Revising minimalism with OBS

Bouchard's "The Nature and Origin of Language " differs quite sharply from the conventional theory in linguistics on the evolution of language. Chomsky, and the modern theory of syntax known as minimalism, asserts that the emergence of the operation known as Merge was the tipping point in pre-linguistic apes developing linguistic faculties. In the literature, Merge falls under the set of third factor properties. Third factor properties were created as a means of refining the evolutionary arguments made inside minimalism to not include the "plethora of complex grammatical principles that had been proposed in the Government and Binding framework" (Chomsky 2007:2, Christiansen & Chater 2008). Third factor stands for a set of general principles of efficient computation with frequent appeals to constraints on time and memory. This move was made by Chomsky as a means of maintaining a saltationist position in regards to the evolution of language in spite of the theories growing cross-linguistic complexity. Given the size of various stipulations and principles made in Government and Binding as more and more languages were studied, saltationist positions on the evolution of language became less and less tractable. Bouchard rejects Chomsky's positions on the evolution of language by adopting different methodological assumptions in guiding his work. Instead of assuming principles of efficient computation, Bouchard assumes that we should look for theories of language that start with pre-linguistic sections of cognition such as CI (conceptual interface) and SM(sensorimotor system) and build language up

from these pillars. He believes that only after we have exhausted our explanatory search in these areas should we postulate rules and principles specific to language. Given that the CI and SM were around long before language emerged, sculpted by years of evolutionary modifications, Bouchard's theory is inherently anti-saltationist.

OBS, short for offline brain systems, refers to a set of neural structures that evolved during hominid evolution. Neurons that are a part of the offline brain system can be triggered in *absentia*. In other words, OBS neurons can be triggered in the absence of direct environmental stimulus, and are triggered by representations of events, instead of the events themselves. Prior to the emergence of OBS, all forms of cognition were directly embedded in the environment, and limited to a simple paradigm of stimulus and response: the temporal dimension of cognition was extremely narrow. Thoughts, concepts, and possible candidates for various actions an organism could carry out were limited to the specific time in which the organism was reacting to events in the environment. The organism would not have the ability to think about various things it would have done or could have done to flee a predator later at night for instance because the very activation of the concept of predator requires the immediate presence of the predator at that point in time. The animal's thoughts were entirely anchored to the here and now. OBS allows for the creation of thought independent of the state of the organism's environment which expands the organism's cognitive dimension of time from

1 dimension(the present moment) to two dimensions: a continuous line that includes the past, present, and future.

Subsections of neurons inside OBS can trigger other subsections, creating the possibility for mental computations to take brain internal inputs: essentially plug the brain back into itself. This opens up the door for recursion, by which representations inside OBS can be taken as inputs in the creation of novel representations. It's important to note, this form of recursivity applies as a domain general principle to both the CI and the SM system. In the CI system, OBS formed thought recursion and the ability for thoughts to be taken as inputs into further mental computations and analyzed in their own right: a necessary condition for metacognition. Inside of the SM, OBS formed the possibility of simulating novel visual and perceptual scenes by superimposing and combining representations of percepts to create new precepts that would not be directly accessible from the environment. OBS allows for distinct neural centers of the brain to communicate by creating a common playing field for communication via representation. The functions and mechanisms of action of the SM and CI systems are very different which, prior to OBS, greatly limited the amount of information that could be exchanged between the two centers. OBS served as a communicative middleman between SM and CI by creating representations of features of SM and CI systems. These representations essentially acted as a unifying currency in the brain such that the SM and CI systems could now exchange information with each other through the same medium of representation. Representations

belonging to distinct neural centers can be Merged together to create novel thought(CI) to action(SM) bits since the representations being combined are not rigidly coupled to their immediate physical antecedents in the brain. OBS was thus not only instrumental in broadening the horizons of both the CI and SM system individually, but in creating an interface between the two systems.

Many questions fundamental to understanding evolution of language have been all but disregarded in the discipline of minimalism. Minimalism starts out with a fully fledged lexicon, taking these elements as the primitives into syntactic computation. This is problematic when attempting to understand how children actually acquire language given that they don't begin with a full lexicon. Moreover, there are many underlying cognitive traits necessary for a child to even begin to learn what any single word means. I will refer to these traits as language precursors: features that aren't strictly linguistic but are necessary in obtaining linguistic competence. The notion of a free-floating rationale is often used to describe complex patterns we find in nature that are produced without intelligent foresight. An example Daniel Dennet uses is the lions and the stotting gazelle. Gazelles that are able to throw extra, random jumps while running signal to the lion that they are harder to catch than the ones that cannot throw such leaps. Thus although energetically inefficient for the gazelle at the onset, the fact that the lions use this information to catch the weaker gazelle optimizes benefits for both sides. Crucially, however, neither does the gazelle need to know why it stotts nor does the lion: hence the

term, free-floating rationale. Children acquiring language are also equipped with free-floating rationales of a different sort. In any conversation, implicit in the act is the fact that the speaker has an intention to convey meaning and intends the listener to not only understand that meaning but understand that the speaker has that intention. This complex structure of reflexive intentionality, described by Grice's theory of meaning, is an example of a free-floating rationale that children are equipped with when learning language. As Dennet put it, “children have deep and wonderful conversations with their peers and parents long before they have the capacity to reflect in this way”. Imbuing others with intentionality requires TOM (theory of mind) which could only have been made possible by OBS. Given that the postulation of someone else's mental state involves predictions about elements not directly explicit in the external environment- you can’t see another mind’s thoughts or beliefs- you need to be able to manufacture and simulate these features. Another free floating rationale children are equipped with is imbuing intentionality to changes in EDD (existence of eye direction detection). Noticing EDD allows the child to notice which objects in the immediate scene are salient in relation to the discourse, assisting children in drawing predictive mappings between the sounds they are hearing and objects in the environment those sounds refer to. It also serves as part of the host of pragmatic cues children use in bootstrapping to syntactic competence. A frequent argument made by Chomsky as evidence of an innate grammar is the poverty of stimulus hypothesis. While direct grammatical feedback in terms of speech is evidently

impoverished, the set of pragmatic cues given to the child is not. If a child speaks incorrectly, they can notice this by reading the confusion on their parents face alongside the inability to attain their intended goal. Thus direct grammatical feedback in the form of speech is never really necessary. Moreover even if grammatical instruction were to be supplied to the child later on in development, we know it would necessarily need to be prefaced by these pragmatic cues as there is a period where the child doesn't know any language and thus cannot receive instruction about language in language.

A sharp distinction between Bouchard's work and minimalism is that he attempts to give an explanation for how a lexicon emerged. Moreover, he argues that a distinction between syntax and lexicon is spurious. This point is worth belaboring, given that the structure of minimalism rests on a division of these two modules. Any derivation begins by extracting a subset of the lexicon, containing uninterpretable and interpretable features. This array is then sent to the syntactic machine, which checks and deletes all uninterpretable features. When the syntactic engine then interfaces with LF and PF, the only features left are interpretable features which LF and PF can understand and process. The issue is that derivations begin with subsets of the lexicon that are chosen randomly. This falls out from Chomsky's inverted-Y model of language where the syntactic engines feed into LF and PF. Since nothing feeds into syntax it is essentially a random string generator, whose outputs, if anomalous, are later ruled out at LF. This is wildly uneconomical, however, given the sheer number of possible meaningless strings that

could be created by the syntactic engine. Moreover a blind, structure building process without semantics strains our intuitions about the purpose of language to begin with: to articulate and externalize an idea we have from the onset of the structure building process.

This sort of structural division has ontological consequences, in that it necessarily makes claims about the likely evolution of language. Modules that are now distinct, would have likely been distinct at their inception, implying that any protolanguage began minimally as a proto lexicon. Stroik and Putnam, in line with Bouchard's analysis, strongly reject the idea of a syntax-free language built solely of a protolexicon. Under this analysis, a protolexicon, if it were to exist, would have resided in the CI system. The issue is determining how likely it seems for a bunch of static, distinct concepts to be embedded inside CI before you could combine them. The sole utility of words and concepts is the ability to combine and thus it seems unlikely for the latter to precede the former. Moreover, as I will describe below the majority of concepts and words in language and cognition generally rely minimally on predication between two elements which is by definition a minimal syntactic relationship.

Once OBS connected CI with SM, it would have the ability to link different elements inside of CI- such as two different thoughts- by linking their antecedents in SM. Thus once an initial mapping between elements inside of CI and SM is made, all mental concepts of CI can be freely conjoined with each other by simply manipulating their

image in the SM system. Stroik and Putnam make the case that linking CI and SM is a more difficult task than linking CI with CI. The first requires arbitrarily linking dissimilar elements, while the latter only requires linking similar elements not merely arbitrarily but with instrumental/semantic guidance. Links between elements in CI essentially fall out once the initial link between CI and SM is forged. Logically, the separation of a lexicon and syntax is problematic when looking at adjectives, words whose meaning inherently rely on predication. Adjectives could have only formed out of a relationship between two parts, the modifier(adj) and the modified(noun), which necessitates a minimal syntax. The moment these words emerge, a minimal syntax emerges. The meaning of a word such as *fast* depends entirely on the noun it modifies - a fast car is a markedly different *fast* than a fast slug- and therefore represents a link of elements inside CI. Additionally, discourse specific words such as *however* and *therefore*, rely on the phrases they link, and would seem unlikely to have emerged in a disconnected, non-compositional lexical space.

Part of the problem in figuring out how a lexicon could have arisen is determining the state of the categories possessed by pre-linguistic animals. It is clear that almost all animals display some form of categorization, as they have multiple action modules which they employ differently in different situations. These categories might also be highly complex and multimodal. The category of a hawk inside a mouse's mind, for example, may include visual information about the hawk in addition to auditory information about the sounds a hawk makes. Importantly, however, there is no reason to think that the

mouse has the ability to conceptualize independent perceptual features of the hawk. Since the hawk is present in its totality in the environment, with its visual and auditory traits rigidly coupled temporally, there is no sense in which the mouse could mentalize these features independently if its mind is purely a reflection of the environment. Thus while we could conceive of a lexicon-like representation of the hawk, these words would generally encompass much more than ordinary words do. We can look to OBS to provide a possible explanation for how refinements and delinations of these early broad categories could have taken place.

I will be proposing that instead of a syntactic operation such as Merge, its polar opposite, called Uncouple, is responsible for the emergence of a lexicon and features of predication that makes a minimal syntax possible. Taking an evolutionary perspective, it is clear that the categories animals have, taken as inputs into OBS, already have a merge-like quality. Any category in an animal's mind is the simultaneous merger of multiple distinct perceptual modalities that appear as a single cognitive unit. It is unsurprising that animals cannot abstract away qualities of an entity from the entity itself because their categories are resistant to decomposition and appear as inseparable, unified wholes. They are entirely anchored to the environment in which they always appear together, temporally and spatially unified. OBS, which forms representations of categories and concepts, can decompose mental constructs by forming a layer of representation not directly anchored to reality. We can compare this to lego building to

show how decomposing an object allows us to rebuild more varied forms of it. Categories in animals appear rigidly Merged, with components inseparable from each other. This is analogous to buying a lego set for a child having the structure already built with the pieces glued together. The child may not even conceive of the notion that parts were put together in building the whole, and therefore lack the analogous notion of predication inherent in the construction process. Instead, if by some device the glue holding the pieces of the house were suddenly dissolved- ie OBS and Uncouple- the builder could break the structure, allowing for the possibility to build an infinite variety of novel structures from the ground up, arriving at discrete infinity. Syntactically speaking, predication is only meaningful after the interacting elements have been separated. It is only through their separation that later merging the two elements in a heriarcle fashion has meaning. For had the two elements been glued together the entire time, it would be impossible to determine which features are inherent and therefore part of the object itself and which features were to be used as descriptors and qualities, imbued onto the object through predication. This Uncouple operation has direct impacts on lexical items, as it determines the amount of semantic information contained within a single semantically atomic unit. Post Uncouple, there must have been few semantically atomic units but they must have been larger, containing lots of separate pieces of information. Post Uncouple, there must have been an explosion in the number of possible new lexical items and thus large semantically atomic units began shrinking as decomposition of bigger categories

into smaller subparts occurred. It is only after atomization occurs that there is any meaningful sense in which prediction can take place. To be able to modify one constituent with another requires that the constituents be separate mental entities at the onset: this is where a minimal syntax can emerge.

Principles such as endocentricity and headedness originally cast as entirely syntactic operations inside the generative framework actually follow logically from the sort of prediction made possible by OBS. Explaining endocentricity within a purely syntactic framework provides an unsatisfying explanatory account as there is no reason why headedness should necessarily derive from a particular ordering of constituents, when such ordering is itself arbitrary and possibly reversible. Prediction requires the imposition of a certain asymmetry between the object being described and the description: the object itself receives a sort of conceptual salience over the descriptive feature attached to the object. Bouchard notices that this asymmetry is realized syntactically as endocentricity. The syntactic category that receives a higher position in the tree determines the syntactic category of the larger phrase that supervenes over elements farther down in the tree.

Boucard states that syntax is just a set of combinatorial signs, structured the same as U-signs. He refers to syntactic structures as C-signs, short for combinatorial signs. According to him, syntax combines signs, and crucially it does not just combine the signifié of both signs or the signifiant of both signs, but combines relations between pairs of signifiants and signifiés. Thus syntactic formations are not to be analyzed in terms of

hierarchical structural dependencies, but in terms of semantic relations derived from the relations between the interacting signifiés of U-signs. Using this approach, he recasts the c-command condition on binding in terms of a purely semantic principle which he calls the Novelty Condition. The novelty condition states that "an anaphorically dependent element cannot have more determinate reference than its antecedent. This condition is purely semantic, as it depends on the particular semantic structure of the elements involved and does not depend on their structural relations to each other. He illustrates the usefulness of such an approach with the following example:

a) A doctor$_i$ walked into the room. The man$_i$ left shortly thereafter.

b) *A man$_i$ walked into the room. The doctor$_i$ left shortly thereafter

In a.) it is possible for the doctor and man to be the same entity while in b.) this is not possible. The only difference between these pairs of sentences is the relative ordering of doctor and man. The reason b.) is incorrect, according to the novelty condition, is because the doctor, the anaphorically dependent element, contains more specifying information than the element it refers back to which is a semantically more general noun. Thus b.) is anomalous while a.) is acceptable. It is clear that only a semantic condition of this sort could account for the differences in interpretation between these sentences as they are structurally identical. Shortening these two sentence pairs into one sentence can show how c-command would wrongly predict that both sentences should be accepted.

c) A doctor$_i$ walked into the room and soon afterwards the man$_i$ left.

d) *A man$_i$ walked into the room and soon afterwards the doctor$_i$ left.

In a.) the doctor c-commands the man and is therefore predicted to be co-referential with the man. In the b.) the man c-commands the doctor and is therefore predicted to be co-referential with the doctor: this, however, is incorrect. Since both of these sentences are structurally identical, in that both share the same c-command relationship, there is no syntactic reason we can appeal to to rule out d.) while leaving c.) acceptable: only a semantic rule like the Novelty Condition can account for these facts.

Another crucial aspect of language left unexplained in minimalist syntax is the processes by which language undergoes change. Here, I will be referring to change in the sense of modifying syntactic structure, not in relation to novel words. If the syntactic engine's sole goal is to produce syntactically valid constructions, it cannot be a part of the generative process used in changing itself. If the generativity of language actually emanates from semantics, and not syntax, then accounting for how syntax changes isn't so difficult. Any sentence produced that is novel syntactically, meaning that it would be weeded out in a syntactic derivation, must have a viable semantic composition dependent on the relations of the signifiés of the U-signs. Moreover, this approach would predict that the given novel utterances would only gradually alter the syntax such that there is only one viable semantic interpretation per novel utterance. This interpretation would then cause the listener to re-evaluate and adjust their syntactic representation, such that

the necessary semantic interpretation bootstraps alteration of the syntactic structure. The intended meaning can’t be directly read off the syntactic tree, so the listener has to mentally readjust the syntactic structure to conform to the necessary, intended meaning. The approach laid out by Bouchard is much more supported by recent neurological and anthropological advances made in relation to the timeline over which language is believed to have evolved and the salient neural structures involved. Chomsky appeals to principles of efficient computation as the baseline driver in creating an explanatory account of language. Many biologists object to this a priori assumption given that “computational economy is not a necessary feature of biological systems, in which redundancies typically provide a safety net for the system”. An example of this would be the fact that 98.8 of the human genome is known as noncoding DNA: DNA that is not currently being used, left dormant with the possibility of coding for proteins in the case of certain future externalities. While the specifics of the molecular genetics aren't relevant to this discussion, Bouchard lists the following set of genes as being specific to humans and crucial for language development: GLLD2, DYX1C1, ROBO1, DCDC2, K1AAO319, OLIG2 and Apo 34. Importantly, this points to a much wider set of genes than the single FOXP2 gene the minimalists assert was central to language formation. One of the important genes in this sequence is the Apo 34 gene, whose job is to regulate synaptic repair. This gene would be critical to maintaining the high cortical density needed for the many cross modular connection OBS facilitates. All these genes present slight

modifications on the existing structures present in the brain. Instead of postulating a novel, game changing software update such as merge, OBS provides a much more plausible evolutionary hypothesis as “these strictly internal (offline) activations of some microanatomical structures represent a small evolutionary step: they occur without altering the make-up of the neuronal network or any of its constituent properties".

Making analogies between different areas of science can sometimes illuminate parallels between distinct contexts and drive interdisciplinary cohesion. Analogies are the chief method by which we synthesize new ideas, by drawing on existing knowledge bases to conceptualize novel concepts. Analogies, however, can become problematic when attempting to understand fundamentally new dynamics. Most emergent behavior inside a complex system, for instance, cannot merely be explained by drawing analogies between the features or relationships of the parts. The question is whether language represents such a phase shift and which existing knowledge bases can be used in illuminating the new territory. Stroik and Putman draw on two analogies in explaining language: one on non-locality and the second on non-teleological constraint based growth in evolution. I believe both of these analogies can have misleading consequences which I will underline below.

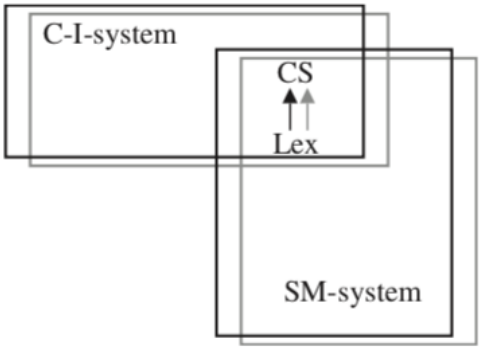
An indisputable claim made by Stroik and Putman, is that language is a process that occurs inside brains which are made of matter which obeys laws of physics. Nothing that can be postulated as a feature of language can violate physical laws, as brains are

reducibly composed of microscopic parts all of which obey physical laws. Of these physical laws, is the principle of non-locality: all casual interactions that occur in space are local. Applying this analogy to an emergent process such as language, however, is problematic. We could conceive of a simulation running inside our universe that instantiates non-local physical laws. The computer running these alternate equations would still itself be abiding by physical law as its circuit board would remain embedded in this universe. Thus knowing the laws governing its circuit board wouldn't necessarily tell you anything about the emergent dynamics running in the simulation. This example unearths the fundamental phase shift that occurs at the point in which information processing occurs inside complex systems. The dynamics displayed by information processing systems can invert lower level dynamics by virtue of the fact that information is not constrained by physical law to the same degree that lower level microscopic parts are. Taking a feature of space at a lower level and applying it to language is essentially making a category error: they are causally linked to each other but their dynamics are not necessarily the same.

While Stroik and Putman disparage minimalism for allowing non-local effects, most of movement operations inside minimalism, including merge, occur to fulfil locality conditions. So although the ultimate effect of "appear" agreeing with "six very hungry children" in the sentence "there *appear* to be *six very hungry children*" is non-local, it is achieved entirely by successive local iterations. A probe, checking the uninterpretable

feature of tense on *appear*, moves linearly down the structure towards its goal “six very hungry children” to check and value this feature. Valuation only occurs under local conditions where the *probe* is adjacent to the *goal*. Similarly, fulfillment of the theta criterion and many other abstract features such as [+wh] and case can only be valued under locality conditions. Proposing the theta criterion has actually spawned new functional projections, the chief example of which is vP(little v). Instead of saying we need more locality, as Stroik and Putnam propose, OBS sheds light on the possibility of letting go of locality altogether. Current locality conditions a priori assume that syntactic computation is 1-dimensional: an element can only "see" another element if it is immediately adjacent. For instance if structure building was 2+ dimensional, no movement operations would have to occur in the satisfaction of the theta criterion, as all elements would be "visible" to all other elements across a 2D sentence line: much in the same way that you looking down on the sentence can check and value case features of “appear” and “six hungry children” non-locally. Assuming computation inside the brain is more than one dimensional falls in line with facts we know about parallel processing taking place inside the brain in which case computational dimensionality could vastly exceed 3 spatial dimensions.

I agree with the general background architecture Stroik and Putman recast language in. Instead of maintaining four distinct modules SM, CI, LEX(lexicon), and CS(computational system), they locate LEX and CS inside the intersection of SM and CI respectively. They use the following visual depiction below to highlight the set of neural networks(rectangles) which could cross-activate information(intersecting rectangles). This representation makes sense in that it is not necessary to posit a lexicon that is seperate from the sensorimotor system. Since the lexicon is entirely embedded inside SM in the form of visual/auditory tokens, it is merely a subset of the SM, with no extra parts independent of SM. Additionally, given that OBS makes recursion a domain general principle, it makes sense to cast the specific form of structural recursion used in language as a subset of CI.



The fundamental disagreement I have with Stroik and Putnam's proposal is that it applies evolutionary logic to the generative process of language. Evolution is a process that creates order and complexity without a goal in mind. As they say, "unlike Chomsky's design of the Faculty of Language, ours permits only bottom-up, strictly local operations that build structures on top of structures non-teleologically, without regard for their own output". While it is definitely the case that biological systems evolve non-teleologically, it is not necessarily the case that their actions are similarly non-teleological. A cell which

notices a PH imbalance in the surrounding environment, can take that information and alter its internal PH level to regain homeostasis. This simple action classifies as teledynamic: it modifies its internal chemical composition in hopes of reaching an end(homeostasis). Similarly, it needn't be the case that structure building inside of language occurs without teleology.

My proposal, drawing only on the existence of OBS, predicts that all structure building in language occurs towards an end goal. This end goal is entirely semantic, and is composed of the representations OBS creates inside of CI. We can think of this semantic goal as an attractor, using analogies from entropy. Analogies of the sort are fair game, moreover, as the discipline of entropy can be applied to any information processing medium that can distinguish between ordered and unordered states. An attractor set of a system is the natural state it equilibrates to when left unperturbed: put simply, it is merely a particular state that the system can embody. Any thought has a certain semantic composition which can be conceptualized as a set inside of CI. The next question that arises is how many additional processes are required for the attractor set to be externalized in speech. I agree with all prior accounts on the question that defining a LEX of some sort is necessary. In this approach, LEX exists as the total set of neural connections between CI and SM, and not as a separate entity in and of itself. Stroik and Putnam propose a copy and concatenate operation when taking two elements “red apple”. Since their derivation starts with a lexicon, it's logical that they need to create copies of

the particular elements that will be utilized inside of the derivation. These copies are then concatenated to produce the new meaning, which is the combination of the copied parts. My approach is more minimal, in the sense the copy operation is not necessary and the concatenate operation is an underlying feature of CI with OBS. Once an attractor set is formed inside of CI, the semantic representation of "red apple" is already fully concatenated. All that is left is for the SM system to form activations that approach the actor set inside CI. No copies of parts of the lexicon need to be made for existing neural connections to fire. This is due to the fact that the lexicon does not exist as a static storage space inside the brain from which items need to be selected. Existing connections (words) between SM and CI fire as they are needed based on the type of attractor sets currently active inside CI.

Below is a diagram showing possible early effects of OBS on SM and CI:

The basic combinatorial functions that OBS provides:

M = { mental element }

SM $\subset$ M, CI $\subset$ M, <SM, CI> $\subseteq$ M

Below are the three minimal operations you need

(1) Subtract Operation:

O(<m1,mi,..,mn>) = <mi> + <m1,0,...,mn>

Reduces dimensionality

(1) extracts a one dimensional feature from the whole

(2) returns the whole with value 0 for one of its dimensions

Example (Inside SM):

Green grass = <green color percept, shape percept in 3D>

O(<green color percept, shape percept in 3D>) =

<green color percept> + < 0 , shape percept in 3D>

 ->  

(2) <u>Add operation:</u>

$O(m_1) + O(m_2) + O(m_n) = <m_1, m_2, ..., m_n>$

Creates objects in higher dimensional spaces

(3) <u>Combine operation:</u>

$O(<m_1, \ldots, m_i, \ldots m_n>) = <m_1, \ldots, m_j, \ldots. m_n>$ such that $m_i \neq m_j$

Combine operation is targeted: can target certain specific features of an object and just change the values of those features

Example (Inside SM):

Green grass = <green color percept, shape percept in 3D>

Using result of subtract operation above + one dimensional blue color percept feature

O(O(<"green grass">)) = O(< 0 , shape percept in 3D>, <blue color percept>)

= < blue color percept , shape percept in 3D>

The above example demonstrates how simply by virtue of OBS allowing recursion of brain internal elements into mental computation, humans gain the ability to construct novel shapes in the mind's eye. By novel shapes,using the term in its broadest sense, I mean sensorimotor combinations that would have not been available in the external environment(such as blue grass). Interestingly, it is open to question where the following subtract, add, and combine operations originate from. Now it is possible that just in a combinatorial tinkering strictly restricted to the domain of SM, we could get outputs that result from dynamics like the functions described above. This would entail random subsets of perceptual elements being arbitrarily combined and modified by other perceptual elements to form new perceptual elements. If this is the case, we run into a problem of combinatorial infinity, with most outputs of such random tinkering returning cognitively useless material. An example of this would be to Merge the visual outlines on a cup, table and calculator to return a jumbled blob. It is more likely that once OBS allowed for the possibility for elements inside SM to be actively used in mental

computation, CI exerted influence on SM more deterministically via already existing <SM,CI> pairs. From all existing <SM,CI> pairs it would carry out additional subtract, add and combine operations to create new pairs based on the relationship between the CI features of the pairs which would be entirely guided by the semantics. Thus the combinatorial explosion would be restricted by the sort of mental computations the CI would "want" to run: likely whichever mental simulations it found adaptively useful to run and thus new <SM,CI> pairs would not be random and nonsensical. Likely candidates that would be evolutionarily useful for example would be simulating possible novel weather conditions or predator relationships to better predict and plan for the future.

Even before the juncture at which OBS creates language, it must be the case that the CI would exert teleological influence on SM. That is, using the *Subtract, Add, and Combine* operations, its domain would span over the set of inputs whose outputs would be predicted to have high utility value. It must necessarily be the case that the domain set of the inputs does not have a definite size. The mere fact that OBS can take an existing brain internal input into a computation and form a novel brian internal output means the set's size must be able to grow. Importantly, this growth is constrained by CI exerting an end directed influence on SM that curtails the possible combinatorial explosion. It performs operations only on input sets that have a predicted evolutionary utility in the future. For example, sets of the form {animal, hunt, time, region} would be commonplace

while {animal, toothbrush, pencil} would not be generated in most environments. It is important to note that at this stage these sets need not be enumerated in any language, and could solely exist as sensorimotor simulations of a purely perceptual quality. The ability to run end directed simulations creates the possibility of counterfactual thought. While in reality only a single event ever occurs, our minds can take that event and run mental experiments adjusting independent variables of its choice.

The central issue with minimalism, if it is to be an account of how language is actually generated, is that the derivation begins without teleology. That means that lexical subsets are randomly combined, without a semantic end goal. Although theta roles limit a vast set of anomalous constructions, such as “eat bill run”, it doesn't limit other grammatical well formed anomalous sentences such as “colorless green ideas sleep furiously”. What Chomsky's own sentence illustrates, ironically, is the questionable result of a formal system that places syntax instead of semantics as the underlying generative process. While it makes perfect sense to view the growth of a single blade of grass as a non-teleological process guided by internal and external constraints, thought introduces an entirely novel dynamic. Thought probes with intention and cannot merely be the result of selection on a random space. Opposing this view still requires us to explain how selection is possible: what knowledge does the *selector (LF)* have and with what criteria does it make selection. Chomsky essentially passes the explanatory buck in sending the

syntactic derivation to LF. OBS, while not answering the latter two questions, places LF at the heart of the derivation and thus reduces certain anomalies common in minimalism.

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