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HOW DO IDEAS BECOME GENERAL IN THEIR SIGNIFICATION?

ABSTRACT: Abstraction is one of the central notions in philosophy and cognitive science. Though its origins are often traced to Locke, various senses of abstraction have been developed in fields as diverse as philosophy, psychology, cognitive science, artificial intelligence, and computer science (e.g. Barsalou 2005). The notion of abstraction on which I am focusing here is as that of a process of similarities recognition across instances of a given kind involving progressive exclusion of instance details. As such, abstraction plays a major role in concept-formation and learning. Traditionally, abstraction models have been deemed circular (e.g. Berkeley 1710/1957), while in recent years abstraction models have also come under fire for being incoherent (e.g. Hendriks-Jansen 1996), requiring large conceptual resources in order to operate, and so forth. Here, I flesh out a psychological process on the basis of which general ideas are formed out of representations of particulars. The main characteristics of the suggested view are that abstract representations are structured entities with general representational powers, while a major role is given to top-down effects in perception. I argue that the challenges that both traditional and modern abstraction accounts faced are avoided in the light of the present suggestion.

1. TRADITIONAL ABSTRACTION MODELS

The question of how we perceive the world has long figured prominently in the agenda of philosophers and psychologists alike. In contemporary philosophy and psychology it is widely accepted that on perceiving the world representations of our environment are formed in our minds (e.g. Findlay & Gilchrist 2003; Gazzaniga et al. 1998; Biederman 1987; Hochberg 1999; Goldstone 1994; Smith & Heise 1992).[1] Furthermore, it is argued that these perceptual representations are often used as raw materials in the process of concept formation in one way or another (e.g. citealtPrinz02,Barsalou99). Concepts, in turn, have an extension in the world and they are thought to pick out all members of a given category. Given that we only have perceptual experiences with particulars though, how is it that we can form mental entities, like concepts, of greater generality or ideas about general properties?

General ideas are critical for categorization, which in turn is one of the fundamental aspects of reasoning, decision-making, linguistic inferences and so forth. For Locke in particular the process of abstraction is of considerable importance to human knowledge, as he thinks that most words we use are general (1690/1975: III, I. 1. p., 409). It is worth clarifying that Locke does not imply that it is only general or sortal ideas that can serve in a classificatory scheme (Uzgalis 2012). Furthermore, abstraction is often seen as a gateway to structured ideas, which in turn are often seen as a hallmark of human cognition that any theory must explain (e.g. Fodor & Pylyshyn 1988).

Furthermore, having an account of how general ideas are formed plays a key role in accounting for learning and concept acquisition. For concepts are precisely mental particulars with general representational powers — they pick out all members of a given category. Admittedly, an account of general ideas is not the only option for accounting for the origins of our conceptual repertoire. However, the alternative options are not without problems. The first option is to argue that there are no representations that exhibit this kind of generality. Instead, ideas of particular instances play that role when used in the appropriate kind of way (functional role). For instance, an idea of a particular triangle could be used as a stand-in for all triangles. The second option is to argue that concepts do not actually derive from perceptual experiences with particular instances. Rather they are part of our genetic endowment. In this way, the need to account for the move from particular ideas to general ones is avoided. Unlike perceptually oriented accounts though, this option raises significant evolutionary concerns.

Admittedly, arguing that a better-equipped mind, full of concepts, is evolutionary less fit than one without any innate concept seems counterintuitive. For, surely, a mind with a large inbuilt conceptual repertoire makes us better prepared for any challenges that our environment might have in store for us. The problem with conceptually pre-packed minds though is that it is not clear how to decide which concepts are and which are not innate. Famously, Fodor (e.g. 1981) argues that all lexical concepts are innate (concepts that can be couched with a single word, e.g. TABLE), which leads to the controversial claim that BROCCOLI and CARBURETOR are also innate. The evolutionary benefits of such a view are far from clear. A more economical account is more appealing from an evolutionary point of view. Unsurprisingly, no contemporary Nativists in the literature argue for innateness of concepts any more (choosing instead to argue for innateness of knowledge biases, propensities and so). For the above reasons accounting for general ideas is a crucial task worth pursuing.

As already mentioned, there are two dominant approaches with regards to ideas about general properties. On the one hand, there are those focusing on abstraction (e.g. Locke), while on the other there are those stressing the functional role of a particular idea (e.g. Berkeley, Hume). In its contemporary form, the debate consists in discussing how we abstract away from the idiosyncrasies of representations of particulars, thus developing a view from the British Empiricists. Primarily, the view originates in Locke who argues that we are in a position to move beyond the details of particular instances on the basis of a process he calls 'abstraction'. More precisely, Locke distinguishes between two abstraction processes (1690/1975: II 11 9; III 3. 6-9). On the one hand he talks about abstraction through sensation and on the other about abstraction through reflection.[2]

Even though sensations are considered to be the sources of simple ideas, abstract ideas can also be generated on the basis of sensations. For instance, while looking at a piece of chalk, one can attend to a specific aspect of a perceptual experience, say the whiteness of the chalk, while ignoring its particularities, i.e. its position on a table, its length

etc. However, even if one can abstract through sensation, the output of this process lacks the kind of generality with which abstraction through reflection provides us. Abstraction through sensation is better understood as auxiliary to abstraction through reflection (III 3. 6–9).

During abstraction through reflection, a subject notices a common feature amongst several distinct stored perceptual representations. As the abstraction process unfolds, particularities of time, place and contextual features of experiences with tokens of a given type are progressively ignored. By leaving out this particular information, the abstracted idea can be applied to subsequent instances of a given kind. Crucially, a subject needs to have experiences of white objects, e.g. a piece of chalk or snow, in order to abstract 'white' or 'whiteness'. In this sense, selectively attending to a certain feature precedes the process of abstraction.

Even though Locke's suggestions are extremely useful, as Berkeley — one of Locke's traditional critics — points out, Locke (IV 7. 9) ascribes contradictory properties to general ideas. As I will discuss, Berkeley bases this attack on Locke on the claim that ideas are picture-like mental images of perceptual experiences, and is thus targeting abstraction as a representational quality.

Despite the problems that abstraction models (AMs) traditionally faced, in recent years AMs have also come under fire for a number of reasons. They have been charged with being incoherent (e.g. Hendriks-Jansen 1996), and it has been argued that specifying the content of an abstraction is an extremely challenging task, that it is extremely hard to choose the correct AM, and that AMs face great difficulties in handling deviations and accounting for potentially crucial features of kinds that are nevertheless not regularly occurring in instances (see Barsalou 2005 for a detailed discussion). Such arguments against AMs have led to more or less of a consensus that AMs cannot work and that we probably need different methodological tools than the ones abstraction is able to provide us with. So, the traditional concerns about AMs are still up-to-date. It is for these reasons that I want to tackle these issues head on with a position that I think can deal with these objections. I start with problems that AMs have traditionally faced and tackle their contemporary counterparts later on. Also, given space limitations, I provide only a small selection of independent empirical evidence in support of the main claims of the suggested view.

It is worth clarifying that the suggested view about how general ideas are formed builds upon the work of Prinz (2002) and Barsalou (1999, 2003). Despite significant similarities though, the suggested view is novel in that, unlike Prinz, it does not appeal to the functional roles of ideas of particulars. Instead, I am suggesting a genuinely Lockean view of abstraction. Furthermore, despite relying on Barsalou's claims about the modus operandi of our perceptual systems, I disagree that there is not a permanent or complete abstraction of a category stored in long-term memory. Barsalou construes abstraction as a skill enabling the construction of temporary online interpretations of members of a given category. That said, in Barsalou's view experience does contribute to diminishing the need for online abstractions to occur every single time we encounter instances of a given category (habitual approaches to interpretation). Departing from Barsalou, I construe abstraction as a developmental process that, once complete, produces an abstracted representation that becomes stored in memory. Furthermore, the suggested view differs significantly from both Prinz's and Barsalou's views with regards to the ways in which concepts are individuated, even though this is not my main focus here. Briefly, in Prinz's Proxytype theory the relation between proxytypes and concepts is a type/token relation, and every concept could be tokened by virtue of a different representation on different occasions. In Barsalou's view (especially in his 1987) concepts are identified with temporary representations of categories formed in working memory. In contrast to both, I argue that concepts are always tokened by virtue of a single abstracted representation plus a representation of a particular, given contextual constraints (contextual constraints play the same role that Prinz suggests). From the above, it should be clear that the suggested view is novel in that it offers an updated yet genuinely Lockean view of abstraction without appealing to the functional roles of ideas of particulars.[3]

1.1. Problems with Traditional AMs

Locke's suggestions on abstraction face several objections. First, there is a delicate distinction that does not receive the required attention in Locke's analysis. It is not clear whether the process of abstraction refers

directly to the process of concept formation or whether Locke is making a semantic point. On the basis of Locke's analysis, it seems that general ideas can represent general properties or kinds, and thus one understands that he is making a semantic point, i.e. a point about how ideas refer to entities, or categories in the case of general ideas, in the world. However, Locke seems to be making this semantic claim on the basis of a claim about the way in which concepts are formed. Let me first elaborate on abstraction as a process of concept-formation. According to Locke, there is a lining up between simple and complex ideas. In particular, general ideas are formed on the basis of comparing specific ideas — (or ideas of individuals) — and focusing on the similarities between specific ideas while ignoring their particularities. So, it must be that general ideas do not contain information about the particularities of simple ideas. Here, Locke moves on from abstraction as a concept formation process and makes a claim about abstraction as a semantic quality. For Locke complex ideas are general in their signification, i.e. they represent a given category. However, it is not clear whether general ideas contain information about particulars but manage to refer to general properties on the basis of Locke's semantics, or whether they do not in fact represent any information from simple ideas.

Second, Locke's account is susceptible to a circularity worry. Recall that, for Locke, different experiences of white objects are compared and contrasted in order for the subject to abstract 'white' or 'whiteness'. The main concern here is that in order for different experiences of white objects to be compared and contrasted, they have to be grouped together. It is incumbent upon Locke to provide an account of how it is that pairs of experiences of white objects are selected in order to be compared. The obvious way of doing that is by having a mechanism that already possesses a concept that represents their commonality, the concept WHITE,[4] in this case. And the problem is clearly that Locke refers to the abstraction process in order to account for how general ideas are formed, while in doing so he presupposes existence of the general idea in question. It is for this reason that Locke's view is susceptible to a circularity worry. If, on the other hand, the selection of experiences for reflective comparison is not done on the basis of possession of the appropriate concept, e.g. WHITE, then Locke owes us an explanation of how it is decided which pair or set of experiences will be compared and contrasted with each other, in order for a commonality to be identified and abstracted.

It is also worth noting, that the process of abstraction through sensation, i.e. when the subject selectively attends to particular aspects of a perceptual experience, is not susceptible to this circularity worry. For it might be that contextual information acquired through sensation can be helpful in indicating which pairs of experiences should be compared. However, having a non-circular account of how a subject selectively attends to specific properties of an object does not suffice to avoid the circularity worry that arises during abstraction through reflection. For even though one can attend to helpful (for the abstraction process) contextual features, one can then supposedly delete all of this contextual information. Furthermore, attending to and storing a bulk of contextual information merely for the purpose of helping determine which pairs of experiences will be compared, may end up being too taxing on the cognitive system.

Additionally, aside from this circularity worry, there seems to be a larger problem for Locke's suggestions on abstraction, deriving from the fact that Locke carelessly claims that

> "[...]the general idea of a triangle [...] must be neither oblique nor rectangle, neither equilateral, equicrural (i.e. isosceles), nor scalenon; but all and none of these at once" (1690/1975: IV 9. 7).

Clearly, there is an inherent contradiction in Locke's account. However, if we were to be more charitable to Locke, and follow his account of abstraction according to which, what is left out during the abstraction process is all the respects in which all the particulars differ, surely Locke should have said that at the end of the abstraction process an idea of a triangle is in itself neither isosceles nor equilateral nor scalene but it can represent triangles of all three kinds. At least this formulation would not appear contradictory. But even in this case, and given that Locke thinks of ideas as images, Locke's suggestions are still susceptible to Berkeley's (1710/1957) famous claim that any triangle will have to be one of these three kinds. So, the claim that the abstract idea can be an image that can represent by resemblance and still represent all three kinds equally threatens incoherence.

It is on this point that Berkeley famously challenges Locke by claiming that there are no representations, or acts of tokening representations, that exhibit this kind of generality. The reason being that there is no such thing as abstractness in the semantic sense and thus that there are no ideas that can be general in their signification.[5]

Berkeley distinguishes between two kinds of abstraction, only one of which he rejects. The distinction resembles the one drawn above between issues regarding concept formation on the one hand, and issues related to a concept's semantic properties on the other. The first kind of abstraction, which Berkeley accepts as sound, is one during which a subject selectively attends to a specific aspect of a perceptual experience. For instance, when looking at an apple on a table one can abstract away from the table, floor, and other details of the room in which the table is situated. In this way, the subject can form an idea of an apple without any other ideas attached to it. While Berkeley accepts that this is possible, the formed idea is not actually abstract but rather an idea of an actual (or possible) particular with certain properties such as a characteristic shape, color, etc. The second kind of abstraction that Berkeley examines, and rejects, is one related to the ways in which an image is related to entities in the world. The reason for rejecting abstraction as a process of arriving at ideas that are general in their signification is that for Berkeley there are no representations that have this kind of generality. For instance, it is not possible to have an idea of all possible dogs. At best, a subject can have an image of a dog, or somehow form a conjunction of dog-parts. In turn, if all a subject can have is an idea of a particular dog, then it is not possible to claim that this idea is general in its signification.

On these grounds, Berkeley criticizes Locke (IV 7 9) for ascribing contradictory properties to general ideas, (and specifically to the general idea of a triangle, to return to the above quotation). It is worth clarifying that Berkeley bases this attack on Locke on the claim that ideas are picture-like mental images of perceptual experiences. If it is accepted that ideas are picture-like mental images, then it is hard to imagine how one can abstract away from particular details. For instance, an image of a triangle will always be an image of an isosceles, equilateral or a scalene triangle. Thus, it is hard to imagine how a mental image can represent triangularity as such, and Locke's suggestions fall short of accounting for the generality of ideas. In this sense, Berkeley's attack is targeting abstraction as a representational quality.

1.2. A Better Solution?

An alternative way to account for how ideas become general in their signification that does not rely on an abstraction process is by appealing to the idea's functional role, i.e. the way it is used by the subject. This comprises the main gist of both Berkeley's and Hume's suggestions.

Having rejected Locke's suggestions on abstraction, Berkeley (1710/1957: Intro) argues that an idea can be used as an exemplar of all members of a given category. For instance, in order to illustrate a geometrical proof, one can use a particular triangle as an exemplar of all triangles. The modern analog of Berkeley's claims is that general ideas (type concepts) can be mapped onto more than one thing (tokens) in terms of their functional role or the way in which they are deployed in thought processes.

Hume makes suggestion similar to Berkeley's in his 'Treatise of Human Nature' (1739/1978: I 1 7). In particular, Hume implies that ideas are not inherently representational, and that they represent things in the world by virtue of their functional or causal role, through the production of mental effects and dispositions. So, it might be that two identical ideas actually refer to different things by virtue of their different functional role in the subject's mental economy. For instance, the idea of a red ball might sometimes be used in order to represent the category of red balls, while at other times the category of balls, and at other times the category of red things of all kinds. For Hume one does not need to posit lack of specificity in the intrinsic (imagistic) qualities of the image in order to explain reference to general categories such as 'all red things of any kind'. Instead this can be done on the basis of the idea's functional and causal role. It is by virtue of the particular functional role that ideas play in the subject's thinking that qualitatively identical ideas can represent either particulars or general kinds. The generality of an idea is not an intrinsic feature; rather, it derives from the ways in which a subject uses the idea in their thinking.[6]

In his 'Enquiry' (1748/1975: II 19), Hume suggests that concepts are faint copies of particular sensory experiences, which he calls 'impressions'. For instance, on encountering a dog a conscious state is produced in the subject's sensory systems, which leaves a trace in the

subject's memory. The conscious state produced during the original experience with a dog, the impression, is more 'vivacious' than the trace left in the subject's memory, the latter is used as a stand-in for either the particular object, the perceived dog in the previous example, or the category of dogs. A second way of acquiring concepts, on Hume's view, is by reflection on our mental states. For instance, a subject can form the concept ANGER by attending to the emotional state they are in when in anger. The concepts derived from sensation and/or reflection can be combined to form a new concept. For instance, a subject merging an image of a mountain and an image of gold can form the concept GOLDEN MOUNTAIN. So, for Hume, the concept GOLDEN MOUNTAIN is a relatively complex idea and the concepts GOLDEN and MOUNTAIN are relatively simple. Complex ideas are fainter copies of the individual impressions from which they have ultimately derived and to which they correspond and resemble. It is worth clarifying that resemblance is only at the level of relatively simple concepts, while complex concepts inherit their semantic properties from their constitutive simpler concepts. Note also that resemblance is a necessary condition for representation but not a sufficient one. For, resemblance does not represent but rather carries information. For instance, the impression of a footprint on the sand does not represent a foot even though it resembles and carries information about it.

As explained, neither Berkeley nor Hume explicitly talks about abstraction since they both argue that general ideas are ideas of particulars used as stand-ins for a given category.[7] Nevertheless, Hume does refer to a process of composing an idea out of previously experienced simple ideas, which in turn derive from impressions. This is done by focusing on specific aspects of impressions, which are then compounded and transposed in order to form a complex idea. In this sense, there are certain similarities to Lockean abstraction to the extent that certain aspects of a given impression are singled out. The difference is that Locke uses those singled out features in order to account for how general ideas are formed, while Hume to account for how a new complex idea is formed.

1.3. Objections Against Berkeley's and Hume's Views on General Ideas

Both Berkeley's and Hume's views seem to outperform Locke's in terms of how general ideas or concepts are formed. However, both of those views are themselves susceptible to a number of concerns. First, as with Locke's view, there is a circularity worry. Namely, both Berkeley and Hume talk about instances of a given kind, and thus imply that there exists an independent criterion of sameness or similarity between them, which is not explicit. As mentioned above, the most plausible way to do that is by presupposing the existence of the appropriate concept, or at least the concept of SIMILARITY, which however would render their views circular in much the same way as Locke's.

The views in question also face two versions of Devitt and Sterelny's (1987) famous 'Qua-problem'. First consider a given particular, say an apple A. Apples belong to many different categories, for instance the category of fruit, the category of edible things, the category of nutritious foods, etc. On different occasions, a subject can use A as a stand-in for all fruit or as stand-in for the category of fruit at different instances. At this point it is not clear what will determine the intended extension. One way to clarify the determinants of the intended extension is by acknowledging that the specific extension is part of the general's idea content, and it is its content that fixes which general idea it is, i.e. apple or fruit. Given that the idea of apple is distinct from the idea of fruit, the problem becomes perhaps more obvious if we consider thoughts like 'All apples are fruit'. In this sense, the way in which a given idea will be deployed needs to be decided prior to using it as a stand-in for a given category. The extension of a general given idea is not pre-fixed.

In a 'reverse' fashion, a representation of a given kind, say a representation of water, could be used both as a stand-in for water and H_2O. And even though their extensions are the same, the ideas of water and of H_2O are distinct. Even if the set of instances could be adequately fixed by inferring from the stand-in for H_2O, it would still be unclear how the class was conceived. The extension of a general idea alone does not suffice to account for how concepts are individuated. Concepts (or general ideas) are individuated in a more fine-grained way.

Finally, views that focus on perceptual experiences inputting the raw materials necessary for abstraction processes to occur seem to have problems with cases of concepts that do not pick out any tangible entities, such as DEMOCRACY, JUSTICE, VIRTUE, etc.

In a nutshell, one could account for general ideas either via an abstraction process or by appealing to the functional role of ideas of particulars. Critics of Locke have deemed his abstraction model circular and incoherent. On the other hand, Berkeley's and Hume's functional accounts also face a number of rather insurmountable problems (e.g. the qua problem). Next, I turn to suggest an alternative AM, which accounts for the formation of general ideas or concepts while avoiding the problems that all three of the above traditional accounts faced.

2. SUGGESTING AN ALTERNATIVE AM

In the interest of simplicity and in order to focus on problems traditionally associated with AMs, the present proposal is illustrated in terms of how simple cases of ideas or concepts, i.e. concepts whose instances have obvious visible similarities, e.g. TREE, DOG, and so forth are formed. However, the suggested abstraction process applies to all concepts that both adults and subjects at early developmental stages posses. That is, a similar process to the one presented here applies also to concepts with widely heterogeneous instances, e.g. DANGER, VEHICLE, as well as lofty concepts that do not pick out tangible entities, like DEMOCRACY and JUSTICE. Regarding concepts with widely heterogeneous instances, despite perceptual differences, there are still overlapping similarities across their instances. For example, in the case of logical concepts like NEGATION, the overlapping similarity is a mismatch between the subject's expectations and the world; for DANGER an emotional state of fear, etc.[8] With regards to lofty concepts like DEMOCRACY, the abstraction process takes place in terms of linguistic symbols (or perceptual representations of words). Note that even though the stage of acquiring DEMOCRACY builds upon the same abstraction process, there is an additional process during which the subject learns how to constrain the usage of her newly acquired linguistic symbol.[9]

General ideas are formed by virtue of the following elements being in place:

1. Representations of particulars.
2. A locus where the raw materials are stored and can be accessed — e.g. Perry's (2001) mental folders.

3. A computational process, which takes as input the bundle of representations stored in a given locus and gives as output a new abstracted representation. The abstracted representation is not identical to any of the input representations and does not merely represent any of the particular instances.

2.1. Raw Materials & Loci

During an encounter with the first instance of a given kind, a representation is formed and stored in long-term memory. On encounter with a subsequent instance – one that gets attended to and identified as a second instance of a given kind – a further representation is formed. At this stage, a scanning process is initiated and a match is sought for in the subject's memory.[10]

The scanning mechanism has a parameter; call it parameter 'X', which sets the threshold of similarity between new and stored representations, at different levels across different scans. Presumably, the scanning starts with X having set the similarity threshold at a very demanding level. If a match is not found, then X is slightly relaxed and the similarity threshold is lowered. This process continues for a few times until a match is found. If a match is not found, the currently formed representation is classified as new and is stored for further investigation. Contextual features along with any known information about the current encounter will determine the location where the representation in question will be stored. (See also Figure 1).

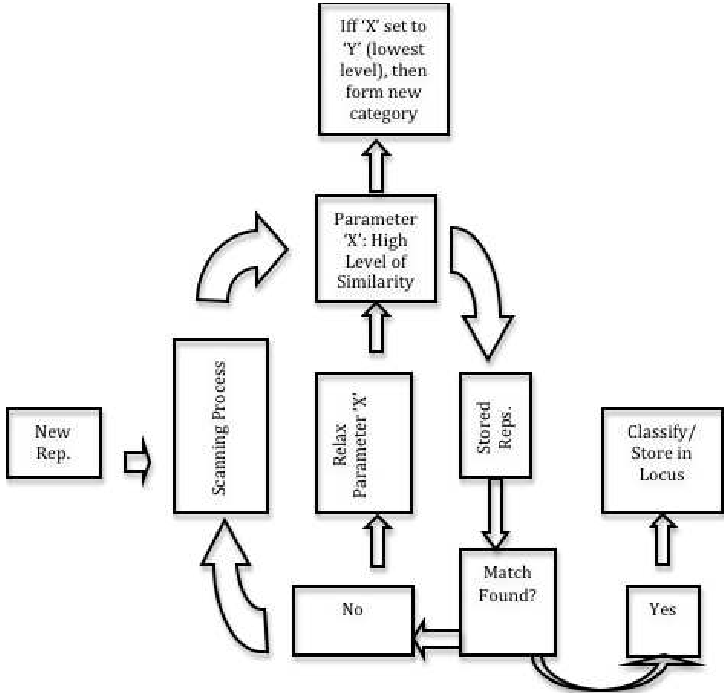

Figure 1: The Matching Process

Once a stored representation matching the currently formed one is found in the subject's memory, the stored representation is activated and drives selective attention in a top-down manner. Crucially, it drives attention to the same parts of the currently perceived instance that the subject had attended to during the encounter with the first instance. Activation of an existing representation, crucially, also allows storage of the currently formed representation in the same locus in the subject's mind (see below).

It is worth clarifying that the cognitive system cannot simply rely on top-down influences of stored representations for acquisition of input representations for the abstraction process. For, by being influenced by accidents and contingencies of what the first encounter was, it would potentially miss out on certain statistical regularities. Thus, top-down influences have to be more liberal to the extent that some non-overlapping information is allowed as a by-product of not being too skewed by the bias of the first encounter.

A similar scanning process occurs every time the subject (encounters and, crucially,) selectively attends to instances of a given kind, at least prior to formation of the appropriate general idea (see below). After a number of encounters, a bundle of representations will be stored in the mind and crucially at a given locus. Once a concept is formed or acquired, storage of representations is less extensive even for instances that the subject selectively attends to. That is, once a given concept is in place, its instances are simply categorized as instances of that concept and do not need to be stored.

Note also that stored representations of previous experiences that do not become reactivated frequently or are not strongly associated with other representations become fainter — to use Hume's terminology — in the sense that they are harder to access even if they remain stored. Furthermore, it is neither the case that all representations play the same role in formation of general ideas, nor that they all have the same positive memory effects.[11]

2.2. *Abstracting Away*

As mentioned above, the abstraction process (AP) uses perceptual representations stored in the subject's mind as input. More specifically, only representations stored in a given locus are selected and fed into the abstraction process. Recall from above that representations are stored in a given locus by virtue of top-down effects from stored matching representations.

AP is neither endogenously controlled nor stimulus driven. Rather it is initiated when a threshold of perceptual representations of instances is reached (and a certain number of representations gets stored in a given folder or locus). In addition to this quantitative threshold there is also a qualitative one. Thus, existence of a certain number of representations alone does not suffice for the AP to become initiated. A suitably diverse range of representations must also be stored in a given locus. Most probably, these diverse representations carry information about different contextual features or non-selectively-attended-

to features that nevertheless became stored (e.g. information acquired through peripheral vision). Thus, existence of non-overlapping similarities initiates a process that is sensitive to overlapping similarities.

In addition to the AP being sensitive to overlapping similarities, the output representation is sensitive to frequency of occurrences in the input. In more detail, in order for a representation of a feature of a given object to be present in the output of the AP, the feature in question needs to be present in a certain proportion of the input representations. In this sense, AP is sensitive to similarities between members of a given set of stored perceptual representations.

The view suggested here does not presuppose the existence of a notion of similarity or of an independent criterion of sameness. Rather, the overlapping similarities within a set of representations are simply the most commonly occurring features within that set. The AP uses information carried by representations stored in a given locus in the mind that are associated with each other with stronger connections. The hypothesis here is that the more frequent a pair of stimuli co-occurs, the stronger the connections between the representations of these stimuli will become. This is in line with the Hebbian rule of learning (Hebb 1949), as explained below. Specifically, this hypothesis builds upon the intuitive claim that members of a given category are similar to each other. Given similarities amongst members of a given category, there will be a significant number of stored matching representations that will drive selective attention to the same perceived features in a top-down manner (see above). In this way, the representations formed during experiences with members of a given category will be similar to each other. In turn, the representations formed during perception of members of a given category will become connected with stronger associations. Crucially, if 'similarity' is understood in the above terms, then a notion of similarity is not required. In turn, the abstraction process simply selects information that is carried by stronger connections.[12]

2.3. *Properties of AP's Product*

As explained above, the output of the AP is an abstracted representation built out of representations of particular instances of a given kind. Despite the fact that perception occurs in a fragmented fashion — (in that we perceive an object by selectively attending to and forming representations of some of its aspects, features, properties and so forth) — the output representation is a representation of an object as a whole.[13] For representations of parts that have been selectively attended carry information about the object's overall shape, (Barsalou 1999), part-whole relations, relations between different parts and so forth. It is because of the ways that perceptual systems are built that the representation of relations of parts are reliably represented in the percept and are, in turn, reliably stored in long-term memory. In fact, information of relations between parts is one of the features that are typically present in the AP output representation. For instance, while perceiving a chair, the legs are most often below the seat and so forth.[14]

The output of AP is general in its signification in two senses. First, it has general representational powers in that it represents a category rather than a single particular instance. Second, it represents a category that includes things that have not yet been amongst the perceived instances. Thus, even though the output is formed out of representations of particulars, it can represent all instances of a given category as well as repeated perceptual encounters with a particular entity. For every time that there is confrontation with a new instance of a given category, a matching process, similar to the one described above, between the representation of the currently and the previously perceived instances, will occur, and matching stored representations will be activated, since every member of a wider category will bear enough similarity with the AP's output representation.

Had it not been for the abstract representation, the matching process would occur between representations of particulars. Thus an atypical member (e.g. Penguin) of a given category (e.g. <Bird>) would not have activated a representation of a typical instance (e.g. Sparrow).

Finally, it is worth clarifying that despite computational similarities to certain traditional AMs, the suggested AP does not take simple concepts as input. More importantly, the output of the suggested AP does not have the rich cognitive role properties of mental particulars like concepts. That is, it is not endogenously controllable or cannot be activated in the absence of the appropriate stimulus, and is therefore not a fully blown concept. (See Tillas (2010) for a further elaboration on this issue).

2.4. How Many Instances?

A further point that is worth clarifying is that despite the above claim that the abstraction process starts when a quantitative and a qualitative threshold are met there are cases of concepts, which are formed by virtue of very few, or even a single experience, with their instances. For instance, it is intuitive to think that subjects will not need to go through a series of painful experiences in order to acquire PAIN. Therefore, even though we might acquire TREE via the suggested 'repetitive' process, it does not follow that all kinds of ideas are acquired through the same process. For instance, there are certain kinds of representations, like emotions, for which associations can be formed by virtue of very few repetitions.[15]

Furthermore, once a super-kind concept is in place, the abstraction process can be significantly simplified. For on the basis of a matching representation of an experience with a new sub-kind, e.g. ARMADILLO and an existing super-kind, e.g. ANIMAL, the new representation will be stored in the same locus with the super-kind until further information about the sub-kind is acquired. Clearly, at this stage, the subject does not possess the concept of ARMADILLO, but rather a single representation or at best a token-concept like THAT-FUNNY-LOOKING-ANIMAL-I-SAW-THE-OTHER-DAY-BY-MY-FENCE. Neither the token-concept, nor the single representation has the general representational powers that concepts have and on which my focus is here. In any case, associations between the representation of an armadillo (or the token-concept) and the super-kind can be formed by virtue of the overlapping similarities between the two, e.g. they both have eyes, legs, a heart, etc.

What is key here is that stored representations and concepts contribute to acquiring new concepts. For instance, even though one has experiences only with dead armadillos on the side of the road, it does not follow that her ARMADILLO concept will be one that picks out dead armadillos. This would follow from a partial reading of the suggested view. My suggestion is that there will be enough overlapping similarities between representations of dead armadillos and ANIMAL (e.g. representations of eyes or a non-armadillo dead animal), to form associations between them. On the basis of these associations, the subject could recognize armadillos as living animals, despite having only experiences with dead ones.

2.5. *Probabilistic and Diagnostic Information*

As explained above, the suggested view relies too heavily upon Hebbian associationism. It is worth clarifying that Hebbian associationism does not merely track correlations between traits. In addition, it distinguishes between different kinds of statistical/probabilistic information that a concept might contain. For instance, conditional probabilities information (e.g. x will have f (e.g. a heart) given that x falls under c (e.g. ANIMAL)) and diagnostic information about the conditional probability that x will fall under c given that x has f. There are two things that need to be pointed out here. First, according to Hebbian learning, relevant statistical information about associations between features is actually stored in the connection weights linking the (nodes representing) traits together. Differences in connection weights between representations of different traits carry information about the hierarchy, so to speak, between traits of a given kind. That is, 'having a heart' will feature more prominently in the ANIMAL folder, in comparison to 'having legs'. For clearly, 'having a heart' correlates more strongly with instances of animals than 'having legs', and the stronger the correlation, the stronger the connection between representations of hearts and animals. In this sense, Hebbian learning does allow for a hierarchical classification of representations of traits. Both the conditional probability and the diagnostic information about the conditional probability are captured in terms of differences in weights of associations (between representations that exist in a given locus). The stronger the connection weights between two representations, the higher up in the hierarchy within a given set these representations will feature. Thus, information like 'having legs' will yield smaller conditional probability, and in turn diagnostic information about it, in comparison to 'having a heart' to the extent that non-living things like chairs and tables have legs, while all animals have hearts (excluding jellyfish and the like).

Second, concepts are not static but dynamic entities. Even though the suggested view focuses on formation of a mental particular with general representational powers, it does not rule out that further information could be added to its representational/informational repertoire in the light of further experiences and/or cognitive processes like reasoning. Crucially, information acquired on the basis of further reasoning is mirrored in the concept's cognitive content or the relations

of that concept with other concepts, which in turn greatly influences diagnostic information about conditional probabilities. In this sense, it would be perhaps too demanding to require from a view about how general ideas are formed that it also provide an accounting for all changes occurring during a concept's lifespan. On the other hand, a psychological story about how ideas with general representational powers are formed that does not allow for updates/additions to idea's representational/informational repertoire would be rather shortsighted.

3. EMPIRICAL EVIDENCE IN SUPPORT OF THE SUGGESTED VIEW

The view suggested here enjoys significant support from independent empirical evidence. In this section, I present a selection of evidence in favor of the main aspects of the suggested view.

3.1. *Reactivation of Matching Stored Representation*

Demarais & Cohen (1998) focused on whether the nature of the visual imagery required by a particular task evokes saccadic eye movements, and whether it determines the spatial pattern of the saccades. In testing these hypotheses, they asked subjects to solve transitive inference (or syllogistic) problems with the relational terms 'left | right' and 'above | below', e.g. 'a jar of pickles is below a box of tea bags; the jar of pickles is above a can of coffee; where is the can of coffee?'. During execution of the task, horizontal and vertical eye movements were recorded by electrooculography (EOG).

The results showed that subjects made more horizontal and fewer vertical saccades while solving problems with the 'left | right' terms than while solving identical problems with 'above | below'. Similarly, subjects made more vertical saccades while dealing with problems using 'above | below' relational terms than while getting involved in solving problems using 'left | right' terms. From the above, Demarais and Cohen conclude that eye movements occur during tasks that evoke spatially extended imagery, and that the eye movements reflect the spatial orientation of the image. Admittedly, none of the above evidence suggests that the same representation was actually reactivated. However, the recorded eye-movements are too similar to be interpreted in any other way.[16]

3.2. *Top-down Effects in Perception*

Evidence in support of top-down effects in perception (that are rather widely accepted) can be found in phoneme restoration experiments. For instance, Elman & McClelland (1985) presented subjects with spoken words such as 'Table' where the sound made by, e.g. the letter 'b', had been covered with noise. The results show that subjects in their majority hear 'Table' with 'b' in place even though this is not the case. Interpreting this evidence Elman and McClelland argue that a perceptual input activates a number of similar (or matching) stored representations, a scanning process occurs and various competing — similar to each other — representations influence perception.

3.3. *Pattern Recognition Abilities*

In this section, I examine evidence for the claim that patterns are perceivable without deploying conceptual resources. Specifically, I show that perception of edges, motion, color, depth, contrast, position in the visual field and so forth occurs by virtue of specific dedicated cells in the early visual system.

3.3.1. Edge Detection

On perception of an object, and due to the object's structural organization, different parts of it are differently illuminated. Differences in light reflected cause different rods and cones in the retina to get excited at different degrees. Differences in excitation of retinal cells are encoded and transmitted to the visual cortex via the optic nerve. After this low-level processing, visual information is sent to extrastriate cortical areas. In these areas distinct regions process information about color, form and motion (Zeki 1992), cited in Prinz (2002).

3.3.2. Color Perception

Different areas of the visual cortex are involved in processing of color and motion information. In particular, Cavanaugh et al. (1984) show that motion perception is lost in color vision.[17] In particular, they show that perceived speed of isoluminant gratings is slower in comparison

to that of their luminance counterparts and that they may appear as stopped for short periods of time.

Lueck et al. (1989) also argue that cells in V4 are specialized in color processing (reported in Eysenck & Keane 2002). In particular, they PET scanned (Positron Emission Tomography) subjects while presenting them with colored or grey squares. The results obtained showed that blood flow within V4 was increased by thirteen per cent on perception of colored stimuli, while other areas remained unaffected.

3.3.3. Form Perception

Processing of form information involves several areas, including V3, V4 and Inferior Temporal cortex (IT). The cognitive neuroscience literature regarding form perception is mainly focused on IT. For instance, Tanaka (1992) tested the hypothesis that cells in IT seem to respond maximally to simple shapes. In doing so, he presented monkeys with various objects, while the levels of activation of individual neurons in IT were recorded. The results show that simple objects produced maximal responses. Tanaka (1996) focused on the role of curvatures and depth in object representation and argues that most cells in the IT cortex respond to moderately complex features but not to whole-object images, except faces.

3.3.4. Motion Perception

Motion information is also processed in the early visual system. More specifically, it is suggested that area V5 is involved in processing motion information. For instance, Anderson et al. (1996) used MRI scanning (Magnetic Resonance Imaging) and MEG (Magneto-encephalography) to assess brain activity in subjects confronted with motion stimuli. They found that certain parts of V5, located near the occipito-temporal border in a minor sulcus (groove) and immediately below the superior temporal sulcus were maximally responsive to motion stimuli, (in Eysenck & Keane 2002). These findings are in line with Zeki et al.'s (1991) PET analyses and in studies using functional MRIs conducted by Tootell et al. (1995).

3.3.5. Face Recognition

Finally, I consider face recognition as an instance of pattern recognition abilities in order to show that even fairly complex stimuli, like faces, could be perceived without deployment of conceptual resources. In support of this claim, Desimone et al. (1984) investigated the responses of Inferior Temporal (IT) neurons to both simple (bars, edges, etc.) and highly complex stimuli such as flowers, snakes, hands and faces. They found that a population of cells responded selectively to faces. The responses of these cells depended on the configuration of specific face features and their response patterns did not alter over changes in the stimulus's size or position in the visual field.

3.4. Significance for the Suggested Account

The above evidence lends support to the claim made above that pattern recognition occurs in early vision without requiring deployment of conceptual resources. Furthermore, this evidence is useful in further illustrating the claim that similarity between perceived and stored representations occurs not by virtue of deploying an independent criterion of sameness but by comparing activation patterns of brain areas, like the ones mentioned above, that ground perception of the stimuli in question.

3.5. Hebbian Associationism

Hebb's rule of learning is ubiquitously accepted and enjoys significant support from evidence showing that electrical stimulation of circuits within the hippocampal formation can lead to long-term synaptic changes (Associative Long Term Potentiation).[18]

4. PROBLEMS WITH ABSTRACTION MODELS

4.1. Traditional Problems with AMs

As explained in the opening pages, traditional AMs were susceptible to a circularity worry. More precisely, the main concern with Locke's abstraction account is that in order for different experiences of white

objects to be compared and contrasted – as part of the process of abstracting 'white' or 'whiteness' — they have to be grouped together. The obvious way to group these instances of white together is by possessing a concept or a general idea of white, which every instance of white will token. As explained, this renders Locke's view circular. The view suggested here avoids this circularity worry by appealing to the role that top-down effects have in storing similar representations in the same locus. Crucially similarities between stored and occurrent representations are detected without deploying perceptual primitives or independent criteria of sameness and similarity. Rather comparisons occur amongst activational patterns of brain areas grounding 'perception' of the entities at hand. In turn, abstraction includes only representations stored in a given locus, and thus the problem of grouping different instances of a given kind together is solved prior to the abstraction process. The adjacent circularity worry is thus avoided.

Recall also that traditional views focusing on the functional role of ideas, e.g. Berkeley's and Hume's views, faced two versions — one extensional and one intensional — of the Qua problem. According to this criticism, the extension of a given general idea is not pre-fixed and the intension of a general idea does not suffice to account for how concepts are individuated respectively. To return to the same example, the representation of an apple will be deployed both as stand-in for the category of apples, (sub-kind) as well as for the category of fruit (super-kind). The suggested view avoids both the extensional and intensional version of the Qua problem since it does not appeal to the functional role of an idea of a particular. Regarding the extensional version, the present view suggests that thinking of the category apple occurs by virtue of deploying an abstracted structured representation of an apple. In turn, thinking of the category fruit, an abstracted representation of fruit, e.g. a representation carrying information about nutritious edible things growing in trees.

What is key here is that both sub-kinds and super-kinds have their own unique (abstracted) representations. That is, an apple is for instance represented as an edible spherical thing. The extension of 'apple' is what this representation picks out — all apples. In the case of the category fruit (super-kind), the representation of nutritious edible things growing in trees is deployed. This representation is different from a representation of an apple. So, the extension of both apple and fruit is fixed. Hence, in the case of the thought "apple is a fruit" different representations will be deployed. In a similar fashion, different representations will be deployed in the case of thinking of apples and/or fruit separately. So, by having the extension of concepts fixed, the (extensional version) of the 'qua' problem is sufficiently dealt with.

With regards to the intensional version, the ideas WATER and H_2O are distinct and are structured from representations carrying information about a tasteless, odourless liquid in the first case, and about a specific chemical constitution in the second. In the suggested view the idea H_2O is acquired on the basis of experiences with chemical formulas and the like, rather than instances of water (alone). The intensional version of the 'qua' problem is thus also avoided, by virtue of representations of 'water' and 'h2o' being different from each other. In this way, concepts in the suggested account are individuated in an adequately fine-grained way.

4.2. Contemporary Problems with AMs

In this section, I am focusing on contemporary concerns facing AMs in general and the view suggested here in particular. With regards to the latter, there is a vast array of empirical evidence that could be potentially used against it. For instance, one could appeal to contemporary Knowledge Nativism (e.g., Spelke 1994; Spelke & de Walle 1993) and argue that the suggested view does not build upon knowledge that Knowledge Nativists argue we innately possess. To this extent, even if the suggested view is plausible it is not informed by recent empirical evidence and should be thus abandoned. Furthermore, evidence from developmental psychology for subjects deploying information about essential properties of things in the world during categorization tasks could be used against the suggested view. (Consider for instance Mandler and McDonough's (1996) argument against Keil's (1989) Original Sim hypothesis).[19]

The present view could also be challenged from a neuroscientific point of view. Specifically, as explained, the present view depends heavily upon Hebbian learning. In turn, Hebbian learning is vindicated by evidence for Long Term Potentiation. However, there is little evidence that directly links LTP to the storage of memories and learning (Shors

& Matzel 1997). Given the central role that LTP plays in the suggested view, a major component of the suggested abstraction view is not empirically, at least not directly, vindicated. Given space limitations, it is practically impossible to do justice to all of these arguments here. Furthermore, convincing replies against such views are well documented in the literature. For instance, (Prinz 2002) has argued convincingly against Knowledge Nativists and showed that even at very early developmental stages experience suffices to provide the knowledge that Nativists take to be innate. Also, Prinz has tackled criticisms of Keil's Original Sim and convincingly argued that despite seemingly appealing to knowledge about essences of things in the world, categorization is still driven by similarity. Finally, Hawkins (1997) has provided significant evidence for the connection of LTP to memory storage, which in turn favors the suggested view, (see also Tillas (2010).

The main reason why I do not focus on the aforementioned empirical work here, however, is because none of these experiments targets the cognitive bases of the view I have suggested. For instance, none of this evidence targets the way top-down effects contribute to avoiding circularity concerns or how appealing to Hebbian associationism could help in identifying similarities amongst instances. For this reason, and in the interest of keeping the discussion focused, I am examining criticisms that do target specific aspects of AMs that are similar to the one I suggest here and in this sense challenge the main cognitive underpinnings of the present account.

4.2.1. In Need of a Library of Representations

The first of the contemporary concerns facing the cognitive bases of AMs that I am considering here regards the existence of a library or locus where representations that are fed into the abstraction process are stored. More specifically, according to Hendriks-Jansen (H-J) (1996), in order for any AM to work, there needs to be a 'library' in the mind where representations of different instances are stored together and from which the AM can abstract the features that these representations of different instances have in common. According to H-J, the available AMs do not and cannot account for the existence of a 'library' of this kind. In my reading of H-J, he is not really concerned with the actual storage device but he is rather concerned with how these representations ended up in a given locus in memory. Also, this criticism could be seen as running in parallel to the claim that specifying the content of an abstraction is an extremely challenging task.

Admittedly, existing AMs cannot account for the existence of a library of this kind. Despite significant similarities with AMs, the suggested view differs in that the task of selecting which representations go through abstraction is not itself achieved by abstraction. Rather, only representations stored in a given locus will enter this process. In turn, top-down effects from representations already stored in the mind determine which representations will become stored in the locus in question.

Alternatively one could appeal to dynamic representations à la Connectionism, to the extent that the relevant statistical information about associations between features is stored in the connection weights linking the (nodes representing) traits together. In this case, storage of representations in loci is not necessary. However, existence of loci allows the system to categorize cases of representations in clusters, and thus use them in order to acquire certain other concepts of sub-kinds, recall for instance the ANIMAL – ARMADILLO example from above. Furthermore, existence of loci allows the system to deploy representations in imagistic thinking more readily, e.g. thinking whether your shopping bags would fit in your car's trunk by virtue of deploying an image or representation of the available space in your car's trunk at a given time *t*.

In any case, representing information in a connectionist way alone does not explicitly yield discrete concepts but is rather only capable of predicting which other features would become co-instantiated with certain given features, e.g. representations of a trunk will be co-instantiated with representations of brunches, in the case of tree. If it is assumed that discrete concepts could be acquired solely in terms of connectionist-like representations, then it is not clear how the acquired concepts could contain information about atypical instances of a given kind, e.g. consider penguin as an atypical member of <Bird>. In contrast, existence of loci allows representations of atypical instances to be stored in the same locus. And even though characteristics of atypical members, e.g. the kind of wings that penguins have, will not feature in the abstracted bird representation, this information will still be available to the subject to categorize penguins as birds once she has acquired bird.

Existence of loci is a psychologically plausible suggestion to the extent that not all past experiences are stored in the appropriate locus, but as explained, only those that are selectively attended to and mainly prior to acquisition of the appropriate concept. Furthermore, existence of loci and stored representations contribute greatly to concept individuation. Briefly, when tokening a concept, the abstracted representation becomes activated alongside a representation of a particular given contextual constraints. These representations of particulars would not have been available to the system had it not been for loci.

4.2.2. Singling Traits Out

A further criticism by H-J concerns the ways that objects are singled out during perceptual experiences. In particular, his concern is that objects can only be singled out by virtue of prior possession (and deployment) of concepts.

Unlike in traditional AMs, in the view suggested here low-level systems like pattern recognition abilities underpin the processes of singling out a given object from its background. In my opinion, H-J is mistaken in claiming that in order to isolate a given area of the sensory projection the subject has to identify the area in question *as meaningful*. Rather, the subject can isolate certain areas or properties of the perceived object by making use of her low-level pattern recognition abilities.

Crucially, the ability to recognize certain similarities across objects in the world has to be in place prior to the AP. There are at least two ways to account for this similarity recognition ability, one that does and one that does not build upon representational primitives. As shown above, similarity recognition abilities that do not build upon representational primitives enjoy significant empirical support (e.g. Kellman 1993). Given that these detectors reside at the lower (non-conceptual) level, they do not pose any circularity threats to the suggested view. Regarding abilities that do build upon representational primitives, recognition of similarities across instances (of a given kind) could be explained by appealing to an innate minimal repertoire of representations, possibly similar to Biederman's 'geons' (1987; 1990). Crucially, these representational primitives are also non-conceptual and thus do not pose any circularity concerns either. Both of these ways show how salient features could be singled out without being identified as meaningful.

5. CONCLUSION

As explained, AMs have been largely seen as untenable. Thus, it is most often argued that we probably need more sophisticated methodological tools than the ones that abstraction could ever provide us with. In this paper, I questioned this idea and put forth an account about how ideas manage to represent general properties or kinds. My motivation for doing this stems from the significance that an account of general ideas has for categorization — one of the fundamental aspects of learning, reasoning, decision-making, linguistic inferences and so forth.

My main point is that abstraction occurs by virtue of recognition of feature overlaps amongst instances of a given kind rather than by deploying a concept of SIMILARITY or an independent criterion of sameness. In presenting my views, I relied heavily both upon Prinz's (2002) and Barsalou's (1999) suggestions. Despite similarities to these accounts though, the suggested view is novel in that it provides a Lockean alternative to Prinz's emphasis on the functional role of ideas of particulars. Specifically, I have shown that general properties are accounted for by virtue of having an abstracted representation. This abstracted representation becomes stored in memory and is deployed whenever the appropriate concept is tokened. As explained, this contrasts with Barsalou's construal of abstraction as a skill for constructing temporary online interpretations of members of a given category.

As shown, the abstraction view suggested here enjoys significant empirical support from independent evidence. Given space limitations, I have only presented a selection of supporting empirical evidence for the main aspects of the suggested account. Namely, I have presented psychological and neuroscientific evidence for the claims that on perception of a subsequent instance of a given kind a matching stored representation becomes activated and drives selective attention in a top-down manner. Furthermore, the presented evidence suggests that pattern recognition occurs at a lower computational level (early vision in the case of visual perception) and thus that no conceptual resources are required.

In a nutshell, I have shown that despite it being currently unpopular, abstraction is still methodologically rigorous. By suggesting an empiricist account of how abstraction occurs that is novel, avoids challenges that both traditional and contemporary AMs faced, and is empirically vindicated, I have hopefully created some vital space for empiricist views dealing with categorization, learning and reasoning.

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Notes

[1] See also Haselager et al. (2003) for a detailed overview of the representationalism debate.

[2] 'Ideas' in Locke's terminology can be mapped fairly accurately to what in contemporary literature are referred to as concepts.

[3] The suggested view exhibits advantages with regards to publicity or shareability of concepts, due to the same abstracted representation being always activated when tokening a given concept, while the additional representation of particulars contributes to accounting for conceptual change. See also Tillas (2010) and Tillas & Trafford (forthcoming 2015) for a detailed discussion.

[4] Henceforth, I will be using small caps for concepts, e.g. WHITE for the concept of white.

[5] It seems here that Berkeley is assuming that the nature of representations is such that representation is resemblance and thus (naturally) interprets ideas as images.

[6] Despite the similarities between Hume's and Berkeley's ways of accounting for representative generality, their suggestions differ in terms of the specifications of the relevant functional relationships. For instance, unlike Berkeley, Hume attributes a major role to words.

[7] That said, see at the end of Book I, Section VII of the Treatise (1739/1978) where Hume does seem to talk about a mental process that he thinks accounts for what others would call abstraction. I owe this historical correction to Ben Bayer.

[8] See Barsalou (1999) for a similar suggestion about NEGATION.

[9] See Prinz (2002) for a similar suggestion.

[10] Evidence in support of this claim can be found, amongst others, in Spivey & Geng (2001); Chao et al. (1999); Barsalou (1999); Demarais & Cohen (1998); Farah (1995, 1989); Finke (1989); Kosslyn et al. (1995); Brandt & Stark (1997); Noton & Stark (1971). Note that the same scanning process is in principle initiated during the encounter with the first instance. However, this process is short-lived and cognitively 'uninteresting' given that at the time of the first encounter there are no matching representations stored in the mind. As explained in the text, comparisons at this stage occur between activational patterns of brain areas grounding perception of instances of the category at hand.

[11]Consider for instance the distinction between bottom-up attention, i.e. attention captured by salient features, and top-down allocation of attention, i.e. attention driven by one's intentions, e.g. Looking for a set of keys in a drawer. Top-down attention has been shown to have stronger positive memory effects in cognitive tasks. This hypothesis builds upon evidence showing that unlike bottom-up attention, top-down attention enhances formation of representations of attended to features/aspects/information, e.g. Corbetta et al. (1990); Noudoost et al. (2010); as well as on evidence showing that information attended to on the basis of top-down attention will later on be relevant for memory formation, Uncapher et al. (2011) or later remembering, Craik et al. (1996).

[12]See also Bayer (2009) for an analysis of similarities as comparative differences.

[13]e.g. Barsalou (1999); Findlay & Gilchrist (2003); Gazzaniga et al. (1998); Biederman (1987); Hochberg (1999); Goldstone (1994); Smith & Heise (1992).

[14]This issue is normally associated with the binding problem, on which I do not further elaborate here, but see Damasio's (1989) 'Convergence Zones' hypothesis for a suggested solution.

[15]Following Prinz (2004), I treat emotions as perceptually based and as contributing to acquisition of concepts like PAIN. Furthermore, emotions could play the role of a sameness marker in cases of heterogeneously instantiated concepts like DANGER, and so forth.

[16]See also Spivey & Geng (2001); Brandt & Stark (1997); Noton and Stark's (1971) 'Scanpath theory'; Farah (1995, 1989); Finke (1989); Kosslyn et al. (1995); Chao et al. (1999).

[17]Similar results can be found in studies by Hawken et al. (1994); Livingstone & Hubel (1987); Lu et al. (1999); Mullen & Boulton (1992a,b); Troscianko & Fahle (1988).

[18]For studies of frequency potentiation (LTP), which greatly resembles Hebbian learning, see Bliss & Gardner-Medwin (1973); Martinez et al. (2002). For objections to the claim that LTP is a learning mechanism see Shors & Matzel (1997) and Hawkins (1997) for a reply.

[19]Briefly in his Original Sim hypothesis Keil argues that at early developmental stages categorization occurs by virtue of visible similarities and at later stages this is done by virtue of information about essential properties of things in the world.

References

Anderson, S. J., Holliday, I. E., Singh, K. D. & Harding, G. F. 1996. 'Localization and functional analysis of human cortical area V5 using magneto-encephalography'. *Proc. Biol. Sci.* 263, no. 1369: 423–431.

Barsalou, L. W. 1987. 'The instability of graded structure: Implications for the nature of concepts'. In U. Neisser (ed.) 'Concepts and conceptual development: Ecological and intellectual factors in categorization', Cambridge: Cambridge University Press.

——. 1999. 'Perceptual symbol systems'. *Behavioral and Brain Sciences* 22: 577–609.

——. 2003. 'Abstraction in perceptual symbol systems'. *Philosophical Transactions of the Royal Society of London* 358: 1177–87.

——. 2005. 'Abstraction as dynamic interpretation in perceptual symbol systems'. In L. Gershkoff-Stowe & D. H. Rakison (eds.) 'Building object categories', 389–431. Carnegie Symposium Series. Majwah, NJ: Erlbaum.

Bayer, B. 2009. 'A Role for Abstractionism in a Direct-Realist Foundationalism'. *Synthese* 180, no. 3: 357–89.

Berkeley, G. 1710/1957. *A treatise concerning the principles of human knowledge*. Indianapolis, IN: Bobbs-Merrill.

Biederman, I. 1987. 'Recognition-by-components: A theory of human image understanding'. *Psychological Review* 94: 115–147.

——. 1990. 'Higher-level vision'. In D. N. Osherson, S. Kosslyn & J. M. Hollerbach (eds.) 'An invitation to cognitive science, vol. 2: Visual cognition and action', 41–72. Cambridge: MIT Press.

Bliss, T. V. P. & Gardner-Medwin, A. R. 1973. 'Long-lasting potentiation of synaptic transmission in the dentate area of the anesthetized rabbit following stimulation of the perforant path'. *Journal of Physiology (London)* 232: 331–356.

Brandt, S. A. & Stark, L. W. 1997. 'Spontaneous eye movements during visual imagery reflect the content of the visual scene'. *Journal of Cognitive Neuroscience* 9: 27–38.

Cavanaugh, P., Tyler, C. W. & Favreu, O. E. 1984. 'Perceived velocity of moving chromatic gratings'. *Journal of the Optical Society of America A* 1: 893–9.

Chao, L. L., Haxby, J. V. & Martin, A. 1999. 'Attribute-based neural substrates in temporal cortex for perceiving and knowing about objects'. *Nature Neuroscience* 2: 913–19.

Corbetta, M., Miezin, F. M., Dobmeyer, S., Shulman, G. L. & Petersen, S. E. 1990. 'Attentional modulation of neural processing of shape, color, and velocity in humans'. *Science* 248: 1556–9.

Craik, F. I., Govoni, R., Naveh-Benjamin, M. & Anderson, N. D. 1996. 'The effects of divided attention on encoding and retrieval processes in human memory'. *J Exp Psychol Gen* 125: 159–180.

Damasio, A. R. 1989. 'Time-locked multiregional retroactivation: A systems-level proposal for the neural substrates of recall and recognition'. *Cognition* 33: 25–62.

Demarais, A. M. & Cohen, B. H. 1998. 'Evidence for image-scanning eye movements during transitive inference'. *Biological Psychology* 49: 229–47.

Desimone, R., Albright, T. D., Gross, C. G. & Bruce, C. 1984. 'Stimulus-selective properties of inferior temporal neurons in the macaque'. *Journal of Neuroscience* 4, no. 8: 2051–2062.

Devitt, M. & Sterelny, K. 1987. *Language and Reality: An introduction to the philosophy of language*. MA: MIT Press.

Elman, J. L. & McClelland, J. L. 1985. 'An architecture for parallel processing in speech recognition: The TRACE model'. In M. R. Schroeder (ed.) 'Speech recognition', 6–35. Gottingen: Biblioteca Phonetica.

Eysenck, M. W. & Keane, M. T. 2002. *Cognitive Psychology*. New York: Psychology Press.

Farah, M. J. 1989. 'The neuropsychology of mental imagery'. In F. Boller & J. Grafman (eds.) 'The Handbook of Neuropsychology, vol. 2', 395–413. Amsterdam: Elsevier.

——. 1995. 'Current issues in the neuropsychology of image generation'. *Neuropsychologia* 33: 1455–71.

Findlay, J. M. & Gilchrist, I. D. 2003. *Active Vision: The Psychology of Looking and Seeing*. Oxford: Oxford University Press.

Finke, R. A. 1989. *Principles of mental imagery*. Cambridge, MA.: MIT Press.

Fodor, J. A. 1981. 'The Present Status of the Innateness Controversy'. In his RePresentations, Great Britain, The Harvester Press Ltd., (pp.: 257-316).

Fodor, J. A. & Pylyshyn, Z. W. 1988. 'Connectionism and cognitive architecture: A critical

analysis’. *Cognition* 28, no. 1: 3–71.
Gazzaniga, M. S., Ivry, R. B. & Mangun, G. R. 1998. *Cognitive neuroscience: The biology of the mind, 1998*. Norton.
Goldstone, R. 1994. ‘Influences of categorization on perceptual discrimination’. *Journal of Experimental Psychology General* 123: 178–200.
Haselager, P., de Groot, A. & van Rappard, H. 2003. ‘Representationalism vs. Anti-representationalism: A debate for the sake of appearance’. *Philosophical psychology* 16, no. 1: 5–24.
Hawken, M. J., Gegenfurtner, K. R. & Tang, C. 1994. ‘Contrast dependence of colour and luminance motion mechanisms in human vision’. *Nature* 367, no. 6460: 268–270.
Hawkins, R. D. 1997. ‘LTP and learning: Let’s stay together’. Commentary on Shors, T. J. & Matzel, L.D. 1997.
Hebb, D. O. 1949. *The Organization of Behavior*. New York: John Wiley.
Hendriks-Jansen, H. 1996. *Catching Ourselves in the Act: Situated Activity, Interactive Emergence, Evolution and Human Thought*. Cambridge, MA.: MIT Press, Bradford Books.
Hochberg, J. 1999. ‘Perception as purposeful inquiry: We elect where to direct each glance, and determine what is encoded within and between glances’. Open peer commentary of Barsalou 1999.
Hume, D. 1739/1978. *A Treatise of Human Nature*. Oxford: Oxford University Press.
——. 1748/1975. ‘An Enquiry Concerning Human Understanding’. Contained in Enquiries Concerning Human Understanding and Concerning the Principles of Morals, L. A. Selby-Bigge, (ed.) 3rd edition. Revised by P. H. Nidditch, Oxford: Clarendon Press.
Keil, F. C. 1989. *Concepts, Kinds, and Cognitive Development*. Cambridge, MA.: MIT Press.
Kellman, P. J. 1993. ‘Kinematic foundations of infant visual perception’. In C. E. Granrud (ed.) ‘Visual perception and cognition in infancy’, 121–73. Erlbaum Hillsdale, NJ.
Kosslyn, S. M., Thompson, W. L., Kim, I. J. & Alpert, N. M. 1995. ‘Topographical representations of mental images in primary visual cortex’. *Nature* 378, no. 6556: 496–498.
Livingstone, M. S. & Hubel, D. H. 1987. ‘Psychophysical evidence for separate channels for the perception of form, color, movement, and depth’. *Journal of Neuroscience* 7, no. 11: 3416–3468.
Locke, J. 1690/1975. *An Essay Concerning Human Understanding*. New York: Oxford University Press.
Lu, Z., Lesmes, L. A. & Sperling, G. 1999. ‘The mechanism of isoluminant chromatic motion perception’. *Proceedings of the National Academy of Sciences* 96, no. 14: 8289–8294.
Lueck, C. J., Zeki, S., Friston, K. J., Deiber, M. P., Cope, P., Cunningham, V. J., Lammertsma, A. A., Kennard, C. & Frackowiak, R. S. 1989. ‘The colour centre in the cerebral cortex of man’. *Nature* 340, no. 6232: 386–389.
Mandler, J. M. & McDonough, L. 1996. ‘Drinking and driving don’t mix: Inductive generalization in infancy’. *Cognition* 59, no. 3: 307–335.
Martinez, C. O., Do, V. H., Jr, J. L. Martinez & Derrick, B. E. 2002. ‘Associative long-term potentiation (LTP) among extrinsic afferents of the hippocampal CA3 region in vivo’. *Brain Res.* 940, no. 1–2: 86–94.
Mullen, K. T. & Boulton, J. C. 1992a. ‘Absence of smooth motion perception in color vision’. *Vision Res.* 32, no. 3: 483–488.

——. 1992b. ‘Interactions between colour and luminance contrast in the perception of motion’. *Ophthalmic Physiol Opt* 12, no. 2: 201–205.
Noton, D. & Stark, L. 1971. ‘Scanpaths in saccadic eye movements while viewing and recognizing patterns’. *Vision Res.* 11, no. 9: 929–942.
Noudoost, B., Chang, M. H., Steinmetz, N. A. & Moore, T. 2010. ‘Top-down control of visual attention’. *Curr. Opin. Neurobiol.* 20, no. 2: 183–190.
Perry, J. 2001. *Possibility, Consciousness and Conceivability*. Cambridge, Mass: The MIT Press, Bradford Books.
Prinz, J. 2002. *Furnishing the Mind: Concepts and their Perceptual Basis*. Cambridge, MA.: MIT Press.
——. 2004. *Gut Reactions: A Perceptual Theory of Emotion*. New York: Oxford University Press.
Shors, T. J. & Matzel, L. D. 1997. ‘Long-term potentiation: What’s learning got to do with it?’ *Behav Brain Sci* 20, no. 4: 597–655.
Smith, L. B. & Heise, D. 1992. ‘Perceptual similarity and conceptual structure’. In B. Burns (ed.) ‘Advances in psychology 93 – percepts, concepts, and categories: The representation and processing of information’, vol. 93, 233–272. Elsevier.
Spelke, E. 1994. ‘Initial knowledge: Six suggestions’. *Cognition* 50, no. 1–3: 431–445.
Spelke, E. S. & de Walle, G. Van. 1993. ‘Perceiving and reasoning about objects: Insights from infants’. In N. Eilan, R. McCarthy & W. Brewer (eds.) ‘Spatial representation’, Oxford: Basil Blackwell.
Spivey, M. J. & Geng, J. J. 2001. ‘Oculomotor mechanisms activated by imagery and memory: Eye movements to absent objects’. *Psychol Res* 65, no. 4: 235–241.
Tanaka, K. 1992. ‘Inferotemporal cortex and higher visual functions’. *Curr. Opin. Neurobiol.* 2, no. 4: 502–505.
——. 1996. ‘Inferotemporal cortex and object vision’. *Annu. Rev. Neurosci.* 19: 109–139.
Tillas, A. 2010. *Back to our Senses: An Empiricist on Concept Acquisition*. Ph.D. thesis, Bristol University, UK.
Tillas, A. & Trafford, J. forthcoming 2015. ‘Communicating Content’. *Language & Communication* 40: 1–13.
Tootell, R. B., Reppas, J. B., Kwong, K. K., Malach, R., Born, R. T., Brady, T. J., Rosen, B. R. & Belliveau, J. W. 1995. ‘Functional analysis of human MT and related visual cortical areas using magnetic resonance imaging’. *Journal of Neuroscience* 15, no. 4: 3215–3230.
Troscianko, T. & Fahle, M. 1988. ‘Why do isoluminant stimuli appear slower?’ *J. Opt. Soc. Am. A* 5, no. 6: 871–880.
Uncapher, M. R., Hutchinson, J. B. & Wagner, A. D. 2011. ‘Dissociable effects of top-down and bottom-up attention during episodic encoding’. *Journal of Neuroscience* 31, no. 35: 12613–12628.
Uzgalis, William. 2012. ‘John Locke’. In Edward N. Zalta (ed.) ‘The Stanford Encyclopedia of Philosophy’, http://plato.stanford.edu/archives/fall2012/entries/locke/, Fall 2012 ed.
Young, M. P. 1995. ‘Open question about the neural mechanisms of visual pattern recognition’. In M. S. Gazzaniga (ed.) ‘The cognitive neurosciences’, Cambridge, MA: MIT Press.
Zeki, S. 1992. ‘The visual image in mind and brain’. *Scientific American* 267: 43–50.
Zeki, S., Watson, J. D., Lueck, C. J., Friston, K. J., Kennard, C. & Frackowiak, R. S. 1991.

‘A direct demonstration of functional specialization in human visual cortex’. *Journal of Neuroscience* 11, no. 3: 641–649.