Discrete Applied Mathematics 197 (2015) 114–122

Contents lists available at ScienceDirect

Discrete Applied Mathematics

journal homepage: www.elsevier.com/locate/dam

Note

Using exploratory analyses to select judges and create the components of a naming test to study aphasia

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ARTICLE INFO

Article history:
Received 26 December 2013
Received in revised form 6 May 2015
Accepted 10 May 2015
Available online 1 June 2015

Keywords:
Aphasia
Linguistics
Selection of assessors
Exploratory factor analysis
Principal component analysis
Correspondence analysis
Multiple factor analysis

ABSTRACT

Aphasia is called the loss of some abilities related to language production and/or comprehension. In the framework of aphasia studies, the ability of the patient to recognize and correctly verbalize a set of images is verified through suitable tests. Since the images are supposed to be easily and unequivocally recognized and named by every person, tailoring images taken from the Snodgrass and Vanderwarts (1980) original test to the Brazilian reality is necessary. We faced the following two issues: the selection of images that are easily recognizable, and the estimate of an index measuring the primitivity of the corresponding word, that is how early in life a person heard the word. To this aim, two surveys have been carried out, where the images were proposed to non-aphasic judges. We report in this paper the results of the exploratory multidimensional analyses carried out to select both images and judges and to define the primitivity index.

1. Introduction

In her Ph.D. thesis, Senna [21] aimed at analyzing the lexical access and phonological representation of normal and aphasics subjects, where aphasia is the loss of some abilities related to language production and/or comprehension, which can be due to brain damage. For this task, she used a set of indicators, some of them resulting from a test in which the aphasic patients were asked to verbalize a series of images of objects that were supposed familiar. Thus, it was necessary to adjust the test to the Brazilian framework, by selecting appropriately the images of [22], internationally used for this purpose, and defining an index indicating each word's primitivity. To this aim, we considered two criteria: (i) the images should be easily and unequivocally recognizable; and (ii) the primitiveness of the word regarding its age of acquisition should be estimated through a survey carried out in Brazil. The age of words' acquisition was first used to evaluate lexical access by Carroll and White [6]. According to them, the age at which the name related to an object is acquired is more important than word frequency in determining the speed of lexical access. Brown and Watson [3] state a difference in the phonological representation of words acquired earlier in life, as they are stored in memory in a more complete form, while a different mechanism occurs for the representation of late-acquired ones. As words acquired later tend to be the first to be lost due to brain damage in aphasia, the inclusion of the age of acquisition (*primitiveness*) in this research is legitimated by a long tradition of lexical access studies, see, e.g., [7].

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http://dx.doi.org/10.1016/j.dam.2015.05.018
0166-218X/

This work deals with these two tasks and with the data analysis methods carried out to perform them. For each task, an independent survey was carried out, involving panels of randomly chosen non-aphasic judges. The first selection of the images was therefore performed according to the general agreement of the judges in recognizing them. The words' primitivity index was built on the basis of another survey. In both cases, an *a posteriori* selection of the judges was necessary, in order to avoid too strong differences among them.

2. The survey and the data

The current study is based on the images found in Snodgrass and Vanderwart [22]. They form a set of 266 pictures to be used in experiments investigating differences and similarities in the processing of pictures and words. The pictures were selected according to a set of rules that provide consistency of pictorial representation. In the authors' experiment, 4 groups of judges were presented to four different sequences of the 266 slides and performed four different tasks in order to evaluate the drawings. They were asked to (i) identify each picture as briefly and unambiguously as possible, by writing only one name; (ii) to score the familiarity of each picture "according to how usual or unusual the object is in your realm of experience" ([22]: p. 183); (iii) evaluate the visual complexity of the image by using a 5-steps scale, from $1 =$ simplest, $5 =$ most complex, where complexity was defined as the amount of detail or intricacy of lines in the picture; (iv) inform about the image agreement, in order to establish how closely each picture resembled their mental image of the object. As a result, the pictures were standardized, according to four characters of central relevance to memory and cognitive processing: name agreement, image agreement, familiarity, and visual complexity, and have been used in different tasks that associated pictures and words.

As said, for our work based on these images, we first selected, among the 266 available, the most correctly identifiable through their specific (Brazilian) name; then, we built a primitivity index of their names, specific for Brazilian people. For both aims, an independent experimentation was carried out, namely

- for the selection of the images, all of them were submitted to a panel of 38 randomly selected judges among non-aphasic people. The answers have been coded as $1 =$ recognized, $0 =$ not recognized. This way, a binary 266×38 data table was built, from which 161 row-images were selected;
- to measure primitiveness, we asked 128 non-aphasic judges (different from the previous ones) to estimate how primitive the 161 represented objects were, according to their personal experience. This estimation was based on two different kinds of scale: (i) the first panel, with 60 judges, labeled *E*, was asked to measure the age of acquisition on a scale from 1 to 7 according to how early in their life each word was first known, without specifically mentioning their corresponding age; thus, 1 corresponds to "very early" in life and 7 to "most late"; (ii) the second panel, with 68 judges, labeled *I*, was asked to measure according to 7 age classes: $1 = 0$–2 years, $2 = 2 - 4$, $3 = 4 - 6$, $4 = 6 - 8$, $5 = 8 - 10$, $6 = 10 - 12$, and $7 =$ 13 years and later. Thus, two ordinal scale 1–7 data tables were built, a 161×60 and a 161×68, forming a supermatrix 161×128.

3. Theoretical framework

Both tasks required a prior check on the quality of the judges, in order to assess their homogeneity. The selection of the assessors is a major issue in all surveys that require their advice or evaluation: in sensory analysis they are particularly trained and international guidelines exist [17]. As well, the *a posteriori* check for their evaluation homogeneity was considered in literature, suggesting some statistical methods to identify non-homogeneous assessors. Several methods were proposed, among which Principal Component Analysis, Generalized Procrustes Analysis, *ANOVA*, Eggshell Plot, Generalized Canonical Analysis [11,19]. For studies aiming at both giving scores to individuals and evaluating submitted items, both *IRT* [8] and *DINA* [9] models are of current use. A major requirement is that the assessors overall responses be uni-dimensional [11], since otherwise at least two independent factors would influence their response, an issue difficult to justify and to use in the following.

The organization of the surveys, in particular the choice of the judges, was not targeted to a further statistical inference, nor the selection needed the implementation of statistical tests. Thus, we limited our attention to the tools available in the framework of exploratory analysis, in line with most of the methods quoted in literature. By the term *exploratory analysis*, due to Tukey [23], we refer to all mathematical, statistical, and computer science methods that may concur to study the structure of a data set to extract the contained information in an interpretable way. Their use, started by Benzécri [2] and his French school, that claim that "the models should follow the data, not the inverse", may be roughly considered a cognitive activity, nowadays referred as *data mining* in the Anglo-Saxon world. The exploratory work is not exhaustive [23]: it is a detective work [10] adopted to ease the acquisition of information contained into the data, with the drawback that this information may not be inferred statistically to a population. In this work we considered one of the two main sets of tools that are available in multidimensional exploratory data analysis, the ordination, as the other, the classification, did not result of interest for our current purposes. Ordination aims at finding optimal uni- or multi-dimensional orderings in the data, that may be used to sort them accordingly, with the aim to provide also graphical representations, able to describe at the best the pattern of the involved items in a reduced dimensional space. The identification of such orderings, usually independent from each other, sometimes allows identifying them with factors that influence the objects at hand, thus causing the found