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THE DEVELOPMENTAL ACQUISITION OF MOTION

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Under the general rubric of the development of object constancy and permanence, the concepts of time, space, motion, and noncentrist motion are assimilated through a hierarchy of steps. This developmental continuum begins at the pervasive ego-centric position of early infancy, where there is no concept of the outside world, and ends at the stage where the world serves as the frame of reference for all subjectively perceived events. The general impetus for movement along this continuum (with allowance for periodic regression) is formulated as a basic tendency to generalize from unitary experience into generalized expectancies. This tendency manifests through integration algorithms that are expressed by establishing induction as a governing principle of phenomenological expectancies, thus forming the essence of a systematic explanatory network comprising an internalized catalog of events the person had encountered in the past. Such historical antecedents serve to extract certain contingencies from the heretofore unexplained or "magical" domain of childhood logic and enable their codification as explainable events. We suggest that this is precisely the opposite of a parallel process that proceeds from total noncentricity to phenomenology of subjectivity: philosophical inquiry into logic events.

Keywords: development, acquisition of motion, object constancy, permanence, phenomenological expectancy.

The perception of environment is composed physiologically of a series of neurological impulse patterns triggered through an individual's interaction with the world. These events are often supposed to be atomistically discrete, with their combination and juxtaposition reflecting within the perceiver the richness and complexity of the external environment. Combining discrete ephemeral units into a meaningful entity

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involves *integration*, which is the process of extrapolating from two or more entities a continuous entity. A simple example of integration is the definition of a line as the product of two or more points along a straight path. Individual points have no length but the series of points is used to define an entity that has a discrete length. Gestalt psychology extends this process further and shows how perceptions are conceived even when discrete portions of an image are incomplete.

In the field of physics, time—along with other common dimensions, such as length, width, and height—is considered as a dimension. When we consider our experience of time passage, it appears that we integrate our momentary perceptions across the time dimension. A single perceptual event has little extension across time. As formulated by Piagetian assimilation mechanisms, the perceiver innately tends to synthesize a succession of discrete events, yielding the subjective experience of time as a singular continuous dimension. Thus, the perceiver can say that s/he saw a snowstorm that continued for 2 hours instead of saying that s/he saw snow in several million successive perceptual interactions. We can assume that, physiologically, these perceptual units are not continuous. The physiological cycle in perception features a pattern of neuronal firing, followed by a period of nonfiring as the chemical balance equilibrates. Thus, the perceptual process of integration can be examined independently (but not in place) of debates about psychophysical isomorphisms.

One premise in this paper is that the basic dimensions of time and space are social, rather than innate, constructs assimilated by the developing child as a means of organizing events in the world into a meaningful (and, hence, useful) system. Thus, when confronted with a simultaneous perception of two objects that are separated from each other by a discrete distance, the child "invents" the dimension of space and then elaborates it by successive experience as a means of internal or mental organization. Similarly, when the child confronts an object and then later confronts the same object again, time is the construct used to organize these two events.

Repetitive experiences with event sequences result in the appearance of abstract generalizations. *Object permanence* (Piaget & Inhelder, 1969) is a pivotal construct in early development, featuring the expectation that objects continue to exist across time. Analysis of the premise behind such a contingency shows that timeframe continuity (Object A is the same at Time 1 and Time 2) is essential to such conceptualization. We assert that the mechanism of temporal integration affects this continuity, allowing time to serve as the medium of transition between these two events of object perception, and allowing their unification into a single object image.

So successful is the process of temporal integration in ordering perceptual events, that it leads to the implicit adoption of an abstract, but social, belief in object permanence despite deviations in the attributes of

the perceived object from Time 1 to Time 2 (cf. Berger & Luckmann, 1966). Thus, the child learns to interpret such deviations as having seen the object change and transform, rather than positing that an object ceased to exist and another, differently attributed, object appeared. At first, such "appearances" and "disappearances" are invariably attributed to the "magic" option that the child uses to explain unexplainable sequences within the constructs acquired to date. Upon acquiring organizing inductive mechanisms for the systematization of sequences, the domain of magic as an organizing construct diminishes.

A useful mechanical analog in understanding the phenomenological process of perceptual integration is the subjective experience of viewing a motion picture. The screen shows a series of discrete static pictures that the viewer's physiological and perceptual system integrates into a dynamic continuum along the time dimension, allowing them to subjectively perceive the picture of an object being transformed. Similarly, a musical score comprising particular notes selected outside of time but combined in time (i.e., played with each other) to create a continuous melody, can be used to describe the way cultures are structured (Levi-Strauss, 1978).

While developmental theorists have been concerned with—and dwelled incessantly on—such concepts as object permanence and object constancy, the child's understanding of motion as a novel construct, over and above those of time and space conception, has not been a focus of inquiry. Thus, we examined the acquisition of the construct of motion, using the above-noted algorithms as guidelines.

Borrowing the motion picture example, let us suppose that two frames are presented successively, where the location of an object differs from frame to frame. At the stage where the child has only acquired the constructs of time and space, such a sequence would inevitably be interpreted magically: "object disappeared and object appeared." No construct is yet available to unify objects that are in different locations at different times. The construct of motion, however, allows precisely such a double integration process. When object permanence (time integration) is superimposed on the space dimension, the conclusion warranted is that the same object exists in the two events, despite the deviation in distance from Time 1 to Time 2. Motion (as such) is not perceivable by definition, given that the atomistic perceptual units are in nature as static as the still frames in movie pictures. It is suggested that motion is an integral, as opposed to perceptual, construct; thus, it is deducible but not observable.

Viewed as an evolution in conception, motion can, thus, be seen as a less restrictive option in defining the limits of the requirements for object permanence. Beginning with the ephemeral existence of an object that is limited to a single timeframe, the child's construct then progresses to allow for the existence of the same (identical and unchanged) object across

a given span of time, then further allows for physical changes in the object's attributes without destroying the object's continuity, and finally allows for spatial transposition or movement across time into the permanence construct. This final step marks the intuitive realization that the primary characteristic pivotal for identifying the object is similarity in (approximate) physical attribution but that the location need not be fixed.

The implicit theoretical foundation up to this point in this paper is that conceptual developmental acquisition of organizational constructs parallels the philosophical and epistemological formulations that are necessary to elaborate such constructs. We shall now attempt to further link these two domains at several points in a hierarchical structure.

From a phenomenological point of view, there are no contradictions implicit in any sequence of events, even those that entail change or noncontinuity. However, there is a tendency toward *inertia of perception*, a notion of expectancy of sameness that prompts a need for explanation when deviations from sameness occur. This results in a superstructuring of contiguous perception into units, and in the construction of the concepts of time, distance, motion, constancy, and permanence. These constructs are first tentatively hypothesized, and subsequently confirmed into axioms through repeated interactions with the outside world.

What are the atomistic units involved in the perception of any object? Phenomenologically, three units are central: (1) The physical characteristics of the object, (2) The background of the object, i.e., a specific location, and (3) The time of the perception. Let us consider the phenomenological consequences of four major permutations of these units:

A. When the object is observed with unchanged characteristics at two different times, the ultimate conception of one unitary object that transcends both time periods depends on the following points: (a) a memory of Percept 1 during the perception of Percept 2; (b) a tendency toward assimilating percepts across different timeframes into a single concept. The conclusion is that the same object has persisted unchanged through the two frames. Implicit is the construct of temporality as a dimension that is utilized as an available organizer of events or percepts.

B. When two objects are perceived at different locations at the same time, their proper perception depends on the following points: (a) the ability to conceive the presence of two discrete objects without the resulting effect of mentally displacing one by the other or merging them into a single object image; (b) a tendency to assimilate the two object percepts into an organizational unity (i.e., they are distinct but share the same timeframe). The notion of paradox ("How can there be two objects instead of just a unitary existence?") yields the creation of the distance/space construct as an organizer, so that the objects are now placed along this space continuum in an attempt at solving the paradox. Philosophically,

this paradox is not derived from an a priori truism, but reflects the ability to perceive incongruity in such situations while simultaneously (albeit unconsciously) inventing constructs to resolve this perceived incongruity.

C. While it is feasible to avoid synthesis in the sequence described in A (where the same object exists across time unchanged) because no incongruity is blatant, consider the sequence where the object's characteristics differ from one timeframe to the other. In the latter case, the conclusion that Percept 1 existed in time while (the different) Percept 2 exists in time requires time as an organizer to explain the discrepancy using the construct of "change over time."

The incongruity of changed objects is predicated against a background base expectancy of nonchange across time. There is no logical mandate that objects continue to exist unchanged across time; what there is, instead, is a conclusion that such nonchange is the mode, and that objects generally have not (in the perceiver's history) changed much in time. The inductive logical conclusion then mandates that such continuity is expected, whereby objects do not disappear or change spontaneously. This then fosters the paradox perceived when change does occur and forces the construction of time as locus for such change.

D. When an object existing at Location 1 at Time 1 appears at Location 2 at Time 2, earlier inductive presumptions—namely, *object permanence*, which confirms that objects do not spontaneously disappear or appear—are confronted by two challenging issues: "What happened to the Object 1 at Location 1?" and "How is it that Object 2 materialized at Location 2?" After several such paired contingencies of unexplainable occurrences, the process of induction assimilates them by accommodating the system of expectancies. Thus, objects are expected to exist through contiguous time frames, but the location of the object may vary. This new option is *motion.*

It is clear that the inductive process does little to explain these events; rather, the individual comes to regard phenomena that occur with some regularity as acceptable. This is the full extent of the adaptation of heretofore perceived magical events as legitimate and reasonable. Thus, the developmental antithesis of magic is expected, rather than understood.

In experimental studies on apparent motion, researchers have simulated and dramatized the intrinsic process of perceived "veridical" motion. In phi phenomenon studies, strobe devices have been used to present a point of light at one location, followed by a point of light at another location. The distance from Point 1 to Point 2 and the duration from Time 1 to Time 2 are then varied, and participants of different ages are asked to report if they perceived the point of light actually moving or if they saw two lights at two distinct times. There is, however, no reason to believe that the not-yet-socialized infant—that is, the child who has not yet fully ascended to what Lacan (1977) calls the symbolic order of language (cf. Lemaire,

1977)—would have the construct of motion available as a way of synthesizing these events. Furthermore, for the infant who has not yet mastered the conception of time continuity, even if Point 2 was flashed at the same location as Point 1, it would be seen as a second event, because the integration of time is not yet present.

Conceiving successive events as a single continuous process, rather than as negations of each other, is complex. Per Heraclitus' assertion about the inability to step into the same brook twice as the brook is constantly in flux and is, thus not the same brook, permanence is nontautological. Using temporality as a possible dimension for integrations allows for the maintenance of permanence of objects even when some characteristics of the object differ (be they locational displacement or physical changes in the brook) as the perspective shifts from frame to frame.

An underlying phenomenon involved in the cognition of temporality is the corollary that the observer him/herself is progressing through time just parallel to the object and the belief that the person him/herself is the same. (cf. Strawson, 1963; Wittgenstein, 1953/68). (We are, of course, limiting ourselves to perception, rather than imagination and recollection.)

The developmental movement away from perceptual egocentricity is central to the transition from subjectivity toward objectivity. The child's concept of object permanence, for example, is a function of the realization that objects have an independence existence (Piaget, 1954). Such decentrizing is even more crucial in the conceptual evolution of motion.

It is feasible to extend one's self-concept as progressing through time, to the spatial dimension. Such an extension becomes important in the conception of events when the observer, rather than the object, is in motion. When the observer can conceive of him/herself as being in motion rather than maintaining that the world is moving while s/he is the frame of reference, the permanence of the environment is maintained conceptually at the expense of egocentric referencing. Such reorientation has various implications in self-development.

It will be useful in carrying this discussion further to present vignettes to serve as the bases for the following analysis.

The first author's children rarely have the opportunity to ride an elevator, but do get the experience when he takes them to visit their grandmother, who lives in a taller building. Their interpretation of this unique process is illuminating:

> Aaron, age 3¼, explains: "First there is number 1 on the wall, then we go in the elevator and the door closes, and then we push the 4 button, and then the door opens and number on the wall is 4 and then we go out to grandma's house." Shulamis, age 4¼, once teased children who live on the ground floor, saying to them as we entered the elevator, "Haha, when we go in there and push 4, you're going to go away." Chaim, upon

reaching the age of 4, also became very excited over the elevator. He was particularly intrigued by the fact that there is a door to an apartment on grandma's floor precisely above the lobby area of the ground floor. When he would arrive at grandma's floor, he would run and point to the apartment door and exclaim, "Look, the elevator makes magic."

There is a striking parallel between the above interpretations of the elevator ride and excerpts from the first author's notes taken in a psychiatric emergency room, where he was on duty one morning:

A 54-year-old Black male was brought in by local police for threatening pedestrians. It seemed that the threats were not personal, but a relaying of messages allegedly originating from God, who was about to wreak havoc upon the world. The patient proceeded to hold a lengthy discussion with me regarding intricacies of biblical literature, a topic he was well versed in and understood quite well. The patient claimed to be an incarnation of Jesus, and offered as evidence blisters on one foot, which he interpreted as stigmata from the cross, as well as his ability to perform miracles. When I asked him to perform a miracle, he agreed, and proceeded to concentrate a moment and then blinked his eyes repeatedly, saying triumphantly: "There, are you convinced now?" I asked for some details about the just-transpired miracle, and he explained, "Didn't you notice everything go dark and disappear?"

Finally, a rather simple interpretation from a child in play:

Aaron, age 3¼, came running excitedly one day, shouting "look Daddy," and proceeded to place a sheet of green cellophane paper in front of his face and marveling at what he saw. He was quite taken for some time afterward with his ability to "make" everything green, just by putting the paper near his face.

What do the above scenarios imply? Whereas Aaron assumes that the elevator "magically" transforms the outer world—a process that occurs while the world is literally hidden behind closed doors—Shulamis has the need to appeal to the construct of motion to maintain continuity of events through the use of object permanence. Nonetheless, her egocentricity still prevails, in that Shulamis sees the world as moving in relation to her, rather than herself moving in relation to the world. This brings us to yet another point where physical and phenomenological development overlap.

The very basics of relativity theory establish that motion is intrinsically relativistic, so that it is equally as valid to assert that the world moves down as I push the elevator button, as it is to claim that I move up when I push the button (Einstein & Infeld, 1938/66). It is a function of egocentricity that man tends to prefer the latter way of saying the

statement—a preference for which Copernicus bore the brunt of much suffering, as he had a similarly "irrational" preference for the former way of expressing the same concept. Indeed, the primary biases responsible for these preferences are based on the tendency we have when watching a larger and smaller object move in relation to each other, of perceiving the smaller as moving while the larger remains stationary. Such a designation is arbitrary at best, and erroneous when it is taken as connoting more than social verbal convention. Motion can only be defined as a relative change of distance between two objects. In effect, then, the developmental deficiency inherent in Shulamis' statement "When I push 4 you will go away" is not cognitive or perceptual; rather, it indicates a lack of socialization by educating forces regarding the verbal convention of phrasing the statement so that the smaller object—even if that happens to be the very observer—is considered moving. Modern physics as a discipline is beholden precisely to the lack of such social indoctrination of which Albert Einstein "suffered."

In the sense that philosophy is iconoclastic, by challenging accepted notions that may be arbitrary, we all start in childhood as quite brilliant philosophers. During our development, perceptual and social interactions shape our cognitive and perceptual modalities, thus restraining our thinking to a specific channel. In the name of common sense, we indoctrinate Aaron, "Do not think that an object is green just because you see it as green; there is a color to the object, regardless of your perception." Yet, a fellow considerably older than Aaron, named Hume, made a mark in academic philosophy by refusing to be socialized thusly.

In the name of convention, we snicker at Shulamis when she tells children on the floor that she can make them move by pushing her elevator button. We do not threaten her (as our forefathers threatened Galileo and Copernicus into retracting their ideas); rather we intimidate her toward conformity through encouraging her to forget such relativistic foolishness, so that she may understand that the world is static and does not move.

There is a striking egocentric relativism (along the notions of subjectivity posited by Hume) in both Aaron's ability to make the world green and in the schizophrenic patient's capacity to make the world disappear and then appear. It is indeed valid to say that for the patient (egocentrically or—more refined—subjectively) the world indeed ceases to exist when he closes his eyes, just as Aaron's world truly turns green when he places the cellophane on his face. What is missing is the objective notion of object permanence (for the schizophrenic) or object constancy (for Aaron). Thus, the acquisition of these notions may well be seen within the developmental evolution of decentration, as egocentricity becomes less and less a focal element of perception and interpretation of interactions.

It seems appropriate to posit that the concepts of object permanence and constancy share with the conceptual acquisition of motion the prerequisite of a gradual evolution away from subjective egocentricity. The movement of the elevator over a series of floors actually represents a stark parallel to earlier phenomena with which the child was confronted. Consider the successive replacement of object by object. Aaron's idea of successive replacement of one floor by another represents a form of conceptual regression, involving working through earlier issues of object permanence.

The final period before relativity of self-world (vs. egocentricity) is mastered, accommodates objects moving while disallowing self-motion as an option. The concept of the child's motion being responsible for the changing perceptions gains support from previous feelings of magical omnipotence, and conceptual regression to self-centered perception (e.g., "The world does not exist when I close my eyes") may be used as a model. Also likely to be helpful is the sensory feedback of moving muscles and vertigo-like feelings that become associated with noncentricity. However, even when noncentricity is mastered, regression to centricity is to be expected in the absence of the telltale perceptions of self-motion. Thus, in a moving, nonaccelerating train, the world is seen as the system in motion.

Finally, the visual cues of objects moving in relation to oneself are utilized to allow for the conceptual option that the child actually moved. Nonetheless, in an enclosed space (e.g., an elevator), when a specific duration elapses before a new location is revealed, the child still cannot conceive that s/he actually changed locations and insists that it is the world that moved. We may well view the attainment of noncentricity of the self, as it is manifest in the acquisition of the motion concept, as the final stage in the integral evolution of the object permanence construct along the time, space, and motion hierarchy.

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