Review article

The cognitive psychology and neuroscience of naming people

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ABSTRACT

The use of proper names enables us to designate entities, including people, at a very specific level of categorization: the unique entity or the individual. The paper presents a general overview of psychological/cognitive and neuroscientific studies that have compared the production of proper names, in particular people's names, with the production of common nouns during the last thirty years. The search for specific brain correlates of proper naming included single-case and group studies of patients with brain lesions, and studies utilizing functional neuroimaging or brain electrical stimulation with healthy participants. These studies have led neuroscientists to hypothesize that the recall of proper names involves a rather complex network including mainly left frontal and temporal regions. Behavioural evidence supports the view that proper names are more difficult to recall than common names, and scientists have proposed different explanations for this relative difficulty. Finally, several new directions for future research are proposed to improve our understanding of both cognitive processes and their brain correlates involved during proper name recall.

1. Introduction

Naming familiar people is a linguistic ability that is fundamental in human everyday social life. Using personal names is a frequent way to refer to individuals. Personal names are commonly used to call or to greet people, to hold their attention during a conversation, or to refer to people absent from the conversation (see Cohen, 1994; Enfield and Stivers, 2007). Although most of us are usually able to name others, it may happen that we fail to recall someone's name at the right moment (for recent reviews see Brédart, 2016; Hanley, 2014), or even, that we call someone by the wrong name (Brédart and Dardenne, 2015; Deffler et al., 2016; Griffin and Wangerman, 2013). Such everyday life difficulties can be very uncomfortable for the person who is unable to retrieve the name, but also for the person whose name is not recalled.

In fact, by saying that personal names (i.e., first names or surnames) are particularly prone to retrieval failures, cognitive psychologists could mean two different things. In some studies, the given meaning was that people's names were harder to retrieve than conceptual biographical information describing these people, such as their occupation or their nationality (for influential models, see Bruce and Young, 1986; Burton and Bruce, 1992; Young and Burton, 1999; for a synthesis, see Hanley, 2011a). Hence these studies were designed to compare access to conceptual knowledge with access to lexical knowledge. In another (largely independent) set of studies, the given meaning was that proper names were more difficult to retrieve compared with other categories of words such as common nouns. These studies were designed to compare

lexical access to nouns with lexical access to proper names. The present paper will focus on the latter set of studies, which were aimed at explaining why lexical access to proper names is more difficult than lexical access to common nouns.

In addition to these psychological/cognitive studies, neuroscientists have investigated the neural basis of lexical access to proper names and found that naming unique entities does not recruit exactly the same brain areas as naming categories of entities. The present paper presents these two lines of research, which have mostly been conducted in parallel, and have not strongly influenced each other (with a few notable exceptions, see Semenza, 2006, 2009). The paper is organized as follows. First, the linguistic function of proper names is defined. Second, the investigation of the neural correlates of proper name recall will be addressed. Third, the behavioural evidence for the particular difficulty of retrieving proper names will be examined. Fourth, different hypotheses formulated to explain the relative difficulty of proper name recall will be presented. At that point, the relationship between the function of proper names and their semantic status will be discussed. Finally, some future directions of research will be proposed, some of them integrating psychological and neuroscientific approaches.

2. The linguistic function of proper names

Despite debates among philosophers of language and linguists with respect to the semantic status of proper names (e.g., *descriptivist theory* vs *causal theory of reference* and *direct reference theory*; for a concise

presentation see Cumming, 2016), there is a general agreement among authors on the primary function of proper names. The linguistic function of proper names is to designate individual entities, whereas common nouns refer to any one of a class of beings or things (Merriam-Webster dictionary; see also the set of definitions reported in Valentine et al., 1996; for a historical review, see Anderson, 2007). Others have formulated things a little differently. They contend that proper names designate semantically unique entities, i.e., entities "normally processed at a conceptual level so specific that the entity is in a class with no other members" (Grabowski et al., 2001). Such unique entities may be persons, animals, stars, geographical entities such as countries, towns, rivers, mountains, islands, but also unique man-made objects such as buildings, ships, airplanes or locomotives (for an overview of the diversity of proper names, see Hough, 2016). In the present paper, we will mainly focus on the retrieval of personal names, given the importance of such names in human social interactions.

Some authors have speculated that the ability to name unique entities could have had an adaptive advantage at some point in human evolution (Semenza, 2006, 2009). The ability to categorize surrounding entities and to name them with generic but precise words such as "tigers" or "swamps" would certainly have been helpful, for example, to warn con-specifics of impending danger. In addition, the ability to call by a proper name individual entities ('X' is a dangerous man, 'Y' is a dangerous place) might have served to refine these warnings, for example, by enabling reference to absent people. As Semenza (2006, p. 891) stated, "Those humans gifted with a neural system that more efficiently and unambiguously sustained designating categories as well as designating individual entities might indeed have better survived natural selection." It is unfortunately difficult to find direct evidence for or against this evolutionary hypothesis. Nevertheless, there is evidence that the function of designating individual entities is associated with specific brain areas. Before presenting and discussing the psychological research showing that the production of proper names is accompanied by more retrieval failures than the production of common nouns, brain research on proper name processing will first be addressed.

3. The brain correlates of naming unique entities

Brain researchers have investigated whether, at some point, proper names and common nouns followed different pathways in the brain. The study of the brain correlates of proper name processing has been primarily aimed at determining whether it is reflected in the "neural reality" that proper names are used to denote unique entities, while common nouns are used to refer to categories (Semenza, 2009). Note that, here, the question at hand was not primarily focused on the issue of the relative difficulty of proper name processing (but see Semenza, 2006). The question was, rather, to establish whether common nouns and proper names serving two different functions, respectively categorization and individuation, are processed by at least partially independent neural systems (Semenza, 2006, 2009).

3.1. Double dissociation between the production of common nouns and proper names

A first approach consisted of describing patients with anomia and searching for a double dissociation between the production of nouns and the production of proper names. Establishing such a double dissociation was considered as a first step indicating that brain mechanisms processing common nouns and proper names are separate (e.g., Semenza, 2009). Since the 1980s, neuropsychologists have been searching for evidence of a double dissociation between the production of proper names, on the one hand, and the production of common nouns and adjectives on the other hand. Several patients have been described with an impaired production of proper names (in the context of a preserved semantic processing without impairment of proper name comprehension) associated with a preserved production of common

nouns and adjectives. Some of these patients showed a proper name anomia, which affected all the tested kinds of proper names, such as personal names, but also geographical names, such as the names of cities, countries, rivers or mountains (e.g., Harris and Kay, 1995; Otsuka et al., 2005; Semenza and Zettin, 1988, 1989) or even titles of pieces of music (Semenza and Zettin, 1989). On the other hand, other patients showed a more specific impairment of the production of people's names (e.g., Cohen et al., 1994; Fery et al., 1995; Lucchelli and De Renzi, 1992; McKenna and Warrington, 1980; Reinkemeier et al., 1997). However, a neat case of a patient with the opposite pattern, i.e., an impaired production of common nouns and adjectives associated with a preserved production of proper names was harder to find (for discussions, see Brédart et al., 1997; Semenza, 2006). Nevertheless, Martins and Farrajota (2007) described two patients with a reversed pattern of impairment of name retrieval. Patient ACB presented an aphasic disorder with impaired object naming but a spared recall of proper names, while Patient JFJ showed normal language abilities and semantic knowledge about people, but a marked anomia for people's names. These cases, examined with the same testing procedure, provided the first clear evidence of a double dissociation between the lexical access to proper names and common nouns.

3.2. Lesion studies

A first study included a sample of 127 patients with focal brain lesions in the left or the right hemisphere without general intelligence impairment and showing no difficulty attending to or perceiving the visual stimuli presented (Damasio et al., 1996). All participating patients had a left hemisphere language dominance, and patients with severe aphasia were excluded. Fifty-five normal control participants matched to patients on age, education, and gender distribution were also included in the study. The participants' task was to name pictures of persons, animals, tools, fruits/vegetables, and musical instruments. Among this large sample of patients, 13 showed an impaired person naming ability. A neuroanatomical analysis of the lesion overlap in these 13 patients indicated that the highest regions of overlap were in the left temporal pole (LTP). A follow-up study was conducted with an expanded sample of 139 patients with unilateral brain damage who were of normal intelligence and had no difficulty attending to or perceiving the stimuli (Damasio et al., 2004). All these patients also had a left hemisphere language dominance and no severe aphasia. Again, 55 normal healthy participants matched on age, education, and gender distribution took part in the study. The participants' task was the same as in the preceding study. Thirty-nine patients showed impaired person naming abilities. Neuroanatomical analyses based on magnetic resonance data showed a concentration of lesions associated with an impairment of person naming in the LTP region only. In a further study, Tranel (2006; see also Tranel, 2009) compared 11 patients with LTP lesions, 10 patients with right temporal (RTP) lesions and 90 healthy control participants in a famous person naming task. Results showed that patients with LTP lesions exhibited a much lower person naming performance (58.1% of correctly recognized people) than did patients with RTP lesions (89.8%) or than did controls (85.0%). In addition, this study showed that the performance of patients with lesions to the LTP was lower in a famous landmark naming task (60.9%) than that of patients with lesions to the RTP (89.6%) and of patients with left-hemisphere lesions outside the temporal pole area (82.2%); these landmarks were either unique buildings (e.g., the Golden Gate Bridge) or natural sites (e.g., the Niagara Falls).

Moreover, patients with LTP lesions (n = 18) also showed a deficit in naming famous people from hearing their voices (only 66.2% of the recognized voices were correctly named) in comparison with neurologically normal participants (95.1%, n = 20) and with patients with right hemisphere lesions (86.6%, n = 18), although the performance of these three groups was very similar in a voice recognition task (Waldron et al., 2014). The results of this study are important because

they suggest that the LTP is not only involved in naming people from their faces but also from their voices, or in naming people not only from visual stimuli but also from auditory stimuli (see also Belfi and Tranel, 2014). Results from this whole series of studies consistently showed that lesions in the LTP area are associated with an impairment of naming unique entities. These results are consistent with the conclusions of previous reviews of single cases and group studies of patients with prevalent damage to the anterior parts of the right or left temporal lobes, which evaluated the patients' difficulties in processing famous people (Gainotti, 2007, 2015). These reviews indicated that a loss of familiarity and of specific semantic information about a person was associated with right temporal lobe damage, whereas a prevalent difficulty in retrieving people's names was associated with the anterior left temporal lobe.

Other lesion studies have evaluated the role of the uncinate fasciculus in the retrieval of proper names. Papagno et al. (2011) compared two groups of patients who underwent the surgical removal of tumours either in the left frontal or temporal pole. For 18 patients, the uncinate fasciculus (UF) had been removed, whereas for 26 other patients, the UF was left in place. These two groups were similar in age and educational level. Three months after surgery, the proportion of patients with impaired performance of proper naming was higher in the group of patients with UF removal than in the group of patients without removal. Object naming was also more impaired in the former than in the latter group, but to a lesser extent. In a follow-up study, Papagno et al. (2016) compared two smaller groups of similar patients (8 with UF removal and 9 without UF removal). In both groups of patients, the performance of object naming was found to recover to the same level as before surgery. However, naming- person performance remained impaired in patients with UF removal. Such data suggest that the integrity of the UF might be crucial for the retrieval of proper names.

3.3. Neuroimaging studies

Functional imaging studies have indicated that naming persons and other unique entities is associated with an activation in the left anterior temporal cortex, in particular the left temporal polar area. This has been observed both in studies that used positron emission tomography (Damasio et al., 1996, 2004; Grabowski et al., 2001) and in studies that used functional magnetic resonance imaging (fMRI) (Tsukiura et al., 2002; Experiment 2) with healthy participants. This result has been reported whatever the baseline task with which face naming was contrasted, when that task consisted either of judging the orientation of an unfamiliar task (Damasio et al., 1996, 2004; Grabowski et al., 2001) or of naming the target person's occupation (Tsukiura et al., 2002). This activation of the left anterior temporal lobe (ATL) was reported whether the task required naming famous people (Damasio et al., 1996, 2004; Grabowski et al., 2001; Tsukiura et al., 2002; but see Gesierich et al., 2011) or naming newly acquired names (Ross and Olson, 2012; Tsukiura et al., 2002). This specific activation was also reported when the task consisted of naming pictures of famous buildings (Grabowski et al., 2001).

There are a number of other fMRI studies that have investigated the brain correlates of proper name retrieval. However, these studies did not involve a task that required overt naming, but rather recognition of associations. (e.g., Tsukiura et al., 2003, 2006, 2008, 2010). The results of these studies will not be presented in detail, but overall, they showed a left ATL selective activation when associations between names and person-related semantic information were successfully recognized.

3.4. Brain electrical stimulation studies

A few studies have examined the effect of transcranial direct current stimulation (tDCS) on the recall of proper names, and the available results are quite contrasted. Ross et al. (2010) reported that anodal stimulation of the right ATL by means of tDCS improved the accuracy of

famous face naming for stimuli that were hard to retrieve (i.e., with a Response Time > 5 s) in young adults. In a further study, anodal stimulation of the left ATL was found to improve healthy older people's naming of famous face (Ross et al., 2011). More recently, it was shown that applying anodal tDCS over the left ATL did not improve the retrieval of newly acquired names, and that applying cathodal tDCS to this region did not impair the participants' performance (Pisoni et al., 2015). However, anodal tDCS over the left inferior frontal gyrus has been shown to improve naming by decreasing intrusions, in comparison with sham stimulation (Pisoni et al., 2015). The 14 fMRI and tDCS investigations presented above were conducted on small samples of 9–20 participants, with a median of 12 participants. This might explain the variations in the reported results.

3.5. Conclusions of brain studies

From these studies of the neural basis of lexical access to proper names, neuroscientists have proposed the idea that the LTP (Brodmann area 38) serves as a heteromodal hub for naming unique entities, including persons. More precisely, the LTP would be an interface that mediates between the retrieval of conceptual knowledge about a person and the retrieval of that person's name (lexical knowledge), regardless of the sensory modality by which the person was recognized (e.g., Collins and Olson, 2014; Damasio et al., 2004; Drane et al., 2013; Olson et al., 2013; Ross and Olson, 2012; Tranel, 2009; Waldron et al., 2014). A relatively recent and dramatic example of support for this hypothesis comes from one study in which intracranial recordings were carried out by means of electrodes placed directly on the surface of the left ATL of three neurosurgical patients undergoing intracranial monitoring for seizure localization. Electrophysiological responses were recorded while participants were naming American presidents as well as control items. Naming pictures and voices elicited nearly identical spectral responses in the left ATL, while this task elicited unimodal responses to pictures in the posterior fusiform gyrus and to voices in the superior temporal gyrus (Abel et al., 2015). It has also been proposed that the ATL is a component of a network that supports cognition about people (social cognition) but not the processing of other unique entities such as unique buildings (Simmons et al., 2010). However, the left ATL does not seem to be the only brain area playing an important role in naming people. As we have seen, some studies have reported that the uncinate fasciculus is also crucially involved in naming persons (Papagno et al., 2011, 2016), while other studies have reported that the activation of frontal regions are involved when naming faces (the ventromedial prefrontal cortex, see Damasio et al., 2004; the inferior frontal gyrus, see Pisoni et al., 2015; the lateral prefrontal cortex, see Huijbers et al., 2017). Instead of concluding that there is one key brain region for proper naming, neuroscientists have hypothesized that the production of proper names recruits a network that involves at least the left ATL and the left orbitofrontal cortex connected together by the uncinate fasciculus (e.g., Papagno et al., 2016; Semenza, 2006, 2011, see also Ross and Olson, 2012).

Studies of the specific brain correlates of proper name processing indicate that the processing of proper names and common nouns involves different brain mechanisms. Does the involvement of different neural substrates explain the relative difficulty (quantitative difference) experienced in attaining lexical access to proper names in comparison with common nouns? By itself, this difference does not directly explain why proper names are more difficult to recall than common nouns. The following passage from Semenza (2009, p.363) illustrates this point well: "Even given two independent roads, it could be the case that one may be large and paved while the other narrow, unpaved or very steep, and thus more difficult to negotiate. The problem thus remains of whether the independent pathways used to process proper and common names pose the same burden to the cognitive system". In order to explain the relative difficulty of proper name recall, one line of research could be to attempt to uncover possible biological factors making the

"proper name network" so vulnerable, such as a larger number of metabolic resources (Semenza, 2011; see also Pelamatti et al., 2003). Another line of research, which started at the end of the twentieth century, consists of analysing the linguistic specificities of proper names and of empirically testing, when possible, whether such specificities impair participants' recall performance. In the following section, different factors likely to make access more difficult for proper names than for common nouns will be considered.

4. Proper names are more difficult to retrieve than common nouns: empirical evidence

4.1. The selective effect of ageing

A commonly cited piece of evidence for the vulnerability of proper names is that ageing disproportionately impairs lexical access to proper names in comparison with other categories of words. Such a disproportionate impairment has been reported in diary studies (Burke et al., 1991; Cohen and Faulkner, 1986) and, more importantly, in laboratory studies in which the number of retrieval attempts across the different categories of words was controlled (e.g., Burke et al., 1991; Evrard, 2002; Rastle and Burke, 1996). Yet, some studies have found results that were inconsistent with this claim (Maylor, 1997; Rendell et al., 2005). However, the discrepancy between studies is presumably due to the fact that, in some studies, the familiarity of stimuli was not equivalent across the age groups and also to the fact that retrieval performance was assessed differently across studies (see James, 2006). James (2006) showed that older participants showed more tip-of-the-tongue (TOT) states than young participants when recalling the names of famous people pre-experimentally selected to be familiar to both groups of participants, whereas no age difference was found for the recall of people's profession. Other studies have used a learning paradigm to equate familiarity of stimuli across age groups and found that, in comparison with young participants, older participants showed a larger performance loss in recalling names than in recalling semantic information associated with unfamiliar faces (Barresi et al., 1998; James, 2004; Old and Naveh-Benjamin, 2012).

4.2. The Baker/baker paradox

Comparing the retrieval of proper names and the retrieval of common nouns under good experimental conditions is difficult. Indeed, studies that recorded retrieval incidents by asking participants to name photographs of famous people (for proper names) and objects (for common nous) were confronted with the extreme difficulty of matching stimuli pictures of faces and pictures of objects for perceptual complexity. In addition, studies that used general knowledge questions requiring the retrieval of a proper name or a common noun were confronted with the problem of equalizing the difficulty of questions.

In order to avoid these difficulties, McWeeny et al. (1987) designed an ingenious procedure. Their participants were presented with pre-experimentally unfamiliar faces and were asked to associate each face with both an occupation and a name ("This man is an X and he is called Y" or "This man is called Y and he is an X"). The interesting feature of the experiment was that some of the words "X" or "Y" were ambiguous, i.e., they could be either a name or an occupation such as baker or cook. So, for half of the participants, an ambiguous word was learned as a name (This man is called *Mr. Baker*), while for the other half, the same word was learned as an occupation (This man is a *baker*). The results of this study showed that the ambiguous words were better recalled after having been presented as occupations than as names. This difficulty of proper name retrieval could not be attributed to the frequency, the phonological complexity, the distinctiveness, or the imageability of the words since the words used to label occupations and names were the same. This effect, known as the "*Baker/baker*" paradox (Cohen, 1990), probably represents the most solid piece of evidence that proper names

are more difficult to recall than common nouns. This effect has been replicated in various studies (e.g., James, 2004; James et al., 2012; Rendell et al., 2005).

4.3. The immediate recall of supra-span lists

Another sign of the difficulty involved in recalling proper names in comparison with common nouns comes from free recall tasks requiring the immediate repetition of supra-span lists of words. In such tasks, participants were presented with lists of 12 words, either common names of the same category or proper names (e.g. first names) and were instructed to recall, in any order, as many words as possible immediately after the presentation of each list. Researchers observed a weaker primacy effect when the lists were composed of proper names than when they were composed of common names matched for word length, frequency (as measured in a dictionary of spoken language (Italian) word frequencies that included proper names), and phonological complexity (Pelamatti et al., 2003; Semenza et al., 1996). The decrease in the primacy effect for proper names only, in the context of a similar recency effect for both types of words, suggests that proper names are more difficult to retrieve in long term memory than common nouns.

5. Explanations of the difficulty experienced in producing proper names

5.1. The particular semantic status of proper names

The question of the semantic status of proper names has been extensively debated within the field of the philosophy of language and in linguistics (Donnellan, 1974; Kripke, 1977, 1980; Russell, 1905; for recent syntheses see Cumming, 2016 and Nyström, 2016). Following the studies of Donnellan and Kripke, psychologists and neuropsychologists have proposed that the retrieval of proper names is particularly difficult because proper names are meaningless, as they are detached from the semantic network representing conceptual information (e.g., Burke et al., 1991, 2004; Cohen, 1990; Cohen and Burke, 1993; Semenza and Zettin, 1988; Yasuda et al., 2000). For these authors, the meaninglessness of proper names corresponds to a lack of descriptiveness, i.e., proper names do not imply any attribute of the entity to which they refer (Semenza, 2006). Names like "*Baker*", "*Cook*" or "*Farmer*" are most frequently borne by people who do not have such a profession, even though these names probably come from ancestors who really did have these professions in the past. The personal name "*Baker*" has lost the rich meaning of the common noun "*baker*". This lack of descriptiveness has led some authors to claim that proper names are arbitrary (e.g., Abrams and Davis, 2017; Cohen, 1990; McWeeny et al., 1987). However, the notion that proper names are arbitrary could be misleading. Indeed, except in the case of onomatopoeia, the relationship between the phonological form of a word and the meaning of that word is arbitrary, even for common nouns (de Saussure, 1916; see also Holdcroft, 1991 for a presentation of de Saussure's theoretical framework in English). There is no necessary reason to assign the name "*bakers*" (the *signifier*) to the people who make bread (the *signified*). In French, the same people are called "*boulangers*" and "*panettieri*" in Italian. This arbitrary relationship is nevertheless conventional, i.e., all the members of a given linguistic community share the same noun that refers to a particular category. The specific arbitrariness of proper names is their lack of descriptiveness, i.e., the fact that, within a language community, they do not provide information about the characteristics of their bearers, whereas common nouns do. For instance, if you are told that someone is a baker, you may infer probable characteristics of that person, such as "makes bread and cakes", "sells bread and cakes", and other attributes typical, even definitional, of this professional category. In contrast, if you are told that someone is called *Mr. Baker*, you cannot infer from that any characteristics about the person

apart from the fact that he bears a common Anglo-Saxon name. Perceiving the personal name *Baker*, a number of people named *Baker* may come to your mind, such as Norma Jean Baker (Marilyn Monroe), Simon Baker (an Australian actor playing in the TV series *The Mentalist*), Ginger Baker (the British drummer of the rock band *Cream*), Josephine Baker (an American born French dancer and singer) or Chet Baker (an American jazz trumpet player). But even though these persons share the same surname, they do not share enough common and relevant semantic features to be considered to belong to the same conceptual category whose members would be called the *Baker(s)*. The above list comprises a series of independent unique entities (each of them being designated by a proper name) rather than five exemplars of a category.

Burke et al. (1991) have proposed an interactive activation model of naming that incorporates the idea that proper names are detached from conceptual information (see also Abrams and Davis, 2016; Burke et al., 2004). In fact, the model is not restricted to the retrieval of proper names. With regard to object naming, the model includes visual concept nodes, which are stored descriptions of the surface structure of objects (although Burke et al. did not address the question, these visual concept nodes could be also be replaced by auditory, haptic or olfactory concept nodes). Each visual concept node is connected to several propositional nodes. Propositional nodes represent conceptual information about the category to which the object belongs, with each node representing a semantic attribute of the category. These propositional nodes are connected to a lexical node that is, in turn, connected to the phonological system that includes syllable nodes and phonological nodes. The route to proper naming is a little different. In this case, the visual concept node that represents a person's appearance is connected to propositional nodes representing biographical information known about the target person, but these propositional nodes are not directly connected to a lexical node. Instead, the lexical access to proper names includes an intermediate stage mediating between conceptual and lexical information: the proper noun phrase. This proper noun phrase corresponds to a person identity node (Burke et al., 2004; Schacter, 2001), i.e., a node marking the existence of an individual possessing the features described at the connected propositional nodes and bearing the first name and the surname represented at the lexical nodes. This means that for proper names, but not for common nouns, the excitation is transmitted to the lexical nodes through only a single connection from this person node, and no other top-down connection can compensate when there is a transmission deficit.

The effect of descriptiveness has been empirically tested by using cartoon characters as stimuli (in the world of cartoons, it is not infrequent that characters bear names that describe them in some way). Characters with descriptive names (e.g., *Grumpy* or *Snow White*) have been found to elicit fewer retrieval failures than characters with non-descriptive names (Brédart and Valentine, 1998; Fogler and James, 2007). In addition, it has been shown that physical descriptiveness is more helpful than mental descriptiveness. Indeed, physically descriptive names (e.g., *Lengthy* for a giraffe) were found to be more easily learned in association with new characters than were mentally descriptive names (e.g., *Classy*) and non-descriptive names (Fogler et al., 2010).

The notion that proper names lack descriptiveness has been related to the fact that proper names usually designate unique entities, whereas common nouns refer to categories (see Carson et al., 2000; Semenza, 2006; Semenza and Zettin, 1989; Valentine et al., 1996). This view could be questioned. Indeed, as was just mentioned, proper names may be descriptive (the "Pink Panther" is pink) but these descriptive names designate unique entities just as non-descriptive names do. Moreover, in the real world, in most European countries before the fourteenth century, people bore non-hereditary descriptive names, derived from locations, relationships, or occupations (Hanks and Parkin, 2016). Furthermore, there are currently places in the world where descriptive names are given to children (Griffin, 2010; Lawson, 2016). However, the way descriptive proper names describe the unique entity they

designate is different from the way common nouns describe an exemplar of the category they refer to. Imagine that you know *John Baker*, a 28 year-old Welsh baker, who moved to London where he sells traditional Welsh bread and pastry. He is married and is the father of two twin daughters. He also plays bass in a local rock band and would like to visit the South of France. As discussed earlier, perceiving the common noun *baker* usually activates conceptual information such as "bakes bread and cakes" or "sells bread and cakes", which are important, definitional information. In comparison, speaking of John, the descriptive surname *Baker* brings only a small part of who *Mr. Baker* is. *Mr. Baker* is not just a baker. He is also a father, a husband, an amateur musician, and these other characteristics are identity-specifying features that are at least as important as his profession. To take another example, *Snow White* was called by that name because she had skin as white as snow. This name is clearly descriptive, but it describes only a part of who this character is; it says nothing about her personality, for example. Therefore, contrary to nouns, descriptive proper names reveal only a small proportion of the important features of the entity they designate. Even when it is descriptive, a proper name can never be as descriptive as a noun because it is bound to a very specific level of categorization, the level of an individual entity who possesses properties that, themselves, can be denoted by categorical labels such as nouns. Thus, the lack of descriptiveness results from the function of a proper name, i.e., that it designates a unique entity. A unique entity, such as a person, is tagged with a proper name but that person's biographical properties may be denoted with common nouns, adjectives and verbs.

5.2. Naming a unique entity requires the retrieval of one specific label

Naming a unique entity may be difficult because it requires the retrieval of one specific label. Common nouns, on the other hand, may often be replaced by synonyms or other semantically related words to mask a momentary impairment of lexical access (Cohen, 1994; Cohen and Faulkner, 1986). In addition to synonyms, words from different levels of categorization of a non-unique entity may be used to refer to that entity (Brédart, 1993). For instance, I can use the words "*trousers*", "*jeans*", "*Levis*", or the more precise "*511*" to name the last piece of clothing I bought. This possibility usually does not exist when naming unique entities such as people. Naming a unique entity requires the retrieval of a label that is associated with a particular level of categorization i.e., the level of individuals or unique things. If someone asks me to give the name of my son's dog, saying generic words such as "*pet*", "*dog*", "*Labrador*" would not be accurate. Faces with the unusual property of being associated with two different names were used to evaluate the hypothesis that the need to retrieve one specific label makes person naming difficult (Brédart, 1993). Participants were presented with the faces of famous actors playing a well-known and nameable character such as Harrison Ford playing Indiana Jones or Peter Falk playing Colombo. Naming these faces with two names was compared with naming the faces of famous actors playing characters whose names were not known, such as Richard Gere playing Zack Mayo in "*An Officer and Gentlemen*", or Julia Roberts playing Vivien Ward in "*Pretty Woman*". Participants were instructed that they could name the face by producing either the actor's or the character's name. Even though the actors' familiarity was equivalent in the two sets of pictures, the faces with two names elicited fewer blocking states than the faces of actors playing a character with an unknown name. Similarly, the faces with two names elicited fewer retrieval blocks than equally familiar faces of famous characters played by actors whose names were not known to participants, for instance, McGyver played by Richard Dean Anderson or Starsky played by Michael Glaser. The "specific label" hypothesis was also tested by directly comparing the retrieval of proper names and common nouns from definitions. In this study, the names of persons and of objects were matched for familiarity and the items were selected to avoid alternative names in the two set of items (Hanley,

2011b). In such conditions, the number of retrieval blocks was similar for the recall of people's names and the recall of common nouns. However, having two names does not always make person naming easier. Indeed, several studies have shown that when the task requires someone to specifically retrieve the names of actors, the characters' names may compete, making the retrieval of the actors' names slower (Stevenage and Lewis, 2005; Valentine and Darling, 2006; Valentine et al., 1999). This phenomenon has been called the *nominal competitor effect* (Valentine et al., 1999).

Thus, if one looks at the number of retrieval blocks and not at the response speed, the need to retrieve in memory one specific label to name a person presents a disadvantage because it prevents the by-passing of a block by producing an alternative name. This factor is not specific to proper names and may also intervene when naming objects (Hanley, 2011b), but it is likely to be more frequently involved when naming persons than when naming objects. The possibility of using synonyms or labels from different levels of categorization of an entity helps avoid retrieval blocks. This is simply applying to naming the general principle that a task is presumably easier when several correct responses may be produced than when only one single response is possible. One limitation of the studies that have evaluated the "specific label" hypothesis (Brédart, 1993; Stevenage and Lewis, 2005; Valentine and Darling, 2006; Valentine et al., 1999) is that when two names were associated with a face, these names did not actually designate the same person. For instance, Harrison Ford is an actor, a producer and Calista Flockhart's husband, whereas Indiana Jones is an unmarried archaeologist who hates snakes. Strictly speaking, none of these studies was perfectly designed to study person naming. Using famous people's stage names (e.g., Marilyn Monroe, Bob Dylan) and real names (Norma Jean Baker, Robert Zimmerman) would have been more appropriate.

5.3. The plausible phonology hypothesis

Consider the following Brennen (1993) thought experiment. If we were told that someone works as a *dreaner*, we would probably think that we have not heard correctly. But if we were told that someone is called *Mr Dreaner*, we would have probably found nothing out of the ordinary about that. Brennen (1993, 2000) has suggested that the range of plausible phonological sequences is wider for proper names than for common nouns. He illustrated that point with the following example. If you must retrieve the word for a profession from the first syllable /bei/ and the last phoneme /ˆ/, only one profession is possible (baker). Now if the word to be retrieved is a personal name, then the task is more complicated because there are many names that may start with the syllable /bei/and end with the phoneme /ˆ/ (e.g., Bader, Baker, Baner, Bater, or Bazer). One consequence of this wider range of phonologies is that retrieved partial phonological information is likely to be less helpful for retrieving the whole phonological form of a person's name than that of a common noun. Furthermore, variability of the phonological forms of proper names has increased dramatically during the last 100 years (Ramscar et al., 2014). For instance, due to increased contacts between different populations and cultures, the number of different personal names that we can hear or read is much higher than 100 years ago. Unfortunately, to date, the set size of the plausible phonology hypothesis has not been empirically tested with participants. However, computer simulations have shown that the arousal of uncertainty due to the variability of phonologies is likely to impact negatively proper name processing (Ramscar et al., 2014).

5.4. Proper names often contain multiple words

Even though famous people such as singers (e.g., Björk, Lorde), actors (Bourvil) or film characters (Aladdin) may have names made up of one single component (monyms), in Western societies, people's names usually comprise at least two components, i.e., a first name and a last name. By contrast, most common nouns are made up of one single word. Hanley and Chapman (2008) evaluated whether the number of words comprised in names could impact the number of retrieval failures. The authors compared the retrieval of famous names made up of two components (a first name and a last name) with that of equally familiar names that comprised three components (e.g., Catherine Zeta Jones, Martin Luther King). The results of this study showed that names containing three words were associated with significantly more retrieval failures than were names with two words. As suggested by these results, the fact that proper names, in particular personal names, usually comprise two or more words instead of one can be detrimental.

5.5. The frequency of use of proper names is relatively low

Some authors have suggested that proper names are difficult to retrieve in memory because they are typically lower in overall frequency of use than other kinds of words (Abrams and Davis, 2017; Fogler and James, 2007). It is more complicated to estimate the frequency of use of proper names than that of other words. Several lexical databases providing word frequency are available (e.g., for Dutch, English and German see Baayen et al., 1995; for French, see New et al., 2004). Unfortunately, there is no such database for proper name frequency. The number of entries in the telephone directory has often been used as a measure of surname frequency. However, this way of estimating the frequency of names has been criticized because the frequency of a personal name is not directly analogous to word frequency (Valentine et al., 1996). Indeed, the frequency of a surname, for example, depends not only on the frequency of that surname in the population, but also on the familiarity of known people bearing that surname (Valentine et al., 1996). For instance, my own surname is not frequent in the population but my colleagues are used to processing it rather frequently through interactions, messages, and so on. In line with this view, the names of personally known people may be recalled faster than semantic biographical information about these persons (Brédart et al., 2005). However, to date, it remains unknown how these two factors should be combined in order to estimate the actual frequency of use. Nevertheless, the idea that higher frequency of use makes the recall of names easier[1] has been indirectly supported by the following findings: 1) that names acquired earlier in life elicit fewer retrieval failures (Bonin et al., 2008), and 2) that these names are recalled faster (Moore and Valentine, 1998; Smith-Spark et al., 2013) than names acquired later on (see also Valentine and Moore, 1995).

Naming a unique entity more typically requires the retrieval of one specific label than does naming an object or a more abstract notion, but it may happen that non-unique entities also require the retrieval of a specific word (Hanley, 2011b). Proper names more typically comprise several words than do common nouns, but common nouns may also be comprised of several words (e.g., compound words). The frequency of the use of proper names is relatively low in comparison with common nouns, but there are common nouns that are very infrequent too. These factors are, in fact, adverse properties that are rather typical of proper names without being totally specific to them. By contrast, the lack of descriptiveness of proper names seems to be a more specific property that makes person naming difficult (although exceptions are possible; see the next section).

6. Future directions

6.1. Investigating the processing of proper names with an adjectival form

So far, we have seen that neuroscientists and psychologists have usually distinguished between the retrieval of proper names and the retrieval of common nouns by typically opposing object naming with person naming, or more generally, the naming of unique entities with non-descriptive or meaningless words with the naming of non-unique entities or categories with meaningful words. However, such a clear-cut binary distinction does not capture all aspects of the everyday use of

proper names. Indeed, proper names, such as the names of cities (*Paris*), countries (*Sweden*) or very famous people (*Newton*), may have an adjectival form (respectively, *Parisian*, *Swedish* and *Newtonian*) and hence appear to be more meaningful than typical names.

It has been suggested that proper names with an adjectival form have semantic connotations (Cohen and Burke, 1993), that there are more connections between conceptual and phonological representations for adjectivized names than for other proper names (Hollis and Valentine, 2001), and that retrieving the phonology of a meaningful adjective may help to retrieve the phonology of an associated proper name (Griffin, 2010; Lucchelli and De Renzi, 1992). However, we know very little about the cognitive processing of proper names with an adjectival form. It has been observed that, in patients with anomia, retrieving the names of towns and countries is usually more preserved in comparison with the retrieval of people's names (Hanley and Kay, 1998). This relative preservation has been attributed to the fact that the geographical names selected in these studies had more often an adjectival form than the famous persons' names to which they were compared (Hittmair-Delazer et al., 1994; Lucchelli and De Renzi, 1992). A more systematic comparison of proper names, with and without an adjectival form, needs to be conducted. It would interesting to evaluate whether personal or geographical names with an adjectival form are easier to retrieve (in terms of both naming speed and occurrence of naming failures) in comparison with names without an adjectival form when factors such as familiarity and frequency of use are properly controlled (see Hanley and Kay, 1998). It would also be particularly useful to compare the brain correlates associated with the production of proper names with and without an adjectival form. If proper names with an adjectival form tend to be processed as, or are partly processed as, common nouns, one would expect their processing to be more associated with activations in the left inferior temporal cortex (Damasio et al., 2004) as well as in the left middle temporal gyrus and in the posterior portions of the superior temporal gyrus (Baldo et al., 2013; Lau et al., 2015) than the processing of proper names without an adjectival form.

6.2. Investigating the processing of proper names used as nouns

Proper names may be used as nouns in some conversational contexts. To illustrate this non-standard use of proper names, consider the following example: *John thinks he is an Einstein* (Pilatova, 2005). In this example, *Einstein* was not used to designate a particular person but rather to refer to the category of very clever and creative people (see also Van Langendonck and Van de Velde, 2016). This non-standard use is not limited to names of famous people. In everyday life, when a person is known by all the people participating in the conversation for a particularly salient feature, his or her name may be used in such a way. For instance, I recently heard a colleague say about a young postdoc *She is a new X*, *X* being a brilliant senior researcher in our research unit. The use of brain imaging techniques should provide precious indications about the way proper names used as nouns are processed, by analysing whether their production recruits areas usually associated with common noun processing, proper name processing, or both. At a behavioural level, one would predict that, in a learning paradigm, it would be easier to learn that a person is considered as an Einstein than to learn that a person is called Einstein.

6.3. The function of interfaces in cognitive/psychological and neuroscientific models

Another important point to be considered in future research is the bridging of the gap between psychological models of person naming on the one hand and the neuroscientific temporal pole theory on the other. We have seen in Section 3.5 that cognitive neuroscientists tend to consider the LTP as an interface between the retrieval of conceptual knowledge stored about a unique entity and that entity's name.

Similarly, in the Burke et al. (1991, 2004) information processing model, the proper noun phrase is an interface between conceptual knowledge stored about a person and lexical nodes[2] (see Section 5.1). Therefore, the notion of an interface between conceptual and lexical information has been included both in the Burke et al. (1991) psychological model and in the Damasio et al. (1996, 2004) neuroscience theory of person naming. But this apparent commonality between psychological and neuroscientific models might be rather superficial. Indeed, the key question about models and theories that include hubs, interfaces, or relays for retrieving proper names is to determine what such intermediary structures do. In other words, what is their functional role? In the Burke et al. (1991, 2004) model, the interface (proper noun phrase) is just a node that simply transmits the input it receives. The impact of the presence of this node results from the fact that this node is the only one that sends an output to the lexical nodes. The unicity of this link makes the connection fragile because, in the case of transmission deficit, no other connections will compensate. By contrast, it seems that, in the LTP theory, the heteromodal hub mediating between the retrieval of conceptual information related to a target person and the retrieval of that person's name is not a mere passive relay, i.e., its function is not simply to relay information from one stage of processing to another one. Rather this hub, being a convergence zone, supports the process of triggering word form retrieval (Damasio et al., 2004; Tranel, 2009). This convergence zone has also been described as a third-party mediation structure that brokers the retrieval of conceptual knowledge and name retrieval (Tranel, 2009; Waldron et al., 2014). In future research, it would be interesting to specify further what information processing operation(s) this kind of intermediary structure carries out. This is crucial to enable a meaningful comparison between models.

6.4. Reconsidering the role of interference in naming

As mentioned in the first paragraph of the present paper, errors in person naming may occur in addition to mere retrieval failures. Studies of person naming errors have indicated that such errors tend to occur when the target person and the intruder are semantically or contextually related, have similarities in physical appearance, and/or have phonologically similar names (Brédart and Dardenne, 2015; Brédart and Valentine, 1992; Deffler et al., 2016; Griffin and Wangerman, 2013). The occurrence of such errors suggests a competition between lexical units (Abrams and Davis, 2017; Griffin and Wangerman, 2013). In the psychological literature on the recall of proper names, the Burke et al. (1991) model is probably the most influential. According to this model, the difficulty in retrieving names is not due to a competition between lexical units but rather to a transmission deficit from conceptual nodes via the proper noun phrase (see section 5.1 here-above). Several studies have presented empirical data supporting this model, which seems particularly good at explaining the occurrence of the TOT phenomenon (for a synthesis, see Abrams and Davis, 2016). However, other studies have reported results suggesting that proper names may compete with one another during lexical access. We have already mentioned the *nominal competitor effect* in section 5.2: it takes longer to name actors known by two names instead of by one single name. It has also been shown that retrieval-induced forgetting applies to face naming, suggesting that it is the occurrence of inhibitory mechanisms that suppresses competitors (Ferreira et al., 2014; Marful et al., 2015). In addition, face naming has been shown to be slower when faces are presented in a semantically homogeneous context than in a heterogeneous context (Marful et al., 2014). In short, studies have shown that the presentation of semantically, contextually and/or phonologically related items may slow down the naming of a target face (Germain-Mondon et al., 2011; Izaute and Bonin, 2006; Marful et al., 2014; Young et al., 1986, 1987) or decrease naming accuracy (Ferreira et al., 2014; Marful et al., 2015). But there are also studies that have indicated that the rates of incorrect responses (Cross and Burke, 2004; Vitkovitch et al., 2006) or TOTs (Oberle and James, 2013) decreased when an

associated person's face had been presented earlier.

In brief, the role of the competition between lexical units may have been underestimated. But the discrepancy between the results of different studies is striking. One important objective of future studies should be to ascertain under which circumstances the presentation of related items helps or, on the contrary, harms the retrieval of a target name. An examination of the procedures used in these existing different studies suggests that an interference occurs when the target face and a related name are presented simultaneously (Young et al., 1986, 1987), quasi-simultaneously (Germain-Mondon et al., 2011; Izaute and Bonin, 2006) or when the target face is presented after related face(s) without intervening unrelated items (Marful et al., 2014). By contrast, when unrelated items are inserted between the related and the target items, the presentation of a related item facilitates the retrieval of the target name (Cross and Burke, 2004; Oberle and James, 2013; Vitkovitch et al., 2006). Further research is needed to test this provisional working hypothesis and to provide an explanation for such a pattern of results.

In conclusion, improving our understanding of person naming requires the further refinement of the existing cognitive models through reflecting more clearly the respective contribution of transmission deficit on the one hand, and competition between lexical units on the other hand, in the occurrence of naming difficulties. It also requires a more precise characterization of the network of brain regions involved in the recall of people's names and a further specification of the information processing operations performed by these brain substrates. The investigation (at the behavioural as well as at the neural level) of proper names possessing an adjectival form might help to evaluate whether the most useful approach is to continue viewing common nouns and proper names are processed as two completely separate categories of words, or rather to consider that there is a continuum between the typical use of common nouns (referring to categories) and the typical use of proper names (designating unique entities).

Notes

Note 1. Note that the frequency of use cannot explain the pattern of performance of patients showing an excellent performance when naming objects with low frequency names while being impaired when naming people that are very familiar to them (Otsuka et al., 2005; Semenza and Zettin, 1988).

Note 2. In the final version of Valentine et al.'s (1996, p. 180) model, the proper noun phrase does not transmit activation from conceptual nodes to lexical nodes.

Conflicts of interest

None.

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