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Hajj Muhammad Legenhausen

In His Name, Exalted

Abstract

The seventeenth century Muslim philosopher Muhammad Sadr al-Din Shirazi, known as Mulla Sadra, introduced the idea of substantial motion in Islamic philosophy. This view is characterized by a continuity criterion for diachronic identity, a four-dimensional view of individual substances, the notion that possibilities change, and the continual creation of all creatures.

Modern philosophical logic provides means to model a variety of claims about individuals, substances, modality and time. In this paper, the semantics of formal systems discussed by Carnap, Bressan and Gupta are reviewed with regard to the issue of substance and identity.

Next a model introduced by Storrs McCall is described that is able to build upon and yet resolve some of the issues about substance and identity as characterized by Bressan and others. McCall's model is also shown to be able to provide an illustration of Mulla Sadra's doctrine of substantial motion.

Keywords: substantial motion, substance, identity, Carnap, Bressan, Gupta, McCall, Mulla Sadra.

1. Mulla Sadra's Doctrine of Substantial Motion

Prior to Mulla Sadra (d. 1641), it was held that motion is confined to the accidents of a thing; in particular, change was said to occur in place, position, quality and quantity (and there was some controversy about quantity). The categories in which motion takes place are considered to be indicated by the extensions of the changes that occur in them. For example, a change in place occurs when there is distance between a given thing at one time and another. At any given moment the object has its own place, which was construed as a spatial envelope in to which the object fits exactly. As a thing moves, it

carries its place with it.

Nevertheless, the place changes because there is distance between the place at the beginning and end of the thing's motion. Distance is covered, or flows through the place of the object over the course of time. Likewise, a change in quality, e.g., color, occurs in a thing because there is a kind of qualitative distance between the color at the start and end of a change, such as fading. During the fading of an object's color, there is a flowing through the color– quality of the object such that there is qualitative difference from start to end. The category of place, position or quality in an object is seen as a channel through which changes flow with time.

Ibn Sina (d. 1037) argued that motion was impossible in substance, because it was the substance that remained the same during such changes. The object that changes in quality, position, quantity or place is the substance. Substance remains fixed while its accidents change.

To the contrary, Mulla Sadra urged that there could be change in substance just as there could be change in place, position, quality and quantity. Just as a thing retains its own place, and yet changes place because of the distance between the initial and ending locations of its place, Mulla Sadra held that a thing could retain its own substantial kind, e.g., being this man, or this tree, yet change substance because of the difference between the thing at the beginning and end of a change or motion. As a human being or a tree grows, Mulla Sadra held, it gains in perfection as its existence is continually renewed and intensified. It is tempting to use the anachronistic metaphor of frames of a motion picture to illustrate what is meant here. It seems as if a persistent object moves, while what is seen is really a succession of similar images. The metaphor fails, however, because Mulla Sadra held that the succession that underlies the appearance of persistence through change is not one of distinct frames or atoms, but is continuous and flowing.

Mulla Sadra responded to Ibn Sina's objection to substantial motion that there was no need to posit an unchanging thing to underlie changes, for continuity is sufficient to link one stage of the thing's career to another.

Mulla Sadra's idea of substantial motion appears to have developed from the Sufi concept of constant creation. Nothing remains in existence. God must supply each thing with a new existence at each moment. Mulla Sadra himself claimed that there were precedents for his views, notably in Heraclitus.

More recent Islamic philosophy has accepted Mulla Sadra's views, although controversy remains. Mulla Sadra held that all substantial motion was in the direction of increasing perfection, because motion is the actualization of what was potential, and the actual is more perfect than the potential. This has led to religious disputes, with accusations that the doctrine is incompatible with the eternity of hell. More vituperative have been charges that the Muslim philosophers' beliefs are incompatible with the doctrine of bodily resurrection, since a disembodied state is more perfect than an embodied state, and substantial motion must be toward the more perfect. Resurrection of the body would mean that after being in a

disembodied state the soul is reunited with its body. Defenders of substantial motion have responded with modifications of the doctrine that allow substantial motion to go forward or in reverse, and even laterally.[1]

My purpose, however, is not to provide an exegesis of Mulla Sadra's views, their sources, or the debates about them among Muslim philosophers today. Instead, I would like to consider how the doctrine of substantial motion could be elucidated with the help of formal semantics. These considerations will build upon the groundbreaking work on substance in formal semantics by Aldo Bressan and Storrs McCall.[2]

2. Bressan on Substance

Bressan's work builds on that of Carnap.[3] So, some of the relevant ideas from Carnap should be understood before we consider Bressan. Carnap holds that for every term in a simple language of first-order quantification with modal operators, there is both an extension and an intension. The extension of an individual term is an individual. The extension of a monadic predicate is the set of individuals to which the predicate truly applies. More generally, the extension of an n-place predicate is a set of n-tuples of individuals. Finally, if $\mathcal{E}$ is a formula, the extension of $\mathcal{E}$ is a truth value, a member of {T,F}.

For intensions, we can depart from Carnap's presentation and resort to the popular device of possible worlds. Then we can say that if □ is an expression, and Ext(□, *w*) is the extension of □ at possible world w, then the function from possible worlds to extensions of □ is the intension of □; in other words, the intension of □ is the function Ext(□, w), where w ranges over possible worlds. Hence, if □ is a formula, the intension of □ is the function from possible worlds to the truth values that are the extensions of □ in each possible world. Carnap calls the intension of a formula a proposition. If □ is an n-place predicate, e.g. the predicate corresponding to "is red" in English, the intention of □ (or property) will be the function from possible worlds to the sets of n-tuples that are the extensions of □ in each possible world, the function for the intension of "is red" would take possible worlds as arguments and yield the set of red things in each of these worlds. So, the property of being red, for example, can be considered as a function that for each possible world assigns the set of red things at that world to the predicate "is red." Carnap calls the intention of an individual term an individual concept, which is a function from possible worlds to individuals.

Some intensions have the same values for all arguments. Tautologies, for example, necessarily have a value of truth. There are also predicates that necessarily have the same extensions, e.g., the predicate, "is greater than itself," which necessarily has the empty set as its extension. A singular term that necessarily has the same (non-null) extension in all possible worlds could be thought of as denoting a substance, although Carnap stops short of this.

Carnap points out that when variables are used in modal contexts, they should take as their values intensions rather than extensions. For example, '□*p* (~N*p*)' should mean that there is a proposition that is not necessary, not that there is a truth value that is not necessary, which makes no sense at all.[4] In

non-modal contexts, Carnap holds that the values given to variables will have both extensions and intensions. With regard to individual variables, Carnap strikes a more tentative note.

In my view the situation with respect to individual variables is quite analogous, although this is usually not recognized. I think that individual variables in modal sentences, for example, in S2, must be interpreted as referring, not to individuals, but to individual concepts.5

Here Carnap takes the important step of recognizing that since the truth values of some statements (quantified modal ones) depend on the values of variables in different possible worlds, the variables should be taken as referring not merely to an extension (an individual), but to an intension (an individual concept).

Carnap doesn't talk about substances, but Aldo Bressan builds upon Carnap's work to do so. Bressan notices that some individual concepts will correspond to particular (primary) substances while others will pick out different individuals in different worlds. Then he reinterprets the conditions of predication to allow for predicates that will distinguish among extensionally equivalent expressions and apply only to those with a preferred intension, somewhat in the way that Carnap said modal contexts need not be true of two extensionally equivalent individual terms. What we find in Bressan, however, is predicates that do not contain modal operators but that truly apply only to a specific selection of individual concepts.

Bressan holds that substance predicates must be modally constant and modally separated. Modally constant predicates are those that apply necessarily to everything to which they possibly apply. Bressan is able to secure this because he takes the extension of (at least some) predicates to be intensions rather than extensions (as in Carnap).6 If we consider, for example, the predicate "is the heaviest object in the room," this will not be a modally constant predicate because that to which the predicate applies in this world is not that to which it applies in other worlds. The predicate, "is human," on the other hand, applies to the same things in all worlds (in which those things exist).7 A modally separated predicate is one that applies to identical objects a and b only if a and b are necessarily identical. Predicates that are both modally constant and modally separated are called absolute.

According to Bressan, common nouns are used in two different ways. Sometimes they are used extensionally, and sometimes as absolute terms. The largest object in the room can be human, in an extensional sense while failing to be human in an absolute sense if the individual concept associated with "the largest object in the room" will be human in one world and non-human in another world. In the extensional sense, human is not modally constant, and hence is not absolute. The absolute concept of human, however, will only apply to individual concepts that pick out the same things in every world in which they refer to an existing object. For an individual concept to fall within the extension of the absolute concept of human, it is not sufficient that it be modally constant, that is, it is not sufficient that the individual concepts to which the absolute concept applies have the same values for all possible worlds-the individual concepts must also be such as to prohibit mere contingent identity.

Bressan writes:

According to scholastics, particularly Aristotle, bearers of properties, or subjects, are (material or nonmaterial) substances. So on the one hand, (natural) absolute properties are important, even essential in certain situations, to denote things as substances.[8]

He also writes:

(1) we emphasized that in certain situations in which we pick out individuals as bearers of properties, i.e. substances, it is important that they should be "the same individuals in all possible cases" in the most natural sense of this phrase; and (2) we showed that it is possible to pick out such individuals by means of absolute attributes of the most natural kind.[9]

Thus we find the basic idea of intensions that have the same value in all possible worlds (in which they have a non-null value) plays an important role in Carnap and is developed further in Bressan in order to provide a refinement of the idea of a substance. This idea, however, presupposes that there is some way to determine in each possible world the same individual, the so-called problem of cross-world identity. Carnap is explicit in his denial of any metaphysical significance to this question for the system of extensions and intensions that he proposes.

We use the term 'individual' not for one particular kind of entity but , rather, relative to a language system S, for those entities which are taken as the elements of the universe of discourse in S, in other words, the entities of the lowest level (we call it level zero) dealt with in S, no matter what these entities are. For one system the individuals may be physical things, for another space-time points, or numbers, or anything else.[10]

Therefore, there is no theoretical issue of right or wrong between the various conceptions, but only the practical question of the comparative convenience of different methods.[11]

Hence for Carnap, when we come to the question of cross-world identity, we are not to imagine that there is a particular substance or individual entity in any metaphysically significant sense that is identified as being the same value of an intension in all possible worlds, rather, some set of terms is taken as standard and intensions that have as their value in each world the extension of the standard term in that world are said to be the individual concepts of specific individuals.[12]

In Bressan's work, we find a heavy reliance on what is natural in order to determine which properties are the absolute ones, and which predicates apply to individual concepts that have the same value in all cases. This marks a departure from Carnap, who sees such issues as being a matter of stipulation or convention and pragmatic convenience. There is evidence for Bressan's reliance on intuitions about what is natural in the previous two quotations from Bressan (1972), as well as the following.

The natural concept of body can be intuitively characterized by the condition that if b is a body, then it is

"the same body, i.e. the same bearer of (possible) properties, in all possible cases" in the most natural sense. So a natural absolute concept is intimately and strongly related to bearers of (possible) properties, i.e., to substances. Furthermore when a common noun of an ordinary language is used in an absolute way it expresses a natural (nonartificial) absolute property.[13]

The line of thought about substances that is found in Bressan is further developed in a monograph by Anil Gupta.[14]

A substance sort in a model structure Q is modally constant and separated intensional property.

Substance sorts are sorts that are modally constant. 'Number', 'man', and 'river' express substance sorts, but 'number of planets' and 'man born in Jerusalem' do not. Nouns that express substance sorts I call substance nouns.. Some substance nouns express sorts that are natural (e.g., 'horse', 'water'); some express sorts that are artificial (e.g., 'number greater than three' and 'man identical to Jones').[15]

With regard to the problems of trans-world identity, Gupta quotes Kripke's remarks that trans-world identity is to be stipulated rather than discovered, and remarks that the systems of modal logic he develops there is no need to assume what he calls the Aristotelian thesis, namely, that everything falls under a unique sort that determines its identity across worlds. The degree of essentialism to which Gupta commits himself is only that every sortal (by means of which restricted quantification is introduced) should supply its own principle of identity. Gupta also suggests several further refinements of Bressan's system, but an adequate review of these would require a discussion too technical for present purposes.

3. McCall on Substance

The line of thought on substance developed from Carnap though Bressan to Gupta does not address the issue of substantial motion, and there is nothing in the sorts of quantified modal logics they propose that would commit one to either an affirmation or denial of substantial motion. Nevertheless, when stipulations are made that result in some individual concepts being said to have the same values in all worlds, this can be taken to model an absence of change in substance, because individual concepts will be interpreted in such a way that in different worlds they may have different qualities or properties, but it is the value of the individual concept in every world that stays the same and individuates the substance in that world, or that functions as the fixed substance that remains through change.

Of course, differences in properties of individual substances in different possible worlds do not indicate change, but rather, counterfactual differences. However, most temporal logics have adopted a variation on possible worlds semantics in which temporal moments play the role of possible worlds, with the difference that moments are ordered from earlier to later and the present moment, now, plays a role analogous to that of the actual world.[16]

If we add a temporal dimension to the description of substances by means of individual concepts, we may consider a function from times to individual concepts. For an individual term, a, at a given time t, we are to consider not merely a given extension for a, but an individual concept for a that has its own value at every possible world. What a substance might possibly be will change through time with the development of the individual. What is possible for a child is not the same as what is possible for the same individual substance when he or she becomes an adult. The extension of an individual term for a given time and world should not be seen as providing the criterion in terms of which an individual concept is taken to correspond to a substance; rather, extensions will merely allow the location of the application of the term at a time and world.[17]

If we do not take extensions as the key to determining identity over time and across worlds, we will break with the conventionalism assumed in Carnap, Bressan, Kripke, Gupta, and many other writers. We do not begin with a given substance at a given time in the actual world and construct an individual concept for it by assuming the same thing to be the extension of this concept at different worlds and times. Instead, we can follow the lead of Mulla Sadra by allowing that the existence of a substance is flowing, and that the continuity of this flow determines in which location the substance is to be identified from moment to moment. In this way, we need not posit any underlying element of the individual, i.e., its substance, as the basis for the identity of the thing through change and the criterion of its reidentification.

There are a number of different ways in which temporal change and modality can be combined along the lines mentioned above. Various positions may be taken with regard to the existence of not yet present future objects, no longer present past objects, and an object's possible pasts and futures. One of the most well worked out of these combinations of modality and temporality, which has also been subject to criticism and refinement over a number of years, is the branched model of Storrs McCall. According to McCall, what takes the place of individual concepts are branched individual histories, or branching four-dimensional individuals, where the branches represent nodes from which alternative possible futures diverge.

While proponents of individual concepts take identity of extension in different possible worlds to suffice as a dissolution of the problem of transworld identity, McCall's understanding of transworld identity develops from his account of diachronic identity. In order to determine whether *a* at *t1* is the same thing as *b* at *t2*, the logical point that the individual designated by *a* at *t1* should be the individual designated by *b* at *t2* will be true but unhelpful, for it leads us to expect that there is a logically prior identifiable substance that remains the same through any changes that might occur from *t1* to *t2* and that is successively labeled *a* and *b*. Instead, McCall advises us to consider whether *a* at *t1* is the same thing as *b* at *t2* by investigating whether *a* at *t1* indicates a stage in the history of an individual that at *t2* is *b*, and to do this we need to review the history of the individual, or the shape of the four- dimensional object.[18]

Natural shapes in the four-dimensional world are associated with sortals; thus to the sortal 'frog' there

corresponds one characteristic shape, to the sortal 'chair' another, etc. Organic shapes exhibit a characteristic temporal developmental pattern…[19]

Like Carnap and Bressan, McCall also relies on the notion of what is natural, however, Bressan seeks a natural sense of being the same bearer of (possible) properties, in all possible cases, whereas McCall appeals to natural developmental patterns. In a footnote he cautions:

The distinction between a 'natural' and an 'artificial' 4-dimensional shape requires much closer examination than it can be given here, but is intended to correspond roughly to the philosophical difference between a substance and a non-substance. Airlines, for example, count 'passengers' differently from 'human beings': two connecting flights may together carry 60 'passengers', but only 40 'human beings'. (Flight A has e.g. 30 people on it, 10 of whom leave while 10 new people join for flight B.) Passengers can be represented 4-dimensionally as the temporal segments of humans while traveling with an airline. Such segments are not 'natural' shapes, and passengers, unlike humans, are not substances.[20]

For McCall we are not relying upon linguistic intuitions about what is natural or not to consider the same value of an individual concept, but rather the natural shape associated with a sortal, or, equivalently, the typical developmental history of an individual of the natural kind indicated by the sortal.

At this point, one might object that what Carnap and others were discussing was transworld identity and the kind of intuitions or conventions needed to resolve this issue are not comparable to the ways in which one might appeal to continuity to solve the issue of diachronic identity. In response, we need to look further into McCall's treatment of transworld identity.

For McCall, the temporal extension of an individual is branched, with the branches bending off into non-actual possible worlds and only one complete branch remaining in the actual world. So, for McCall, being in a possible world is considered in a much different way than do those philosophers, who consider possible worlds as maximal consistent sets of proposition (like Carnap) or abstract states of affairs.

For Kripke, as for Plantinga and R. M. Adams, non-actual possible worlds do not exist in space and time, nor do thy occupy any spatio- temporal volume. In the branched model, on the other hand, possible worlds and the individuals in them are concrete entities, not abstract; and what allows a single individual to exist in many possible future branches is the connectedness and continuity of the branched object which is its four- dimensional representation.[21]

4. Substantial Motion

Needless to say, Mulla Sadra did not attempt to provide an answer to the problem of transworld identity. The problems he was engaged with come out of a different tradition than those of Carnap and Kripke. Nevertheless, there are striking similarities between the sort of position taken by Mulla Sadra and that

described by McCall.

First, there is the four-dimensional representation of objects, where time is the fourth dimension. According to McCall, the first group of philosophers to contemplate conceiving of individuals four-dimensionally was the group at Cambridge around 1900, including Russell, McTaggart, Broad and Johnson.[22] However, in the seventeenth century, Mulla Sadra clearly took a four-dimensional view of objects in his magnum opus, the Asfar. Mulla Sadra asserts that individuals in nature are extended in two ways, in the three spatial dimensions and in time.

So, time consists in the measure of the renewal of the essence of a nature [i.e., a natural physical substance], with regard to what is before and after of the essences, just as the body for instruction is taken to accept three dimensions. So, a nature has two extensions with two measures for them, one of which is gradual and temporal, divisible in the mind into what is temporally prior and later, and the other of which is momentary and spatial, divisible into what is spatially before [nearer] and after [further].[23]

The great reviver of Islamic philosophy in the twentieth century, 'Allamah Tabataba'i, comments on this passage as follows:

This is explicit in seeing that there are four dimensions for a corporeal nature: length, width, depth and time.[24]

McCall's branching model and Mulla Sadra's view also share an emphasis on continuity. Both claim that instead of looking for an ineffable haecceity or individual substance to connect the stages of a thing through its changes, we should focus on the continuous nature of the change. While proclaiming the advantages of the four- dimensional view of substances, McCall writes:

Transtemporal identity derives from the topological connectedness of a 'natural' four-dimensional object. To adopt this line of thought is . to make spatio-temporal continuity the basis of identity.[25]

In his explanation of Mulla Sadra's view, Eshkavari writes:

For the moving existence preserves its unity and continuity because of the continuous oneness (wahdat al-ittisaliyyah). Continuous unity is identical with personal unity (wahdat al-shakhsiyyah). Motion in substance, which is only possible on the basis of the fundamentality of existence and its gradation, occurs in the manner of intensity and weakness. The identity of a thing is preserved, but the limits and levels of existence of the thing are in a flow and transformation. With substantial motion, a thing, at every moment, attains a new identity. But because of continuity between the identities, the individual unity of identity is preserved despite the state of motion.[26]

McCall and Mulla Sadra also agree that the possibilities for a thing change through time. For most philosophers who discuss modality, the properties of a thing are divided into the essential and non-essential or accidental, but there is no question of this division evolving through time. For Mulla Sadra,

however, as a substance develops, it gains powers and perfections that make things possible for it that were not possible at earlier stages. This idea may be graphically illustrated in McCall's branching model, if different levels of development are distinguished. We begin with what McCall calls the life tree of an individual,[27] which includes all the branches that split off from the individual's beginning. This life tree is then divided into various levels or stages of development. Then to say that *p* is possible for individual *a* at developmental level *l* means that *p* is true on some branch of *a*'s life tree within level *l*. Hence, there will be some possibilities that are not realized in some of the branches of *a*'s life tree until a achieves some level further than *l*. A given frog, for example, cannot breathe while it is a tadpole. This may be interpreted to mean that there is no branch of the frog's life tree within the tadpole level of its development in which it is true that this individual breathes.

However, there is another manner in which possibilities may be said to open up or close off for an individual during the course of its life that is not dependent upon distinguishing specific levels of development. We can say that for *a* at *tn* some proposition *p* is a future possibility if and only if there is some time *tm*, *m* ³*n*, such that there is a branch that stems from *a* at *tn* and extends to a at tm in some branch where *p* is true. (Of course, this requires us to allow for propositions that have different truth values at different times.) This, however, only allows that what once was possible may no longer be possible because branches that were open to past nodes may not be available at later subsequent nodes. It does not explain, however, how something might be possible for a after a certain point that was not previously possible. One way to explain this was by means of the levels of development mentioned in the previous paragraph. Another way can be described as follows. Suppose that at *tn* ~*Fa*, and that at all branches of a that stem from *a* at *tn*, if ~*Fa* then ~*p*, while there is such a branch where *Fa* and *p*. Then we can say that the future possibility of *p* for *a* at *tn* depended on the acquisition of the property *F*; *p* only becomes possible for a when a becomes *F*.

All of this is compatible with a substance maintaining essential properties throughout its life tree. McCall defines essential properties as follows:

An individual's essential properties are the ones it possesses on all branches of the branched structure which represents it at the moment when it starts to exist. Its other properties, which it has on some branches but not on others, will be contingent or accidental.[28]

Likewise, Mulla Sadra holds that substantial motion does not imply that things can change their essential properties, or that individuals of one substance sort might change to another natural kind.

Both Mulla Sadra and McCall would agree that time does not flow through a static substance as change occurs in its accidents. A major difference between McCall and Mulla Sadra, however, is that for Mulla Sadra, it is the existence of the substance that flows through time taking on different forms in constant creation, not merely the apparent continuity of form that McCall relies upon. Another major difference is that McCall's ontology is limited to entities that occupy space and time, whereas for Mulla Sadra, substantial motion is limited to corporeal substances, while incorporeal entities are permitted in the

Sadrean metaphysics for which there are no changes.

Despite these differences, I have tried to show how McCall's model of four- dimensional substances with branches in different possible worlds can be used to provide a model for the sort of metaphysics of substantial motion advocated by Mulla Sadra. However, if we use McCall's model to understand substantial motion, one difference that we obtain from Mulla Sadra is that motion can be toward or away from perfection or lateral, while Mulla Sadra apparently assumed that substantial motion would always be in the direction of increasing perfection. But this is an aspect of Mulla Sadra's philosophy that has come under criticism within contemporary Islamic philosophy,29 so that McCall's model may provide a better model for more contemporary versions of transcendental wisdom (as Mulla Sadra's school of thought is called) than for the view of substantial motion as first elaborated by Mulla Sadra.

1. See Ayatullah Muhammad Taqi Misbah Yazdi, Philosophical Instructions (Binghamton: IGCS, 1999), 473–488; 'Ali 'Abidi Shahrudi, "Goftar dar harakat jawhari va khalq-e jadid," in Sayr-e 'irfan va falsafeh dar jahan-e islam, (Tehran: Mu'assesseh Mutali'at va Tahqiqat Farhangi, 1363/1984), 193–235, an English version of which is "Substantial Motion and Perpetual Creation," in Christian Kanzian and Muhammad Legenhausen, eds., Substance and Attribute: Western and Islamic Traditions in Dialogue (Frankfurt: Ontos Verlag, 2007), 193–214; also in this volume see Mohammad Fanaie Eshkavari, "Mulla Sadra's Theory of Substantial Motion," 25–43.
2. Aldo Bressan, A General Interpreted Modal Calculus (New Haven: Yale, 1972); Storrs McCall, A Model of the Universe: Space-Time, Probability, and Decision (Oxford: Oxford University Press, 1996).
3. Rudolf Carnap, Meaning and Necessity, 2nd ed. (Chicago: University of Chicago, 1970). The first edition of this book was published in 1947.
4. Carnap, 179.
5. Carnap, 180.
6. Bressan, 51.
7. This is a simplification. Carnap and Bressan handle non-existent objects by means of a "chosen object theory" but the details of this are not relevant to the analysis of substance.
8. Bressan, 88.
9. Bressan, 91.
10. Carnap, 32.
11. Carnap, 33.
12. Once again, this is a simplification. Carnap introduces standard terms through semantical rules. See Carnap, 168–172.
13. Bressan, 88.
14. Anil Gupta, The Logic of Common Nouns: An Investigation in Quantified Modal Logic (New Haven: Yale, 1980).
15. Gupta, 35.
16. See A. N. Prior and Kit Fine, Worlds, Times and Selves (Amherst: University of Massachusetts Press, 1977).
17. The idea of extensions as locations is suggested by Carnap's own language: ".the extension concerns the location of application of the designator." Carnap, 157; "Knowing the meaning, we discover by an investigation of facts to which locations, if any, the expression applies in the actual state of the world. This factor is explicated in our method by the technical concept of extension." Carnap, 203. [My italics in both passages.]
18. McCall argues that the three dimensional and four dimensional descriptions are equivalent in McCall, 214–217; and more recently in Storrs McCall and E. J. Lowe, "The 3D/4D Controversy: A Storm in a Teacup" Nous 40 (2006), pp. 570–578. I will assume in what follows that this thesis is correct without examining the arguments for and against it.
19. McCall, 211.
20. McCall, 211, fn. 32. McCall credits Gupta, 23, for the example.
21. McCall, 220.

22. McCall, 209.

23. Mulla Sadra (Sadr al-Din Muhammad Shirazi), Al-hikmat al-muta'aliyah fi al-asfar al-'aqliyyah al-arb'ah, vol. 3 (Beirut: Dar Ihya al-tirath al-'arabi, 1410/1990), 140. Also see 'Abd al-Rasul 'Ubudiyyat, Nezam-e Hikmat Sara'i, vol. 1 (Qom: Samt and the Imam Khomeini Education and Research Institute, 1385/2006), 310f.

24. Mulla Sadra, 140, fn. 1.

25. McCall, 213-214.

26. Eshkavari, 31.

27. McCall, 237f.

28. McCall, 227.

29. See Misbah Yazdi, 481-488.

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