scan slices. As they report, eighty-three percent of the radiologists missed the blatantly visible outline of a gorilla inserted into one of the pictures despite directly looking at it.

This cognitive shortcoming, however, is neither limited to object-oriented contexts nor to high-concentration tasks or to present perception but instead reaches into social contexts and extends to implications with long-term episodic memory. Simons/Levin (1998) designed a clever pair of experiments in which an actor would initiate a conversation with an unaware pedestrian, just to be replaced by another actor featuring different clothes, hair, face and voice during the interaction. Only about half of the pedestrians detected the change, exemplifying how much information is discarded even in interpersonal interactions. This, of course, casts much doubt on the intuitively assumed validity of events in memory, including high-stake circumstances like courtroom eye witness testimony, a situation only worsened by empirical findings directly related to episodic memory. Despite individuals typically reporting high subjective certainty in the truthfulness of their memory, studies demonstrate significant vulnerability to the incorporation of false information through influences both preceding as well as postdating formation of memory (e.g. Loftus/Pickrell 1995). Even the wholesome confabulation of personal episodes in memory is easily possible under certain circumstances or following psychological influencing (see the same and also Shaw/Porter 2015). In this sense, narrative clarity does not only seem to be a theme in short-term perception but also in ongoing attention as well as long-term memory formation.

This assessment is further substantiated by a suit of cognitive biases that have been identified and empirically explored by the psychological literature. In the given paper, it is by no means possible to present anything like an exhaustive or even representative exploration of the issue, meaning that, once again, the discourse will be highly exemplary in its nature. In a way, agency detection and pattern recognition could be counted as their own categories of cognitive bias, but can also be seen as more fundamental than others that will be the focus in the following. A first entry point shall be given in the form of the focusing illusion, i.e. the tendency that "[w]hen people consider the impact of any single factor […] they are prone to exaggerate its importance" (Kahneman et al. 2006: 1908), due to its direct relevance to problematic reasoning that transcends fallacies in layperson argumentation, reaching deep into scientific discourse. An early study finding this effect is available through Strack et al. (1988), who devised experiments in which subjects were put into two groups. Both groups were given the same two questions but in a different order. One group was asked to rate their overall satisfaction with life and their satisfaction with a specific component of life, while the other group got the questions in reverse. The first group showed no significant correlation in how they answered these two questions, but the second group showed a similarity in both answers.

Interpreting this result, it seems that once attention is drawn to a specific factor that has an impact on a more general judgment, the particular factor dominates the attention that is paid towards generating the general judgment in disregard of potential other factors that may also play a role but are not focused on. As Schkade/Kahneman (1998: 345) conclude after an ensuing decade of research: "Nothing that you focus on will make as much difference as you think". However, such focus is exactly what happens in many areas of private, public (e.g. political), and even scientific discourse, i.e. in the latter when competing research groups or traditions each overly focus on parts of the empirical landscape in order to promote the strengths of their position, model or theory. While, at this point, this constitutes a purely hypothetical statement, the next section will present a couple of real-world examples from the scientific domain. Similarly to this focusing illusion, people tend to anchor their opinion or judgment on an issue on initial pieces of information, crucially biasing subsequent reasoning and development of their position (Sherif et al. 1958, Tversky/Kahneman 1974), an effect that is prominent even when participants are made aware of the methodology of anchoring in a study design (Wilson et al. 1996).

This situation is not helped by another cognitive phenomenon, confirmation bias(es), which is the tendency to handle or interpret available evidence in a way that confirms the position one already holds. Showing this type of bias, Mynatt et al. (1978) document that even advanced undergraduate science majors have a strong tendency towards confirmation strategies instead of falsification when playing a game in which the goal is to test the governing rules of a dynamic system systematically. This demonstrates that the collection of evidence is biased towards the affirmation of the hypothesis, even at a postgraduate level. Snyder and Swann (1978) come to the same conclusion in a social setting where people were tasked to judge others' personalities. Additionally, Stanowich et al. (2013) show that rational thinking skills, including resistance or vulnerability to confirmation bias, are not significantly correlated with intelligence, further emphasizing the innateness of such biases. But not only the collection of data is subject to confirmation biases: When the exact same information is presented to individuals, they exhibit biases in interpretation, coming to widely differing conclusions (Lord et al. 1979), and set higher standards of evidence for findings that contradict their current position (Taber/Lodge 2006), with emotion being a central driver in skewed, double standard reasoning (Westen et al. 2006).

Emotion and current, situation-dependent motivated reasoning also influence the recall of information from memory, hinting that memories are not simply retrieved but reconstructed to fit current opinions and emotions, entangling abovementioned shortcomings in episodic memory with confirmation biases (Levine et al. 2001, Sanitioso et al. 1990, Snyder/Cantor 1979).

In light of all this, it is not only feasible but mandatory to conclude that cognitive biases as well as unconscious modifications of perception, processing and memory "clean up" both experience and thinking about reality, leading to an innate propensity towards conceptual, narrative and explanatory clarity. This results in an inherent tendency featured by all humans, including scientists (as demonstrated and argued for in studies and reviews, e.g. Emerson et al. 2010, Letrud/Hernes 2019, Mahoney/DeMonbreun 1977), to simplify explanations about reality and engage in biased interpretations. The scientific process in itself minimises human error and bias methodologically, but problems stay alive even within science. Human perception and thinking abstract from reality's richness in a way that allows for conceptual and narrative clarity – something that even scientists are not immune to. In a noteworthy sense, hypotheses, models and theories constitute idealized bundles of information that mirror humans' innate tendencies, meaning that science embraces human nature and incorporates its faults to some extent in spite of its objective to control for human subjectivity methodologically. Additionally, all too often, false dichotomies and even tribalistic thinking take hold in the scientific discourse. The next section will expand on these notions and will stress how, apart from methodological controls, mindfulness of human limitations and (adequate, not exaggerated) openness to ideas are prerequisites to avoiding those cognitive pitfalls that are built into all of us.

7. The Impact of Cognitive Biases in Science

To summarize the discussion up to this point, human experience and thinking are permeated by perceptual and cognitive biases. They are an inherent part of the human condition and, therefore, in principle, influence all people in a comparable manner. The domain of science cannot be excluded from this statement either, which is almost trivially true when, for example, psychologists, linguists or medical scientists work with laypeople subjects. These individuals are biased by framing effects (i.e. the way that is talked to them, the specific wording that is used and even the testing context itself), bandwagon effects (subjects acting or answering the way they perceive to be expected to act or answer), availability biases (inferring intuitively from what they know or feel instead of assessing neutrally or rationally), placebo effects (interventions are perceived as successful even in the absence of objective success) and many more such psychological phenomena. This is why much of the established methodology in certain disciplines that work with laypeople subjects is constructed to control for such biases. However, many researchers' knowledge of cognitive biases is limited, and thus, they may underestimate the importance of factoring in these phenomena.

In this sense, experimenters and their assistants may fall into the same cognitive traps as their test subjects or they may facilitate their subjects' biases unintentionally. Additionally, unaware of their own biases, they may overly focus on specific aspects of their work, distort the significance of results or disproportionally engage in confirmatory behavior. Additionally, p-hacking and the abuse of researcher degrees of freedom are rampant in many disciplines and are all too often not a result of deliberate forgery but unconscious, well-intended decision making, fueled by inherent biases (e.g. Young and Karr 2011 to consider their proposals to mitigate such problems; also see Sönning/Werner 2021). Of course, in the grand scheme of things, the self-correcting framework of the scientific endeavor still shows itself to be the most reliable pathway to an adequate understanding of reality currently available, but these issues deserve significant attention nonetheless. In a similar vein, scientists' knowledge of methodological protocols, proper controls and internalized scientific thinking does indeed offer a moderate level of passive bias resistance (e.g. Čavojová et al. 2020). Still, human fallibility and biases in all of their facets are, as discussed, not absent within science.

Beyond these aspects within primary studies, when considering the realm of formulation and development of theory, focusing effects once again play a significant role. Scientists often overly focus on the key concepts of their own research and disregard or diminish the significance of alternative accounts. This is further substantiated by anchoring effects, which often underly focusing effects. In other words, if a student is taught to think in a specific way about problems within a field of study, then every future investigation will be anchored, i.e. biased, by the previously acquired conceptual framework. For most individuals, any work done from that point on will be focused on that way of thinking. Inherent confirmation biases will lead to a warped sense of data importance, meaning that cherry-picking (i.e. the fallacy of choosing incomplete, biased evidence to represent all of the evidence) may ensue in a way that is skewed towards confirming the position one already holds. Further, innate biases towards conceptual clarity may lead to false dichotomies and inappropriate idealization, both of which simplify the messy and complex nature of reality. Many theoretical conflicts between research groups stem from such idealization and subsequent cherry-picking. Once such a situation arises, both sides may show themselves to be resistant to nuanced engagement with the empirical evidence because of behaviors and decision making deeply rooted in inherent human biases that have been described in this paper.

Especially when attempting to explain complex phenomena or developments that rest on multiple variables or factors, researchers often prioritize a single one of those as solely or mainly responsible and typically do so due to anchoring and focus effects. Examples that could be cited are numerous, but one that demonstrates this observation quite well lies in the discussion on why language may have evolved. Arbib (e.g.

2012), a computational neuroscientist and co-discoverer of mirror neurons, champions the neuroanatomical system as the evolutionary link from imitation to protosign and, ultimately, language. Tomasello (e.g. 2008), a developmental and comparative psychologist, sees joint attention as the scaffolding that supports both language ontogeny and phylogeny. Dunbar (e.g. 1996), an anthropologist and evolutionary psychologist specializing in primate behavior, proposes that language originated as a grooming substitute when group sizes grew throughout human evolution. It is obvious that these researchers, alongside many others who remain unmentioned here, develop their reconstruction of language evolution in accordance with their expertise. That means they each uncover a by itself severely limited perspective on the interdisciplinary problem and piece together what is missing by reconstructing a scenario that is compatible with the sensibilities of their field. Through that process, they inadvertently end up with an idealized conceptualization that is not wholly wrong but insufficient. Only by synthesizing the plethora of available insights may one triangulate the problem adequately and potentially reach satisfactory answers (see, e.g. the methodology of Breyl 2021a, also employed in 2021b).

Arguably, another example from our own discipline presents itself through the conflict between generativist and constructionist traditions. Generativists hold the position that humans possess an innate endowment to language that is triggered by input and constructionists contrast this position by proposing that linguistic structures are not innately specified, but built as generalizations from input. Both thought schools generally conceptualize themselves to be in a mutually excluding dichotomy and, as such, authors from both sides often characterize the opposition as rather unreasonable and deny each other noteworthy legitimacy. They do this despite a certain degree of overlap in their respective explanations on the reality of language and its acquisition. Both traditions acknowledge that something biological must allow humans to acquire language, and both agree that language learning is heavily based on language input. Further, both approaches feature explanatory strengths, as Ambridge and Lieven (2011) review. As such, the most productive way forward could very well be a cooperative effort to reconcile their differences and navigate towards an iterated linguistic successor theory (for a discussion of linguistic nativism that further addresses the points brought up here see Breyl 2023, in print). However, many linguists shy away from such a course of action in order to stay within the boundaries of their respective theoretical background. Indeed, many generativists and constructionists consciously avoid the work of the contrasting tradition, including their respective terminology. If they discuss the other side at all, they often employ straw man characterizations (i.e. simplified versions of the real theory/position for ease of critique) and cherry-pick as well as overgeneralize the empirical evidence. In short, both theoretical traditions claim exclusivity and regard the other as deeply unreasonable, ignoring the simple question of how thousands of otherwise highly conscientious scientists may hold such a presumably obviously unreasonable position.

In light of all this, an important question presents itself: How is this to be avoided? The given paper neither has the room for an extensive exploration of possible answers nor does it see this as its focus. Training conscientious, methodologically vigorous scientists would indirectly help as methodological knowledge indirectly prevents naive judgment errors. Nevertheless, explicit knowledge about human fallibility is invaluable, too, as innumerable students and too many established academics lack a true appreciation of how important those factors that have been discussed here really are – and through their naivety, they may fall victim to their biases. All of us, from laypeople to scientists, judge some evidence that is presented to us as more important than other evidence, and somehow the "more important" evidence often falls on the side of what we are trying to argue for. This, of course, is not a coincidence but mirrors innate human biases. Sometimes we have good reason to discard one explanation or opinion for another, but sometimes we do not have good reason to do so, yet it nevertheless feels like we have. Differentiating between the two is hard work and entails conscientiously questioning oneself. This holds true for any person interested in the truth, but even more so for scientists, whose profession is more focused on finding the truth than most other occupations like those of car salespeople, screenwriters or, rather obviously, politicians.

8. Summary

As has been expanded upon throughout this paper, fallibility and biases are innate aspects of human consciousness and very hard, if not impossible, to fully avoid. Not only that, but the ways in which humans err are nothing short of systematic. Naive data collection, at the core of unscientific processes in the formulation of opinion and in decision making, of course can be methodologically controlled for (though they rarely are in people's daily lives). Still, perceptual and cognitive shortcomings have become human nature for evolutionary reasons and therefore influence everybody from the layperson to the scientist. Nothing makes the latter inherently less susceptible, but at least scientists benefit from methodological training throughout their years of academic undergraduate and postgraduate studies. Depending on the discipline and the extent of the methodological training therein, knowledge of proper protocols, controls and general scientific thinking results in varying levels of passive bias resistance. However, many students are not explicitly taught about human fallibility or scientific methodology as a countermeasure to fallibility, which leaves them wide open to fall victim to their innate biases.

Dimensions of this innate tendency towards biases and fallibility have been presented within the given paper. For evolutionary reasons, neuroanatomical resources are limited, and bottlenecks in processing capacity lead to heuristics that do not always accurately represent reality. Similarly, perception and thinking facilitating survival, often nonveridical instead of adhering to truth, have been selected for in chronospecies preceding modern humans, entailing additional sources of error in judgments on reality. Further, pragmatically dealing with neuroanatomical limitations, moment-to-moment attention, as well as formation of memory, are rather narrow in detail, focusing on selected perceptual information within ongoing experience and simply confabulating the rest when reconstructing memories at a later point. Indeed, episodic memory is highly malleable by many factors predating as well as postdating memory formation, and memories change over successive retrievals to fit current opinions and emotions. These opinions and emotions also profoundly motivate how (new and old) information is perceived and assessed. In this sense, anchoring and focusing biases tempt laypeople, students and researchers alike to stick to frameworks they have previously acquired, often leading to a motivated, overly strong adherence to a given favored position. Even in primary studies, no matter the apparent strictness of a given methodology, researcher degrees of freedom always allow for varying levels of manipulation that nudge results towards preferred outcomes. In light of all this, arguably, some basic knowledge of these topics is important. Proper mindfulness of relevant notions helps in preventing and resolving pathological science.

References

Ambridge, Ben and Elena V. M. Lieven. *Child language acquisition: Contrasting theoretical approaches*. Cambridge: Cambridge University Press, 2011. Print.

Arbib, Michael A. *How the brain got language: The mirror system hypothesis*. New York: Oxford University Press, 2012. Print.

Arkes, Hal R. "Costs and benefits of judgment errors: Implications for debiasing". *Psychological Bulletin* 110 (1991): 486–498. Print.

Bompas, Aline, Grace Kendall and Petroc Sumner. "Spotting fruit versus picking fruit as the selective advantage of human color vision". *i-Perception* 4 (2013): 84–94. Print.

Breyl, Michael. "Reconsidering linguistic nativism from an interdisciplinary, emergentist perspective". *Evolutionary Linguistic Theory* 5 (2023). In print.

Breyl, Michael. *Forschungsfeld Sprachevolution: Methodik, Theorie und Empirie der modernen Sprachursprungsforschung*. Berlin & Boston: De Gruyter, 2021. Print.

Breyl, Michael. "Triangulating Neanderthal cognition: A tale of not seeing the forest for the tress". *WIRES Cognitive Science* 12 (2021): Article e1545. https://doi.org/10.1002/wcs.1545. 27.1.2023.

Bunford, Nóra, Raúl Hernández-Pérez, Eszter Borbála Farkas, Laura V. Cuaya, Dóra Szabó, Ádám György Szabo, Márta Gácsi, Ádám Miclósi and Attila Andics. "Comparative brain imaging reveals analogous and divergent patterns of species- and face-sensitivity in humans and dogs". *Journal of Neuroscience* 40 (2020): 8396–8408. Print.

Castel, Alan D., Michael Vendetti and Keith J. Holyoak. "Fire drill: Inattentional blindness and amnesia for the location of fire extinguishers". *Attention, Perception, & Psychophysics* 74 (2012): 1391–1396. Print.

Čavojová, Vladimíra, Jakub Šrol and Marek Jurkovič. "Why should we try to think like scientists? Scientific reasoning and susceptibility to epistemically suspect beliefs and cognitive biases". *Applied Cognitive Psychology* 34 (2020): 85–95. Print.

Cowan, Nelson. "The magical number 4 in short-term memory: A reconsideration of mental storage capacity". *Behavioral and Brain Sciences* 41 (2001): 87–114. Print.

Drew, Trafton, Melissa L.-H. Võ and Jeremy M. Wolfe. "The invisible gorilla strikes again: Sustained inattentional blindness in expert observers". *Psychological Science* 24 (2013): 1848–1853. Print.

Dunbar, Robin. *Grooming, gossip, and the evolution of language*. Cambridge: Harvard University Press, 1996. Print.

Emerson, Gwendolyn B., Winston J. Warme, Frederick M. Wolf, James D. Heckman, Richard A. Brand and Seth S. Leopold. "Testing for the presence of positive-outcome bias in peer review. A randomized controlled trial". *Archives of Internal Medicine* 170 (2010): 1934–1939. Print.

Gigerenzer, Gerd and Daniel G. Goldstein. "Reasoning the fast and frugal way: Models of bounded rationality". *Psychological Review* 103 (1996): 650–669. Print.

Gigerenzer, Gerd and Henry Brighton. "Homo heuristicus: Why biased minds make better inferences". *Topics in Cognitive Science* 1 (2009): 1756–8757. Print.

Goto, Hiromu. "Auditory perception by normal Japanese adults of the sounds ‚l' and ‚r'". *Neuropsychologia* 9 (1971): 317–323. Print.

Haselton, Martie G., Daniel Nettle and Paul W. Andrews. "The evolution of cognitive bias". *The handbook of evolutionary psychology*. Ed. David M. Buss. New York: John Wiley, 2005, 724–746. Print.

Hoffman, Daniel D., Manish Singh and Chetan Prakash. "The interface theory of perception". *Psychonomic Bulletin & Review* 22 (2015): 1480–1506. Print.

Johnson, Dominic D. P., Daniel T. Blumstein, James H. Fowler and Martie G. Haselton. "The evolution of error: Error management, cognitive constraints, and adaptive decision-making biases". *Trends in Ecology & Evolution* 28 (2013): 474–481. Print.

Kahneman, Daniel, Alan B. Krueger, David Schkade, Norbert Schwarz and Arthur A. Stone. "Would you be happier if you were richer? A focusing illusion". *Science* 312 (2006): 1908–1910. Print.

Kanwisher, Nancy and Galit Yovel. "The fusiform face area: A cortical region specialized for the perception of faces". *Philosophical Transactions of the Royal Society B* 361 (2006): 2109–2128. Print.

Kuhl, Patricia K. "Is speech learning 'gates' by the social brain?". *Developmental Science* 10 (2007): 110–120. Print.

Kuhl, Patricia K., Barbara T. Conboy, Sharon Coffey-Corina, Denise Padden, Maritza Rivera-Gaxiola and Tobey Nelson. "Phonetic learning as a pathway to language: New data and native language magnet theory expanded (NLM-e)". *Philosophical Transactions of the Royal Society B* 363 (2008): 979–1000. Print.

Leiss, Elisabeth. "Categorical versus thetic sentences in the Universal Grammar of Realism". *Thetics and categoricals*. Ed. Werner Abraham, Elisabeth Leiss and Yasuhiro Fujinawa. Amsterdam: John Benjamins, 2020, 13–29. Print.

Letrud, Kåre and Sigbjørn Hernes. "Affirmative citation bias in scientific myth debunking: A three-in-one case study". *PLOS ONE* 14 (2019): Article e0222213. https://doi.org/10.1371/journal.pone.0222213. 27.1.2023.

Levine, Linda J., Vincent Prohaska, Stewart L. Burgess, John A. Rice and Tracy M. Laulhere. "Remembering past emotions: The role of current appraisals". *Cognition and Emotion* 15 (2001): 393–417. Print.

Loftus, Elizabeth F. and Jacqueline E. Pickrell. "The formation of false memories". *Psychiatric Annals* 25 (1995): 720–725. Print.

Lord, Charles G., Lee Ross and Mark R. Lepper. "Biased assimilation and attitude polarization: The effect of prior theories on subsequently considered evidence". *Journal of Personality and Social Psychology* 37 (1979): 2098–2109. Print.

Ma, Wei Ji, Masud Husain and Paul M. Bays. "Changing concepts of working memory". *Nature Neuroscience* 17 (2014): 347–356. Print.

Mahoney, Michael J. and Bobby G. DeMonbreun. "Psychology of the scientist: An analysis of problem-solving bias". *Cognitive Therapy and Research* 1 (1977): 229–238. Print.

McGurk, Harry and John MacDonald. "Hearing lips and seeing voices". *Nature* 264 (2009): 746–748. Print.

McKay, Ryan T. and Daniel C. Dennett. "The evolution of misbelief". *Behavioral and Brain Sciences* 32 (2009): 493–561. Print.

Miller, George A. "The magical number seven, plus or minus two: Some limits on our capacity for processing information". *Psychological Review* 63 (1956): 81–97. Print.

Mynatt, Clifford R., Michael E. Doherty and Ryan D. Tweney. "Consequences of confirmation and disconfirmation in a simulated research environment". *Quarterly Journal of Experimental Psychology* 30 (1978): 395–406. Print.

Sanitioso, Rasyid, Ziva Kunda and Geoffrey T. Fong. "Motivated recruitment of autobiographical memories". *Journal of Personality and Social Psychology* 59 (1990): 229–241. Print.

Schkade, David A. and Daniel Kahneman. "Does living in California make people happy? A focusing illusion in judgments of life satisfaction". *Psychological Science* 9 (1998): 340–346. Print.

Shaw, Julia and Stephen Porter. "Constructing rich false memories of committing crime". *Psychological Science* 26 (2015): 291–301. Print.

Sherif, Muzafer, Daniel Taub and Carl I. Hovland. "Assimilation and contrast effects of anchoring stimuli on judgments". *Journal of Experimental Psychology* 55 (1958): 150–155. Print.

Simons, Daniel J. and Daniel T. Levin. "Failure to detect changes to people during a real-world interaction". *Psychological Bulletin & Review* 5 (1998): 644–649. Print.

Snyder, Mark and Nancy Cantor. "Testing hypotheses about other people: The use of historical knowledge". *Journal of Experimental Social Psychology* 15 (1979): 330–342. Print.

Snyder, Mark and William B. Swann. "Hypothesis-testing processes in social interaction". *Journal of Personality and Social Psychology* 36 (1978): 1202–1212. Print.

Sönning, Lukas and Valentin Werner. "The Replication crisis, scientific revolutions, and linguistics". *Linguistics* 59 (2021): 1179–1206. Print.

Stanovich, Keith E., Richard F. West and Maggie E. Toplak. "Myside bias, rational thinking, and intelligence". *Current Directions in Psychological Science* 22 (2013): 259–264. Print.

Strack, Fritz, Leonhard L. Martin and Norbert Schwarz. "Priming and communication: Social determinants of information use in judgments of life satisfaction". *European Journal of Social Psychology* 18 (1988): 429–442. Print.

Taber, Charles S. and Milton Lodge. "Motivated skepticism in the evaluation of political beliefs". *American Journal of Political Science* 50 (2006): 755–769. Print.

Tomasello, Michael. *The origins of human communication*. Cambridge & London: The MIT Press, 2008. Print.

Tversky, Amos and Daniel Kahneman. "Judgment under uncertainty: Heuristics and biases". *Science* 185 (1974): 1124–1131. Print.

Webster, Michael A. "Evolving concepts of sensory adaptation". *F1000 Biology Reports* 4 (2012): Article 21. https://doi.org/10.3410/B4–21. 27.1.2023.

Westen, Drew, Pavel S. Blagov, Keith Harenski, Clint Kilts and Stephan Hamann. "Neural bases of motivated reasoning: An fMRI study of emotional constraints on partisan political judgment in the 2004 U.S. presidential election". *Journal of Cognitive Neuroscience* 18 (2006): 1947–1958. Print.

Wilson, Timothy D., Christopher E. Houston, Kathryn M. Etling and Nancy Brekke. "A new look at the anchoring effects: Basic anchoring and its antecedents". *Journal of Experimental Psychology: General* 125 (1996): 387–402. Print.

Young, S. Stanley and Alan Karr. "Deming, data and observation studies. A process out of control and needing fixing". *Significance* 8 (2011): 116–120. Print.

Zaidi, Qasim, Andrea Li, Carson Wong, Elias H. Cohen a d Xin Meng. "Hard-wired and plastic mechanisms in 3-D shape perception". *Shape perception in human and computer vision. Advances in computer vision and pattern recognition*. Ed. Sven J. Dickinson and Zygmunt Pizlo. London: Springer, 2013, 311–338. Print.

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