The Entry Point in the Identification of Familiar Objects

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***Abstract*—This paper reports an experiment which explores whether there is a preferential level of abstraction that serves as the entry point in identification of familiar objects. In a category-verification task the participants were presented with a category label and asked to indicate whether a picture presented a brief time later was an example of the category. Familiar entities from three different categories of objects (artwork, building and product) and unfamiliar entities from three contrasting categories (home furnishing, utensil and musical instrument) were categorized at three different levels of abstraction (superordinate, basic and subordinate). We found that participants were faster to identify familiar entities at the unique level of identity (subordinate level) than they were to verify them at the basic level. On the contrary, verification times for unfamiliar entities were faster at the basic level than at the subordinate level. These results suggest that the entry point of familiar entities is shifted to the most subordinate level of abstraction in object identification (i.e., the level of singular concepts). Implications of these findings for the basic level advantage effect are discussed.**

***Keywords*-entry point; singular concepts; basic level advantage; unique level of identity.**

I. INTRODUCTION

Humans have an extraordinary ability to identify individual objects and this ability is crucial for daily life. We need to correctly recognize and identify all the individuals with which we interact (e.g., people, pets, objects) and successfully perform actions and have reactions that must be directed to these entities.

Any individual object can be identified at multiple levels of abstraction. For example, whereas a painting can be identified as a *painting* (basic level), the same painting can be identified more generally as an *artwork* (superordinate level) or more specifically as a *portrait* or *Mona Lisa* (subordinate or unique level, respectively). In this paper we aim to investigate whether there is a preferential level of abstraction at which an individual is first identified. Do we first identify the most famous Leonardo's painting as *Mona Lisa* or as a *painting*? Is there a direct and rapid access to the unique mental representation of Mona Lisa (i.e., the singular concept of Mona Lisa) during the identification process, or is this access mediated by accessing higher level conceptual representations (i.e., general concepts)? These questions deal with the bottom-up access to mental representations of individuals in object recognition. To investigate if the singular concept represents the first conceptual representation activated during the identification process - *the entry point* in individual object recognition to use a term proposed by Jolicoeur et at. [1] - we performed an experiment which investigates whether people identify individual artifacts from three different categories (i.e., artwork, building and product) as quickly (or more quickly) at the unique level of identity (e.g., Mona Lisa) as at the basic level (e.g., painting). The results of the experiment challenges the hypothesis that objects are necessarily first identified as members of basic-level categories before further identification, and provide preliminary evidence, which may stimulate the debate about individual objects and their conceptual representations. The rest of the paper is organized as follows. We review related work in Section II. In Section III we discuss the motivations and the hypothesis of the study. Section IV presents the experiment and results. Finally, the contribution of the paper with respect to the previous work is discussed in Section V.

II. RELATED WORK

The idea that, of all the various categories to which a given entity belongs, some appear to be more readily accessible to the human mind than others, has been widely investigated by Rosch et al. since from their first studies on human categorization [2]. The authors found that, although all objects can be categorized at different levels of abstraction, there is one level, called the basic level, that has a special status in categorization (a phenomenon known as basic level advantage). To test the relation between basic level advantage and object identification, Rosch and colleagues [3][2] used several object-identification tasks. The authors found that people prefer to use basic-level terms to name objects (e.g., dog) over more general or specific terms (e.g., animal or poodle), they are faster to verify objects at an intermediate level of specificity than at more general and more specific levels and they are primed by basic-level terms more than by subordinate- or superordinate-level names.

To explain the basic-level effects, Jolicoeur, Gluck and Kosslyin [1] proposed that certain nodes within the hierarchical representation of object categories in memory serve as "entry points" for probing the semantic network. An

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entry point corresponds to the level where "the perceptual stimulus first makes contact with its underlying memorial representation". Visual stimuli are first identified through one of these entry-level categories so that any information stored directly with the corresponding entry-level node is activated earliest in the identification process. Additional information becomes available later, as activation spreads downward toward more specific concepts or upward toward more general concepts. Basic-level effects are observed for typical category members because the basic-level category nodes serve as the entry-point for such items.

However, research on human object identification have demonstrated that the entry point can be modulated by at least two factors: 1) typicality of an exemplar for its corresponding basic level and 2) domain-specific expertise. Jolicoeur et al. [1] suggested that atypical category members fail to show a basic level advantage because their entry-points are specific rather than basic. An atypical member is structurally dissimilar to the other members of the same basic level category and, therefore, it is more easily categorized at subordinate level than at the basic. Murphy and Brownell [4] explain this effect arguing that atypical subordinates have many of the characteristics of basic categories (i.e. they are specific) but, unlike other subordinates, they are also very distinctive.

Also expertise in a particular field is likely to shift entry level of many objects towards the subordinate level. Johnson and Mervis [5] and Tanaka and Taylor [6], for example, studied the interaction of knowledge and basic-level categorization in individuals with varying levels of knowledge about song-birds and dogs, respectively. They found that experience increased accessibility to categorical knowledge at subordinate levels, causing these levels to function as basic. However, the efficiency advantage of the previous basic level was not lost as knowledge about subbasic categories increased.

In the domain of face perception, Tanaka [7] proposed a similar expertise-mediated shift in identification of familiar faces. According to this hypothesis, even though few people are experts in recognition of objects from a particular category, all adults can be considered experts in human face recognition [8]. Therefore, if face recognition follows the pattern of other kinds of expert object recognition, people should show a downward shift in recognition as a result of experience. In this case, however, the face expertise hypothesis predicts that the entry point of face recognition is at the most subordinate level of abstraction that is the level of unique identity where the category label is a proper name referring to a single individual in the world (e.g., Barack Obama). The results from four experiments support the face expertise hypothesis showing that, for example, a face is more likely to be identified as *Barack Obama* rather than as a *person* or as *politician*. Similar results have been reported by Belke et al. [9] in the context of art recognition. In this study the authors provides empirical evidence that art is distinguished from other real world objects in human cognition, in that the identification of visual art is at the subordinate level of the producing artist rather than at the basic level of the object.

III. Rationale for the Study

The studies described above provide evidence that for many objects the identification process operates at levels other than the basic level. Moreover, for a special class of stimuli (i.e., familiar faces) the entry point appears to be shifted to the level of unique identity. Since human faces have been often considered special stimuli in visual recognition, the question whether a similar shift can happen for other types of familiar entities remains open.

The first aim of the present study is to investigate whether the entry point in the identification of unique non-face objects is at the level of unique identity as that of face objects. Up to now, research in the domain of object recognition has been concerned with object classes such as furniture, every-day-objects and even artificial objects, but very little is known about the representation and initial identification of unique entities belonging to these classes. For instance, what might be the first access to semantic memory when a person identifies the "Eiffel Tower"? According to a strong form of the basic-level advantage hypothesis, called by Murphy et al. [4] *basic-first hypothesis*, we should expect that the entry point in this case is at the level of "monument" or "tower", or even more general "work of art", corresponding to the basic level of the stimulus. People may access to the unique level of identity only after the basic level is activated. Therefore, if the access to the subordinate level of identity is mediated through the basic-level, we should predict that the basic-level categorization should be faster than the subordinate-level categorization. On the contrary, if the stimulus is recognized at the level of unique identity, as "Eiffel Tower", recognition times should be as fast as or faster at this level than at the basic level.

Our hypothesis is that a person first recognizes an individual entity at the level of unique identity when she possesses a singular concept on that individual entity in semantic memory. We assume that the initial identification of an individual entity, whose information is structured in memory as a singular concept, yields cognitive processing that differs from that involved in the identification of objects which are not individuated in memory by means of singular concepts. Initializing the individual concept of an entity makes that entity unique and identifiable (i.e., atypical in a sense) from the other members of the same basic level category. Then, this entity can be categorized faster at the most subordinate level of categorization, namely the unique level of identity. Having the singular concept of an object entails the direct recognition of the object through that concept which serves as the access node to the knowledge that the agent has

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about the object. As a result, any information stored at the level of the singular concept becomes available earliest in processing.

On these premises, we hypothesize that the direct access to semantic information about unique individuals during the recognition process is not a cognitive process specialized for human faces, but is a general mechanism that humans use in the recognition process of unique identifiable entities. To test this hypothesis, we investigated the identification process using another category of unique entities, i.e., artifact. We predict that, if the entry point is set on the basis of the level of the uniqueness of the items within the category, the unique-level categorization of unique items should be faster than their upper-level categorizations.

IV. The experiment

In the experiment we used a category verification task similar to that adopted by Tanaka [7] in the domain of face recognition and by Belke [9] in art recognition. Participants were shown with a superordinate, basic or subordinate level category name and a brief time later were shown with a picture. Their task was to indicate whether the picture was an exemplar of the category. The results were compared between familiar and unfamiliar objects. Familiar entities were selected from three categories of objects (i.e., artwork, building and product) and contrasted with unfamiliar entities from three contrasting categories (home furnishing, utensil and musical instrument). In the experiment, participants were asked to verify exemplars from these categories at superordinate (e.g., “artwork”, “building”, “furnishing”), basic (e.g., “painting”, “tower”, “chair”) and subordinate levels (e.g., “Mona Lisa”, “Eiffel Tower”, “rocking chair”) of categorization. In previous research [2], [1], it has been shown that participants were faster to categorize exemplars at the basic level (e.g., verifying that an entity is a “dog”) than categorizing exemplars at the superordinate level (e.g., verifying that an entity is an “animal”) and at the subordinate level (e.g., verifying that an entity is a “poodle”). Therefore, according to the basic-first hypothesis, artifacts should be categorized first at the basic level (regardless of the fact that they are familiar or unfamiliar). That is, basic level verifications should be faster than superordinate verifications and than subordinate verifications (unique identity name or model name verifications). For instance, people should be faster to verify that a picture is a “painting” than to verify that it is an “artwork”or “Mona Lisa”. On the contrary, we expect that subordinate-level representations will be more accessible than the basic-level representations for familiar objects. That is, participants should be as fast or faster to verify the unique identity of a familiar object (e.g., “Mona Lisa”) than to verify that the object is an “artwork” or a “painting”. We expect the same pattern of results for very familiar products, like familiar car models. That is, people should be as fast or faster to verify that a car is a “Fiat 500” than to verify that is a “vehicle” or a “car”.

A. Method

1) Participants: Twenty participants (12 males and 8 females) took part in the experiment. Mean age was 31.15 (SD=6.35), ranging from 23 to 45 years. Participants were tested individually and they were not paid for participation.

2) Stimuli: Pictures were chosen from three categories of familiar entities (artwork, building and product) and from three contrasting categories of unfamiliar entities (home furnishing, utensil and musical instrument). As famous artworks, some of the most well-known paintings and sculptures in art history were selected (e.g., Mona Lisa, David). Famous building were selected from those used in [10] (e.g., Eiffel Tower, Twin Towers). Finally, for the product category we used some of the most popular models of vehicles and electronic devices in Italy (e.g., Fiat 500, Iphone). For each category we selected 4 items. Additionally, four pictures other than those used for experimental trials were selected for practice trials.

3) Procedure: At the beginning of the experimental session, participants were presented with instructions explaining the category verification task on a monitor screen. They were also provided with the complete list of the subordinate-level terms for all of the 24 target exemplars presented in a random order one after the other. Subsequently, to signal the beginning of each trial, a fixation cross appeared for 1000 ms on the monitor. Next, a blank screen appeared for 1000 ms, followed by a category word which remained for 2500 ms. Finally, after 500 ms blank interval, the category name was replaced with a picture. The participants’ task was to verify whether the picture matched the category name, by pressing as quickly as possible the corresponding TRUE or FALSE buttons. The picture remained on the screen until the answer was given. The two response keys were counterbalanced for hand across participants. Trial order was fully randomized. Figure 1 illustrates the design of a sample trial in the category-verification task used in the experiment. The experiment consisted of 144 experimental trials, resulting from 24 items with two response types (TRUE and FALSE) and three levels of categorizations. That is, each item was shown six times. In the superordinate level and true condition, the category-word could be “artwork”, “building”, “product”, “furnishing”, “utensil”, “musical instruments”. In the basic level and true condition it could be “painting”, “tower”, “phone” and so on. Finally, in the subordinate level and true condition the category word was the proper name of the artifact, the model name of the product or the specific type of furnishing, utensil or musical instrument. In the false conditions, category words were taken from a different exemplar of the same higher-order level category. For example, the “Eiffel Tower” letter string and the “Leaning Tower of Pisa” picture stimulus were paired, falling both

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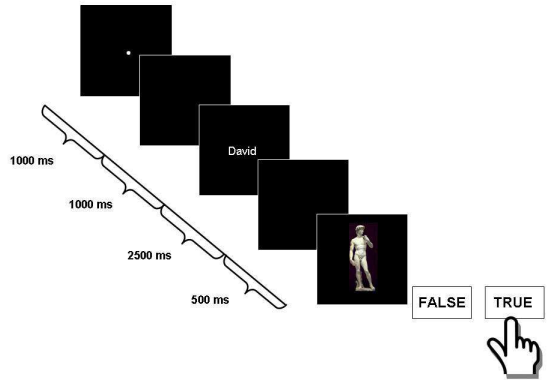

Figure 1. Trial presentation sequence in the category verification task. On each trial, a word was viewed (at superordinate, basic or subordinate level), followed by a picture, and the subjects were asked to indicate whether the picture matched the word.

under the same inclusive category "tower". In the basic level condition, a false word label that shared the same superordinate category was provided (e.g., the letter string "painting" was presented with a "statue" picture stimulus, with both referring to the superordinate category "artwork"). False trials were designed with the restriction that each word-picture combination at the subordinate level would appeared only once during the experiment and each word within a level of categorization would appeared with the same frequency in order to prevent response bias. The experiment was implemented in Matlab using the Psychtoolbox-3. An example of the category words used in the three categorization levels for true and false conditions is shown in Table I. We note that the results of the experiment critically depend on the ability of participants to identify the target stimuli at the subordinate level of identity. For example, a person who has never encountered the statue of David by Michelangelo and who is not familiar with his name would not be able to verify the David name in a category verification task. To exclude the possibility that basic-level categories were advantaged due to a lack of familiarity with the subordinate level categories, at the end of the experiment, participants were asked to identify each stimulus on a very specific (subordinate) level. For example, participants were asked to indicate the title of a painting or the model of a car. Pictures that could not be named at the subordinate level were omitted from the analysis for the corresponding participant.

		Category Word	
Stimulus	Level	True Condition	False Condition
Mona Lisa	Sup.	artwork	building
(familiar)	Basic	painting	sculpture
	Sub.	Mona Lisa	The Scream
Eiffel Tower	Sup.	building	utensil
(familiar)	Basic	tower	skyscraper
	Sub.	Eiffel Tower	Leaning Tower of Pisa
Fiat 500	Sup.	product	building
(familiar)	Basic	car	audio player
	Sub.	Fiat 500	Mini Cooper
rocking chair	Sup.	furnishing	artwork
(unfamiliar)	Basic	chair	table
	Sub.	rocking chair	folding chair
bread knife	Sup.	utensil	artwork
(unfamiliar)	Basic	knife	spoon
	Sub.	bread knife	flick knife
electric guitar	Sup.	musical instrument	building
(unfamiliar)	Basic	guitar	drum
	Sub.	electric guitar	acoustic guitar

Table I
STIMULI AND CATEGORY WORDS USED IN THE EXPERIMENT

B. Results

An analysis of variance was performed on reaction times of correct true and, separately, of correct false responses. Before performing the analysis, trials with outlying RTs (i.e., below 300 ms or above 3000 ms) were excluded from the data set. To test for differences between the three familiar categories, mean RTs were submitted to two-way ANOVA with Category (artwork, building and product) and Category Level (superordinate, basic and subordinate) as within-participant factors. This analysis showed that the main effect of level of categorization was significant, $F(2, 38) = 8.93$, $p < 0.001$. Neither the main effect of category $F(2, 38) = 1.36$, $p = 0.27$, nor the interaction between category and category level were significant $F(4, 76) = 0.20$, $p = 0.93$. The same analysis was performed to test for differences among the unfamiliar categories. Mean RTs were subjected to a 3 (Category: home furnishing, utensil and musical instrument) $\times$ 3 (Category Level: superordinate, basic and subordinate) within-participants ANOVA. As in the previous analysis, we found that neither the main effect of category $F(2, 38) = 1.03$, $p = 0.36$, nor the interaction between category and category level were significant $F(4, 76) = 1.73$, $p = 0.15$. On the contrary, the main effect of level of categorization was significant, $F(2, 38) = 11.20$, $p < 0.001$.

Consequently, categories of familiar entities and categories of unfamiliar entities were collapsed to obtain individual mean RTs to familiar and unfamiliar entity types, respectively. Table II shows the separate reaction times for true responses as a function of category (Familiar vs. Unfamiliar) and category level (Superordinate, Basic and Subordinate). An analysis of variance (ANOVA) was performed for reaction times of correct true responses with Familiarity (familiar or unfamiliar) and Category Level (superordinate, basic and subordinate) as within participant factors. The main effect of Familiarity was not significant $F(1, 19) = 0.93$, $p = 0.35$, indicating that overall participants were not faster to categorize familiar entities than they were to categorize unfamiliar entities. On the contrary, the main effect of category level was significant, $F(2, 38) = 13.61$,

	Category Level		
Category	Superordinate	Basic	Subordinate
Familiar	1200	1072	949
Unfamiliar	1236	979	1096

Table II
MEAN REACTION TIMES FOR THE TRUE RESPONSES AS A FUNCTION OF CATEGORY (FAMILIAR VS. UNFAMILIAR) AND CATEGORY LEVEL (SUPERORDINATE, BASIC AND SUBORDINATE).

$p < 0.001$. Critically, the Familiarity $\times$ Category Level interaction was also significant, $F(2, 38) = 5.69$, $p < 0.01$. As shown in figure 2, participants were faster to categorize unfamiliar entities at the basic level than at subordinate level, $F(1, 19) = 4.10$, $p < 0.05$. For instance, they were faster to verify that a bread knife is a "knife" than they were to verify that it is a "bread knife". On the contrary, for familiar entities, participants were faster to categorize entities at the subordinate level (i.e., unique level) than at the basic level, $F(1, 19) = 7.72$, $p < 0.05$. For example, participants were faster to verify that the David is "The David" than to verify that it is "a statue". The results seem to confirm the assumption of a general basic-level advantage [2] for unfamiliar entities. However, contrary to this assumption, we found a different pattern of results for entities that can be identified at the unique level of identity (i.e., familiar entities). At the subordinate level (i.e., the unique level of identity) familiar entities were categorized faster than at the basic level, showing that the basic-level advantage disappears for entities that can be identified at the most specific level of identity.

Direct comparisons between TRUE judgments showed that subordinate-level judgments in the familiar category were significantly faster than subordinate judgments in the unfamiliar category, t(19)=3.74, p<0.01. The related comparison between reaction times for the familiar-basic and unfamiliar-basic categorizations showed the opposite pattern. Unfamiliar-basic judgments were significantly faster than familiar-basic judgments, t(19) = 2.36, p<0.05.

In summary, these results demonstrated that familiar entities were identified differently from unfamiliar entities. People are faster to categorize familiar entities at subordinate level than they are to verify them at the basic level. On the contrary, verification times for unfamiliar entities were faster at the basic level than at the subordinate level. Moreover, the results seem suggest that the shift of the entry point in recognition towards the subordinate level is not peculiar of some special categories of entities but is a more general phenomenon concerning all the entities that have a unique representation in memory. An ANOVA was also performed for correct false reaction times with familiarity (familiar or unfamiliar) and category level (superordinate, basic and subordinate) as within-participant factors. Table III shows the separate reaction times for false responses as a function

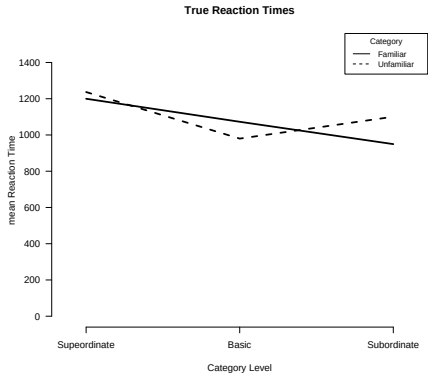

Figure 2. Mean Reaction Times for categorizing familiar and unfamiliar entities at superordinate, basic and subordinate levels in the TRUE condition.

of category (Familiar vs. Unfamiliar) and category level (Superordinate, Basic and Subordinate). The results of this

	Category Level		
Category	Superordinate	Basic	Subordinate
Familiar	1108	1104	1052
Unfamiliar	1118	1010	1182

Table III
MEAN REACTION TIMES FOR THE FALSE RESPONSES AS A FUNCTION OF CATEGORY (FAMILIAR VS. UNFAMILIAR) AND CATEGORY LEVEL (SUPERORDINATE, BASIC AND SUBORDINATE).

analysis were globally in accordance with those obtained for correct true response times. The main effect of familiarity was not significant, $F(1, 19) = 1.40$, $p = 0.24$. This means that people were not faster to verify familiar entities than unfamiliar entities. Instead, the main effect of level of categorization was significant, $F(2, 38) = 12.97$, $p < 0.001$, indicating slower responses for a more specific level of categorization. Critically, the Familiarity $\times$ Category Level interaction was also significant, $F(2, 38) = 6.59$, $p < 0.001$. The interaction indicates that participants were faster to correctly reject unfamiliar entities at the basic level than at the subordinate level, $F(1, 19) = 4.10$, $p < 0.05$, whereas they were equally faster to correctly reject familiar entities at basic level than at subordinate level, $F(1, 19) = 0.161$, $p = 0.69$. The last result represents a difference compared to the previous analysis on the correct true reaction times. While participants were faster to verify a familiar entity at the subordinate level than at the basic level, they were equally fast to correctly reject a familiar entity at the subordinate-level as at the basic-level. This result could be explained arguing that the mismatch between the singular concept activated by the word category and that activated by the picture takes more time to be recognized. However, the result does not contrast our hypothesis since it shows that it is not the case that correctly rejecting a familiar

entity at the basic-level is faster than rejecting a familiar entity an the subordinate level, as predicted by the basic-level advantage hypothesis. On the contrary, the lack of a basic level advantage for the true rejecting trials of familiar entities indicated that representations of familiar entities are highly accessible at a specific level of abstraction which is related to the proper name of the entities.

As in the TRUE condition, we found that direct comparisons between FALSE judgments showed that basic-level judgments in the unfamiliar category were significantly faster than basic-level judgments in the familiar category, $t(19)=4.07$, $p<0.001$. These results open the question whether a mechanism of inhibition may come into play to favor the access to singular representations compared to higher level representations. To answer this question, future experiments should compare familiar and unfamiliar entities from the same categories to reduce as much as possible processing differences due to the category.

V. Conclusion

The purpose of the study was to provide empirical evidence for the direct access to semantic memory of unique entities through individual concepts. The results from a category verification experiment, which has previously proved sensitive to address the entry point identification issue, suggest that the initial point of contact between the perceptual stimulus of a unique distinguishable object and its memory representation is not mediated by high level conceptual structures (i.e., general concepts).

The results of our study mirror previous findings in recognition of familiar faces [7] and visual art identification [9], in that a preferential accessibility to more specific representations in memory has been previously demonstrated for famous face and art recognition. However, in these studies the underlying idea is that there is something "special" in the target entities that lead people to develop specialized mechanisms of identification. Belke [9], for instance, explicitly states that "art has a special status amongst external-world objects since it allows for a memorial representation based on stylistic features that are linked in semantic memory to the creating artist" (p.199). The special status of faces was instead conceived by Tanaka [7] in terms of expertise. According to the face expertise hypothesis, the high level of specialization in face recognition explains the shift of the entry point for faces at the most subordinate level of abstraction. We suggest an alternative explanation for the preferential access to unique representations in memory. The idea is that having an individual representation of an object in memory is a sufficient condition to shift the entry point of recognition to the most subordinate level of categorization, that is the unique level of identification. The recognition mechanism of unique familiar entities is different from that of entities that can not be identified at the unique level of identity (i.e., unfamiliar entities). In principle, a familiar individual could be first recognized as whatever other unfamiliar individual, namely as a member of a basic level category. Our experiment provides evidence against this hypothesis. We found that unique familiar entities are verified more quickly (or rejected as quickly as) at the subordinate level of unique identity than they are at the basic level. In conclusion, the results of the experiment provided evidence in favor of our hypothesis that people are faster (or at least equally fast) to verify entities at the unique level than at higher levels of abstractions. These results suggest that whereas the entry point in recognition for most unfamiliar objects is a the basic level of categorization (i.e., the first contact with a memorial representation is at the level of a general concept), the entry point of unique familiar entities is at the subordinate level of unique identity (i.e., the first contact with a memorial representation is at the level of a singular concept).

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