Sesgos: ¿Vemos según estos son o son estos según vemos?

Biases, do they precede or succeed learning?

Matías Grinberg

Diciembre 2018

Abstract

In this work, the representational bias in humans as a function of expertise accumulation is studied. In particular, the hypothesis of whether those who had considerable formation in Exact Sciences show lower levels of empathy and social cognition was evaluated. A test including the free description of natural scenes and the memory of a story is carried out, and by applying NLP techniques, specifically *GloVe* word vectors, systematic attentional tendencies are compared with the biases predicted by the proposed hypothesis, while external validity is contemplated through the '*Reading the Mind in the Eyes*' test.

1. Introduction

Learning, defined as the improvement in a task and the accumulation of cognitive information through cerebral plasticity in some type of declarative or non-declarative memory, entails an increase in the efficiency of information processing [1]. Procedural motor memory, for example, allows us to learn to ride a bicycle by coding a complex series of independent body movements in an organized representation. This fact is based on phenomena known through different domains, such as in the different types of apraxias, anomic aphasia specific to lexical groups, or the hierarchical organization of the visual cortex. This borderline between the subjective and the objective refers back to a ubiquitous dtebate in philosophy, including empiricism and rationalism, and the impossibility of demonstrating qualia [2], but it exceeds the scope of this work.

The cognitive mechanism of '*chunking*', where different strategies mediate the retention in working memory, coding, storage and recall [3], is another example that exhibits these mechanisms called *'top-down'* [4]. This processing mode can be observed in optical illusions like '*The Checker Board Shadow Illusion*' by Edward H. Adelson [5], where the expectations given by the visual patterns learned by the early layers of the visual cortex distort a characteristic in the perception.

From a more modern approach, we can identify curiosity as the active exploration of the world to learn useful information and to reduce uncertainty by generating parsimonious representations. These become expectations, which provide us with a unified perception of consciousness, and give us an adaptive advantage allowing us to anticipate possible threats and economize the sensorium [6]. This active curiosity can be modeled from a Bayesian perspective [1] [7] [8], where the aim is to reduce the prediction error and the degree of uncertainty, minimizing the entropy of the priors (variational free energy).

To study this interaction between bias and learning, language offers a good window. The choice of words, and of all the elements within the continuum between form and content [9], transmits in itself a large amount of information, about the context of communication, the relationship among speakers, and other meta-information. Through language, one can contemplate so many characteristics of the speaker as alert level, years of education, profession, or even detect health disorders as psychiatric conditions [10]. We can notice if the speaker or writer is emotionally close or distant, reflective or superficial, and possibly extroverted or open to new experiences. The semantic use of the word is a significant marker and an occasional mediator of social and personality processes. [11]

The ability to read others' emotions is linked to "social intelligence". Since the eyes are a prominent signal in human social communication and social categorization [12], they serve as an adequate stimulus for the present study. In particular, the '*Reading the mind in the eyes*' test [13] measures the ability to read emotions of others. It was developed in Great Britain and the images were taken from British magazines in the 1990s. As expected, the test does not work perfectly for people who are not native english speakers or for people who come from cultures that are very different from those in Great Britain, however, it shows convergent validity with social tests. cognitive of the theory of the mind. In the present work, it will be used as a reference to measure the ability to read emotions.

Previous studies have shown that engineers have low levels of social competence, particularly engineering students showed less empathy than psychology students and social workers in the subscales of fantasy and perspective taking [14]. This motivates the proposal to study the incidence of the empathy topic in two groups, students or graduates of exact careers (studies in Computer Science, Mathematics, Physics and Engineering are taken and they will be defined as: 'exact') versus students or graduates of other careers or without specific training ('non-exact').

Empathy is generally defined as an affective trait (for example, the ability to experience another's emotions [15]) and/or a cognitive capacity (for example, the ability to understand another's emotions [16]).

2. Experimental design

The test was distributed through a web interface, made with HTML and Javascript with the JsPsych library for psychological experiments. For utility programs, the server or "backend.ªnalysis, Python language was used. The libraries used were: Flask to create the server, SpaCy to do the processing of natural language, and several others like Pandas, NumPy, sci-kit learn and matplotlib for the analysis. The link to the experiment is still available. [24] and the analysis was conducted predominantly on the Google Collaborative open platform and is also available for review. [25]

The design proceeds sequentially. It starts with a story to read and remember. Then two 20-second videos are projected separately, and when the subjects are done visualizing each one, they must describe them is as much detail as possible in writing with a minimum of 120 words.

Then a reduced version of the 10-image '*Reading the mind in the eyes*' test is evaluated. Next, some questions are presented to learn if the subjects study or have studied an exact sciences career, their age and gender. A continuous bar was proposed for the last item, in which they could answer based on self-perception.
It is also asked to solve a mathematical exercise [17] with multiple choice answers.
After that, the subjects are asked to describe what they remember of the story they read at the beginning, in this case a minimum of words is not required. Finally, they are asked to distribute the link to the experiment in order to create a 'snowball' effect.
The test was performed by 86 subjects, of which 16 belong to the 'exact' group and 70 to the 'non-exact' group.

3. Analysis

To measure the semantic similarity between the descriptions, we used *Word Embeddings* of GloVe type [18], pre-trained at the University of Chile [19], to compare the distance from the word .ᵉᵐpathy"between the 2 groups of subjects.
There are many ways to generate embeddings, such as latent semantic analysis (LSA), extended use, or Word2vec. It is a method that allows to represent natural language in the form of vectors, with the aim that words of similar semantic meaning are close in that vector space (distributional hypothesis) [20]. To evaluate the embeddings, the UMAP dimensionality reduction [21] was applied to generate an interactive 3D graphic [22] and observe its adequacy. It was exhibited at the end of the experiment as a playful booster, with the words closest to the answers given by the subject, see Figure (1). Also, the words closest to .ᵉᵐpathy"were explored, which turned out to be in line with expectations (e.g. "generosity", "solidarity", "feeling")

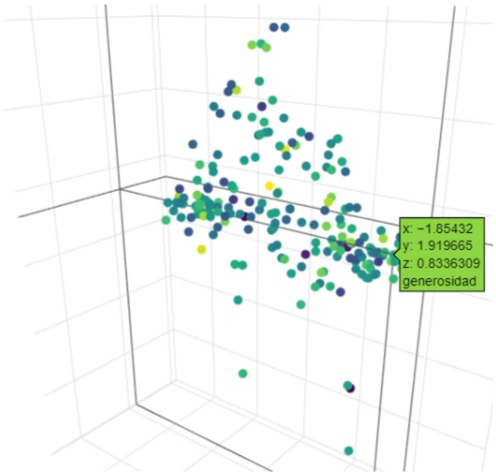

Figura 1: 3D ScatterPlot. Each point represents a word in the semantic space, these being the vectors closest to 'empathy'.

A subject was assigned to the 'exact' group after having answered affirmatively to the question "Do you study or have you studied exact sciences?", and having solved the mathematical exercise correctly. This was done to ensure procedural learning in that task, assuming that pursuing careers with mathematics practices is associated with better numerical skills [23]. For testing, the following steps are followed:

- Concatenation of each subject's texts.
- Removal of stopwords and punctuation.
- Computation of cosine distance between each word of each subject and 'empathy'
- Binarization of distances using an a priori defined threshold (0.15) [26]
- Counting positive words for each subject
- Rank-sum test or Mann-Whitney U test between groups.

4. Results

The subjects were divided into two groups, those that declared to study exact sciences (A) and those that did not (B), and the answer for the mathematics exercise was evaluated as seen below in Figure (2):

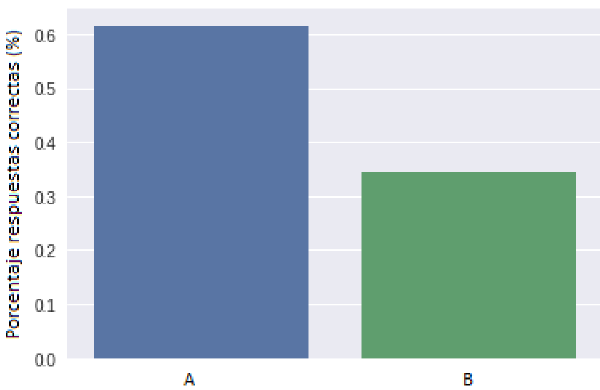

Figura 2: Graph in which the subjects of both groups that correctly answered the math problem are shown

61.5 % of the A group answered correctly, while 34.4 % of the B group did. The fact that the A group solved the mathematical exercise significantly better (r = 0.56, p ¡0.001) reinforces the hypothesis about procedural learning being associated with better mathematical thinking skills.
Then the subjects were separated into the experimental groups ('exact' versus 'non-exact') with the aforementioned condition (having answered affirmatively to the question "Do you study or have studied exact sciences?.ªnd having solved the mathematical exercise correctly).
The results for the reduced version of the '*Reading the mind in the eyes*' test are shown below, Figure (3):

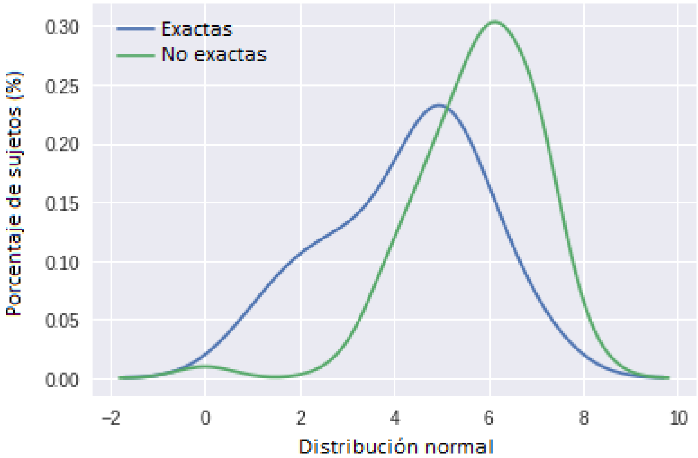

Figura 3: Results of the reduced version of the '*Reading the mind in the eyes*' test.

This indicates that the 'exact' group shows less empathy than the 'non-exact' group with the reduced version (T=3.69 p <0.001).
Regarding the results of the embedding test, the data showed statistically significant results that supporting an hypothesis opposite to the alternative proposed (U=48.0, p <0.001). The distributions obtained are shown in Figure (4):

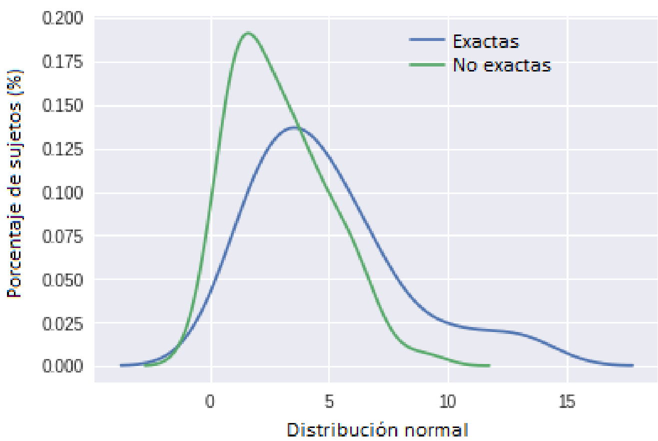

Figura 4: Results obtained from the Mann-Whitney U test.

Additional information about the subjects:

The self-perception of gender is shown in Figure (5)

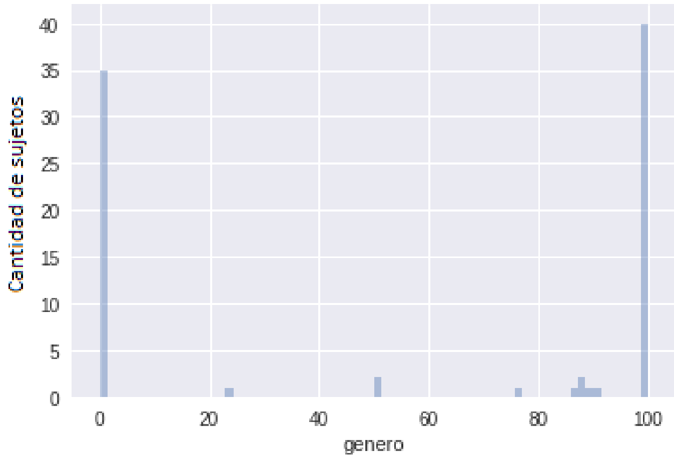

Figura 5: Graph obtained for the gender bar, where 0 indicates female and 100 indicates male.

Of the total, 35 subjects self-perceived completely female and 40 completely as male.

Age is plotted in Figure (6)

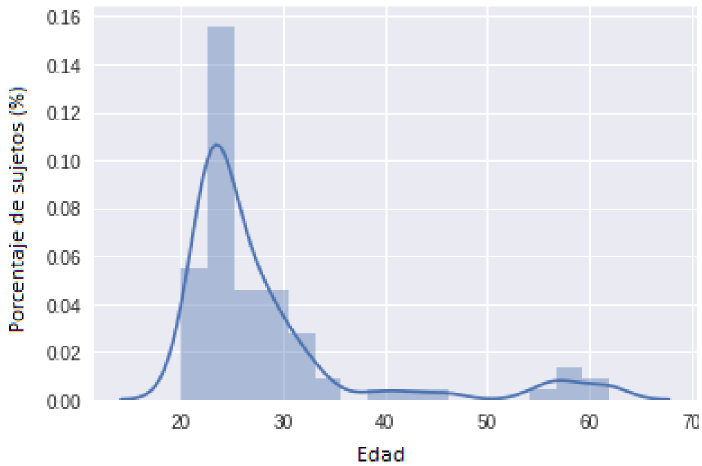

Figura 6: Graph obtained for age.

Figure 6 shows that the great majority of the subjects who did the experiment are between 20 and 35 years old. Analyzing that age range in particular could lead to a better response in the embeddings test.

5. Conclusions

- The reduced version of the '*Reading the mind in the eyes*' test yielded satisfactory results that support the hypothesis about the 'exact' group showing less empathy than the rest.
- The online collection methodology is a great advantage for data sampling, despite partially relegating control of the environment during its execution.
- It is likely that statistics calculated for example for the Mann-Whitney U test would reach a different result and if more subjects were taken, specifically of the 'exact' group.

- The embedding design proposed is taken as a baseline, as other analysis steps could be more adequate.
- The 'exact' group solved the mathematical exercise significantly better than the other, which reinforces the hypothesis about procedural learning being associated with better mathematical thinking skills.
- Embeddings proved to be a robust tool for measuring the semantic similarity and comparing the distance to 'empathy' between the two groups.
- It would be preferable to collect more data in order to control possible spurious sources of variability such as sleep hours, distractions, or noisy latent factors.
- Given that the resulting embeddings depend on the text corpus with which they were trained, and that 'transfer learning' appears to be essential for good performance, it would be preferable to compute embeddings *ex profeso* for the task, using regional texts.

Referencias

[1] Hesselmann, G., Sadaghiani, S., Friston, K. J., Kleinschmidt, A. (2010). Predictive coding or evidence accumulation? False inference and neuronal fluctuations. PloS One, 5(3), e9926.

[2] Dennett, D. C. (2014). Why and how does consciousness seem the way it seems?. Open MIND. Frankfurt am Main: MIND Group.

[3] Gobet, F. (2005). Chunking models of expertise: Implications for education. Applied Cognitive Psychology, 19(2), 183-204.

[4] Kveraga, K., Ghuman, A. S., Bar, M. (2007). Top-down predictions in the cognitive brain. Brain and cognition, 65(2), 145-168.

[5] http://www.cogsci.rpi.edu/˜

heuveb/teaching/CriticalThinking/Web/Presentations/PerceptionMemory.pdf

[6] Hesselmann, G., Sadaghiani, S., Friston, K. J., Kleinschmidt, A. (2010). Predictive coding or evidence accumulation? False inference and neuronal fluctuations. PloS One, 5(3), e9926.

[7] Mandel, D. R. (2014). The psychology of Bayesian reasoning. Frontiers in psychology, 5, 1144.

[8] https://scholar.harvard.edu/files/xiaoshengmu/files/paying_attention_161129.pdf

[9] Ashual, O., Jurgenson, T., Grinberg, D. (2017). Deep Text Style Transfer.

[10] Altszyler, E., Berenstein, A. J., Milne, D., Calvo, R., Fernandez-Slezak, D. (2018, November). Detección automática de casos urgentes en foro de salud mental. In XIX Simposio Argentino de Inteligencia Artificial (ASAI)-JAIIO 47 (CABA, 2018).

[11] Pennebaker, J. W., Mehl, M. R., and Niederhoffer, K. G. (2003). Psychological aspects of natural language use: Our words, our selves. Annual review of psychology, 54(1), 547-577.

[12] Zebrowitz, L. A. (2006). Finally, faces find favor. Social Cognition, 24(5), 657-701.

[13] Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., Plumb, I. (2001). The "Reading the Mind in the Eyes" test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. Journal of child psychology and psychiatry, 42(2), 241-251.

[14] Chato Rasoal, Henrik Danielsson and Tomas Jungert (2012) Empathy among students in engineering programmes, European Journal of Engineering Education, 37:5, 427-435, DOI: 10.1080/03043797.2012.708720

[15] Bryant, B. K. (1982). An index of empathy for children and adolescents. Child development, 413-425.)

[16] Hogan, R. (1969). Development of an empathy scale. Journal of consulting and clinical psychology, 33(3), 307.)

[17] Kahneman, D., Egan, P. (2011). Thinking, fast and slow (Vol. 1). New York: Farrar, Straus and Giroux.

[18] https://nlp.stanford.edu/pubs/glove.pdf

[19] https://github.com/uchile-nlp/spanish-word-embeddings

[20] Naili, M., Chaibi, A. H., Ghezala, H. H. B. (2017). Comparative study of word embedding methods in topic segmentation. Procedia Computer Science, 112, 340-349.

[21] UMAP https://arxiv.org/abs/1802.03426

[22] https://plot.ly/.

[23] Landerl, K., Bevan, A., and Butterworth, B. (2004). Developmental dyscalculia and basic numerical capacities: A study of 8–9-year-old students. Cognition, 93(2), 99-125.

[24] https://cerebrock.github.io/mindspace/

[25] https://colab.research.google.com/drive/1AsVS4pFXIba38-XxQ1IIS6Eq-h5Tf3Ap

[26] Diuk, C., Fernandez Slezak, D., Raskovsky, I., Sigman, M., and Cecchi, G. A. (2012). A quantitative philology of introspection. Frontiers in integrative neuroscience, 6, 80.