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Explanations, mechanisms, and developmental models

Why the nativist account of early perceptual learning is not a proper mechanistic model

Abstract *In the last several decades a number of studies on perceptual learning in early infancy have suggested that even infants seem to be sensitive to the way objects move and interact in the world. In order to explain the early emergence of infants' sensitivity to causal patterns in the world some psychologists have proposed that core knowledge of objects and causal relations is innate (Leslie & Keeble 1987, Carey & Spelke, 1994; Keil, 1995; Spelke et al., 1994). The goal of this paper is to examine the nativist developmental model by investigating the criteria that a mechanistic model needs to fulfill if it is to be explanatory. Craver (2006) put forth a number of such criteria and developed a few very useful distinctions between explanation sketches and proper mechanistic explanations. By applying these criteria to the nativist developmental model I aim to show, firstly, that nativists only partially characterize the phenomenon at stake without giving us the details of when and under which conditions perception and attention in early infancy take place. Secondly, nativist start off with a description of the phenomena to be explained (even if it is only a partial description) but import into it a particular theory of perception that requires further empirical evidence and further defense on its own. Furthermore, I argue that innate knowledge is a good candidate for a filler term (a term that is used to name the still unknown processes and parts of the mechanism) and is likely to become redundant. Recent extensive research on early intermodal perception indicates that the mechanism enabling the perception of regularities and causal patterns in early infancy is grounded in our neurophysiology. However, this mechanism is fairly basic and does not involve highly sophisticated cognitive structures or innate core knowledge. I conclude with a remark that a closer examination of the mechanisms involved in early perceptual learning indicates that the nativism / empiricism debate (as usually construed in developmental literature) is wrong headed and should be closed.*

Keywords: *mechanism, development, explanatory models, nativism, perceptual learning*

Since the mid 20th century the interest in scientific models, their nature, and the way they relate to scientific theories have been on the rise.[1] As expected, philosophers of science have defined scientific models differently, but it seems that those arguing for their importance have reached at least some agreement about their role (see e.g. Black 1962, Campbell 1957, Harre 1970, MacKinnon 1975). For most philosophers of science scientific models are not only psychological tools that scientists use to construct formal theories but are constitutive parts of those theories. This, in fact means, that at least some scientific models are what gives theories the ability to explain. Due to them we are able to extend the theory to cover new phenomena and provide intellectually satisfying account of the phenomena.

It is important to note that not all scientific models could play such an explanatory role. In his paper "When mechanistic models explain" (2006) Craver correctly notices that some models are data summaries, some are only explanation sketches, while some are *possible* mechanisms of the phenomenon. All of these models play important part in scientific research. However, unlike other kinds of models mechanistic models are usually construed to provide the explanation of the phenomenon. Craver (2006) has developed a number of criteria that a mechanistic model needs to fulfil if it is to be explanatory. The main goal of my paper is to show that some of these criteria could be of great use in developmental psychology. In order to achieve this goal I am going to apply Craver's criteria to a particular kind of developmental model, namely the nativist account of perceptual learning in early infancy and show that this particular model fails one of the most important criteria for a successful mechanistic model.

But, before I turn to the nativist developmental explanation of early perception, I will make the case that there is a variety of developmental models that fit nicely in the categories of phenomenal and/or explanatory models proposed by Craver. In other words, it seems that developmental models do range from purely phenomenal to mechanistic models, where the former aim to describe the phenomenon while the latter aim to describe *and* explain the phenomenon. To show how things went astray in nativism I start with an outline of nativist theories of early perceptual learning, the empirical evidence that nativists use, and their

1 Ovaj članak nastao je u okviru projekta "Dinamički sistemi u prirodi i društvu: filozofski i empirijski aspekti" (evidencioni broj 179041), koji finansira Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije.

argument for the thesis that innate knowledge plays a crucial causal role in the developmental mechanism of early perception. Then, I say a bit about Craver's criteria for mechanistic models. When we focus on the way models describe and explain the phenomenon at stake we cannot help but notice that things can go wrong on both levels: on the level of description as well as on the level of explanation. This, in effect, means that if we describe the phenomenon properly we can still miss the right explanation. However, if we don't get the description of the phenomenon right we will not be in a position to explain it properly. The latter is one of the most important criteria for a proper mechanistic model that Craver proposes. I argue that nativist developmental accounts are a good example of what happens when you fail such a criterion. In other words, my goal is to show that nativists do not properly describe but instead mischaracterize the phenomenon they aim to account for.

In addition to this, I present the empirical evidence coming from the studies in intermodal perception. These studies indicate that a far simpler developmental mechanism responsible for early perceptual learning is at play. From this we can conclude that the concept of innate knowledge is a good candidate for what Craver calls a 'filler term', which underlying mechanism is not likely to be found. This means that innate knowledge, as a filler term with no specified or specifiable underlying mechanism, can no longer aim to play the explanatory role that nativists hoped for. Finally, I end this paper with a remark that the closer examination of the mechanisms involved in early perceptual learning seems to be telling us that the nativism / empiricism debate (as usually construed in developmental literature) is wrong headed and that we should leave it behind us.

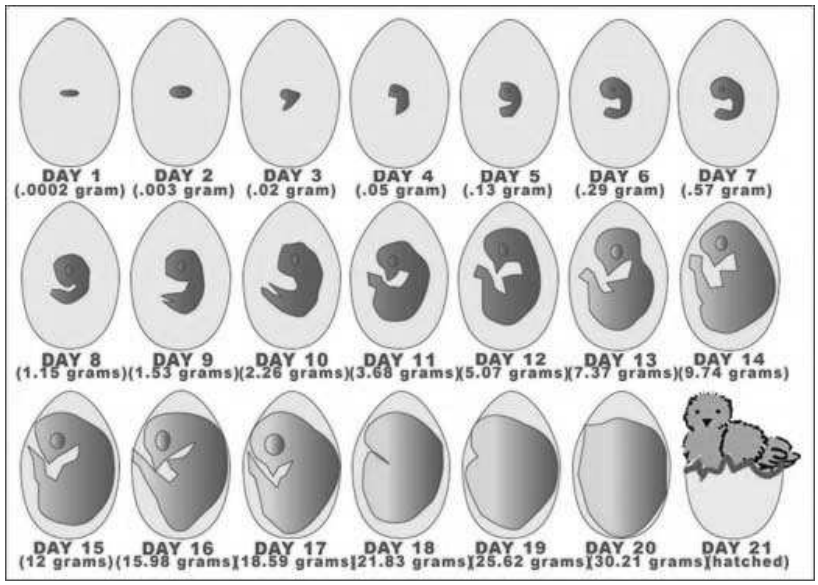
Developmental models: from phenomenal to mechanistic models

Phenomenal as well as mechanistic models belong to particular kinds of scientific models, namely representational models. When constructing a representational model we aim to describe a particular real system. Such a real system could be the circulation of blood, DNA structure, or the orbit of the planets in the solar system. Also, we can make representational models in a variety of ways. We can make them as actual three-dimensional models, or we can draw them on a piece of paper by using lines and arrows, or we can express them through a set of mathematical equations. Regardless of the medium we chose though,

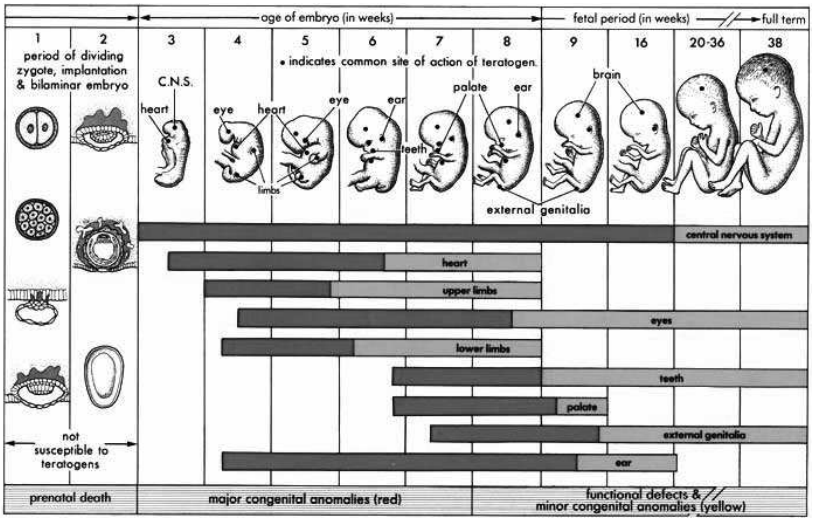
what all representational models have in common is that they aim to capture the relevant features of the phenomenon and present it correctly. Indeed, what features are depicted as relevant and how detailed our model is highly depends on the main purpose of the model.

Typically, when we are building a model of a phenomenon we are interested in describing the mechanism that brings about such a phenomenon. This means that we are interested in describing properly the conditions under which the phenomenon in question occurs (i.e. in identifying its causes). In doing so we believe that we are providing the explanation of the phenomenon. However, there are some cases when we aim to provide a phenomenally rich description of a phenomenon, but where such description does not constitute the explanation of the phenomenon. As Craver puts it: "A model can be richly phenomenally adequate and non-explanatory" (2006, p. 357) He argues that such models do capture some important aspects of the phenomena and allow us to make some predictions. For instance, as Craver notices, by using the Ptolemaic model of the solar system with all its epicycles, deferents, equants, and eccentrics we can predict where the planets are going to be in the night sky but nobody believes nowadays that such model provides an explanation for the planetary movement. Now, some could argue that at the time, the Ptolemaic system *was considered to be* the explanation of the planetary movement not only the description or a useful predictive tool. So, it seems that it is somewhat debatable if the clear-cut distinction between explanatory and purely phenomenal models could be made. Craver develops an instrumentalist defence of the distinction and argues that explanatory models are always more useful (e.g. they enable us to make better predictions) than phenomenal ones. But, regardless of whether we can make such distinction in each and every case of a scientific model it seems that sometimes such a distinction is viable. Developmental biology and developmental psychology seem to be the right place to look for both phenomenal as well as explanatory models. Models in developmental sciences also nicely illustrate Craver's point that explanatory models do need to start with a proper description of the phenomenon if they are to provide the proper explanation of the phenomenon.

Picture 1



Picture 2



Picture 1 and 2 are illustrations of two developments. The first one is the development of a chick inside the egg while the second one represents prenatal development of a human foetus. Both seem to be good candidates for purely phenomenal models, as they say nothing about the

underlying mechanics of development. They do not describe the function of DNA or RNA, the roles of enzymes, protein folding and the like nor do they invoke any environmental factors of development. They describe the phenomenon of development and leave the mechanics of it to be supplemented in a different model. Now, both of these models do have predictive power. We can predict with a high precision what the foetuses in question are going to look like at a certain day/period of development. Nonetheless, they have no explanatory power. Based on these two models we cannot conclude anything about the driving forces of development nor could we infer anything about the causes of derailment of development should such derailment occur.

The aforementioned models are both models of biological development. The question that I want to tackle next is whether we could find similar phenomenal models in developmental psychology. Kinds of developmental psychological models that seem to fit best this category are stage models, particularly those that we could find in parenting books illustrated in the charts of developmental milestones (see picture 3). Any chart of developmental milestones is a phenomenal model of a psychological development, whether it aims to describe linguistic, social, cognitive or affective development. To put it differently, these charts describe what most children are able to do at different stages of development. They are given to parents as guidelines they can use to evaluate their child's progress. Of course, these charts are usually accompanied with the suggestions what parents could do to help their child go through developmental milestones successfully. These further suggestions implicitly endorse some view of the mechanics of psychological development, but this hidden mechanics is not to be found on the chart itself.

Picture 3

Some Milestones in Language Development

Approximate Age	Language Performance
Birth	Cries
12 Weeks	Coos, gurgles
16 Weeks	Differentiates sounds and responds to human sounds
20 Weeks	Makes vowel and consonant sounds
6 Months	Babbles single syllable (ma, mu, da, di)
8 Months	Reduplicates babbles (mama, didi), intonates
12 Months	Understands some words as symbols
18 Months	Still babbles, utters 2-50 words, not many joined
24 Months	Shows vocabulary of 50+ words (specially nouns), uses two-word phrases
30 Months	Shows fastest vocabulary increase – daily additions
36 Months	Shows 1,000-word vocabulary, 80% of which is intelligible to strangers

The ages in this table are approximations. Parents need not assume that their children will have language problems if they are somewhat behind. Source: Adapted from Lennebeg (1967)

There are, of course, other examples of stage models that nicely fit the category of phenomenal. For instance, the purpose of Kohlberg's model of moral development (1973) is to describe how such development unfolds. According to Kohlberg, children go thorough several stages and substages before they reach the moral maturity of an adult. Many have questioned if Kohlberg's model is a proper characterization of moral development as his sample turned out to be biased, namely it consisted only of boys (Gilligan, 1982). Then, it has been questioned if his model could be a truly universal developmental model given that the final stage of moral development is reached mostly by highly educated males of Western societies (Crain, 1985). However, despite all of the acknowledged weaknesses, Kohlberg wanted his model to be a description of a certain phenomenon (i.e. moral development). Sadly, for all kinds of reasons it failed to be such a description. Now, if we wanted to provide the explanation for moral development described in Kohlberg's model we would certainly be on the wrong track. Such explanation would be the explanation of a non-existent developmental phenomenon and as such would not be an explanation at all.

Besides purely phenomenal stage models there are other kinds of stage models in developmental psychology. That is, some of developmental stage models aim to be more than a proper description of the phenomenon. They usually identify some kind of underlying mechanisms that bring about developmental change. Piaget's developmental model is a good example of such a model (1926). According to Piaget, what changes during development are certain cognitive structures. These cognitive structures are particular kinds of logic(s) (initially very simple and later more complex) that a child uses in making sense of the world. These structures are postulated to account for the children's growing ability to successfully communicate with their peers and adults, solve problems, and make sense of the social and physical world. Thus, in his model Piaget starts off with the description of what children can do at a certain stage and postulates cognitive structures to account for such behaviour. Children's behaviour that is progressively getting more sophisticated reflects the development of the underlying cognitive structures. In addition to the changing cognitive structures that explain child's behavioural progress, Piaget proposes mechanisms of this change as well. He argues that the processes of assimilation and accommodation essentially contribute to the development of cognitive structures. In other words, the child is able to adjust her inner cognitive structure based

on the new data that are available to her. These new data are coming to the child as the child acts on the world, manipulates the objects, and observes the changes. So, when more primitive logic fails the child and the child in turn fails to solve a particular problem, the child is forced to refine the logic she is using. In other words, the child then adopts more complex logic in order to solve the problem she is facing.

It is questionable if Piaget's description of cognitive development is the correct description as well as if the underlying cognitive mechanism that he refers to explains cognitive development successfully. But, it is important to note that his model aims to be not only the description of cognitive development but also the explanation of how and why this development unfolds. That is, Piaget provides not only the description of what the child does at different stages but also the mechanism that is supposed to tell us why the child is able to do that.

In the next section I turn to the developmental model that also aims to do both: to describe and explain a particular phenomenon. That is, I turn to the nativist model of early perceptual learning. The focal point of this account is the innate knowledge and the causal role it plays in development of early perception.

Nativist theory of early perceptual learning

In a nutshell all nativist accounts in psychology, particularly those shaped by the cognitive revolution of the last century, are grounded in the same kind of reasoning, namely that we need to postulate some innate knowledge in order to explain psychological development. Within nativist accounts innate knowledge is the key driving force of psychological development. This knowledge helps the child in facial recognition, understanding of facial expressions, and causal reasoning. It also helps her acquire language, learn concepts and categories, develop Theory of Mind, and develop feelings of sympathy. Overall innate knowledge is there to help a child develop most lower and higher psychological capacities. Thus, together with environmental factors, innate knowledge is there to make psychological development happen.

In all the aforementioned cases a nativist's main argument runs as follows: given the sheer number of stimuli coming from the external world and the fact that children do learn remarkably quickly in the first years of life it must be the case that children do have at their disposal some fairly structured innate knowledge. Such knowledge enables them to

quickly categorize incoming stimuli and make sense of their surroundings. If it wasn't for such knowledge children would not be able to learn as quickly as they do (or to learn at all for that matter) whatever it is that they need to learn.

Nativists interested in the early perceptual learning have used the same kind of argument. In addition, they performed a number of habituation studies with infants in order to find empirical support for the claim that children do indeed perceive and become sensitive to the regularities in the world from early on. This early development of perceptual learning would be inexplicable, nativists argue, if children didn't have innate knowledge to help them out. The starting point of these habituation studies is that children tend to look longer in the direction of the object or event that appears to them as unusual, i.e. that surprises them in some way. In other words, if the child is accustomed or habituated to the way objects appear or interact she will show a certain surprise if objects start behaving differently. The main assumption of the habituation studies is that this surprise could be measured, as the child looks longer at the unusual object/event.[2].

In the last several decades a number of these studies have suggested that even infants seem to be sensitive to the way objects move and interact in the world (Leslie & Keeble, 1987; Baillargeon, Kotovsky, & Needham, 1995; Spelke, Breinlinger, Macomber, & Jacobson, 1992; Spelke, Katz, Purcell, Ehrlich, & Breinlinger, 1994; Aguiar & Baillargeon, 1999; Spelke, 2004; Spelke & Kinzler, 2007). So, it has been found that infants look longer when objects violate certain expectations: if objects say 'walk' through each other or if inanimate objects seem to affect the other object at a distance. In other words, infants look surprised and their attention is on the unusual event. The conclusion from this series of studies has been that infants seem to expect objects to behave according to spatio-temporal principles of cohesion (objects move as connected and bounded wholes), continuity (objects move on connected, unobstructed paths), and contact (objects do not interact at a distance). This seems to be true for newly born infants in the first months of their lives (Lea, Slater & Ryan, 1996)

2 The other kind of habituation studies assumes that children prefer to look in the direction of the stimuli that is familiar to them. When presented with particular kind of stimuli such as mothers face as opposed to strangers face or a face that speaks their mother tongue and the foreign language they will show preferential looking toward the former not the latter.

By relying on the results of these studies nativists made their case for the innate knowledge responsible for the perceptual learning in early infancy. Their argument follows the form of the aforementioned standard nativist argument. Given that the onset of the sensitivities to how objects move and relate happens so early in infancy it *must* be the case that some core knowledge of objects and the way they interact is innate. Otherwise, nativists argue, the early onset of evidenced capacities would be inexplicable. In other words, they argue that infants would not be able to develop such sensitivities merely through experience and induction simply because infants do not have enough time for that. The sheer number of stimuli bombarding them from the external world on an everyday basis is enormous. Infants would not be able to categorize them, form expectations about how objects move, and become sensitive to the regularities in the world without a little help from the innate knowledge of objects and basic causality. At least they would not be able to do that so quickly.

Let me now take a closer look at the nativist proposal. However, as promised in the introduction, I would like to do that from a particular angle, namely by looking at the nativist model through the lenses of Craver's criteria for a proper mechanistic model. I believe that this way of looking at the nativist proposal will help us get a better sense of how and where the nativist account stands and how successful as a developmental explanation it is.

Craver's criteria and nativism

Along with Gelennan (1996, 2002) and Kaufmann (1971) Craver argues that mechanisms (i.e. mechanistic models) are always mechanisms of a given phenomenon. This is what nativists in their developmental account certainly do: they do propose a certain mechanism of a certain phenomenon**.** However**,** in order to assess how successful their proposal is, it is important to unpack what the phenomenon they aim to account for is and what the mechanism they propose is.

So, for nativists, what is the phenomenon in need of explanation? First and foremost it seems that the results of the aforementioned habituation studies need to be accounted for. These results tell us that infants tend to attend to certain stimuli (i.e. they attend to the irregularities in the movement or appearance of objects) while they remain inattentive to others, namely to the objects appearing and behaving in the usual way. So the question is: why is this the case? Why do infants seem to be

sensitive to the difference between usual and unusual movement of objects? Second, why does such sensitivity occur in the first months of life?

We have already seen the mechanism nativists propose. They argue that innate knowledge of objects and their relations along with the appropriate exposure to the environment produces the aforementioned phenomenon. In other words, they argue that infants' attention is guided by their innate knowledge how the world works and when they encounter a counter example they look longer in that direction. This happens so early in infants' life only because infants have such knowledge at their disposal. It would take them much longer to figure out what is usual and what is unusual in the 'behaviour' of objects should they be without such knowledge.

There are a few questions to ask regarding the nativist proposal. Firstly, we need to ask if the phenomenon they target to explain really is the phenomenon that requires explanation. This means that we need to ask if nativist provide (and start off with) a proper description of the phenomenon. Secondly, we need to see if the proposed mechanism is a proper mechanistic model or rather the explanation sketch that leaves important parts of the mechanism to be discovered later. And finally, the question is whether nativist explanation sketch (if it turns out that their proposal is the explanation sketch) is on the right track to become a full blown mechanistic explanation or it is rather a misleading explanatory attempt.

Craver argues that a mechanistic explanation must begin with a proper description of the phenomenon. Such a description should include when and under which conditions a phenomenon occurs or fails to occur, which are its side effects and the like. So, the first thing we need to do is to see if the nativist description of the phenomenon (that is to be accounted for by their mechanistic model) is the proper description of the phenomenon. Two problems come to mind with the way nativists describe the phenomenon in question. Firstly, their description of the phenomenon appears to be partial at best. While they did document a certain number of particular cases when the effect of prolonged attention occurs they haven't examined a variety of factors that might prevent infants to attend to certain stimuli nor did they do the extensive research on when (under which conditions) attention in infants occurs[3].

3 Fortunately, other kinds of habituation studies did exactly that and I will say more about them in the next section. These habituation studies will in fact cast new light on the results of habituation studies nativist use in their argument.

The second problem, which is even more pressing, is that nativists do import a particular *theory* of perception into their *description* of the phenomenon. That is, when nativists say that it is necessary to postulate innate knowledge of the causal relations in order to account for the occurrence of *early* sensitivity to the irregularities in the behaviour of objects in infants they already presuppose that early infants' perception functions in a particular way. They assume that the nature of perception is such that the child perceives the world as chaotic and with discrete stimuli. The number of these stimuli is overwhelming and the child could not possibly be able to discern important regularities/patterns among them merely by using induction and experience. At least the child would not be able to accomplish that so quickly. The perception needs to be guided, nativists say, by an innate mechanism if the child is to make sense of the chaotic world of stimuli. However, this particular theory of how the child perceives the world, (namely that the child perceives the world as an enormous number of chaotic, discrete stimuli), requires further evidence and cannot be taken for granted. Now, I am not saying that it is never legitimate to import a certain theory into the description of the phenomenon. However, when we do that we need to have strong, independently given evidence for it. But, this is exactly what the nativists in this particular case are lacking. Scientists who study perception are more than aware of all the problems with the theory of perception nativists presuppose. As a matter of fact, studies in intersensory perception that I am going to turn to in the next section, indicate a radically different theory of perception from the one nativists accept. From here we can conclude that the nativist characterization of the phenomenon to be explained is already highly problematic.

But, before I move to different theories of early perception and a different set of habituation studies let me say a bit about another important concept that Craver uses in differentiating fully explanatory mechanistic models from the mere explanation sketches. Craver argues that we often use filler terms to identify some processes in the mechanism that we believe are taking place but do not know exactly how they are being carried out. In other words, we use filler terms to identify some processes (or entities) when we still haven't identified the underlying mechanism responsible for these processes. The usual candidates for filler terms are concepts such as activate, cause, encode, inhibit, produce, process, and represent. They do label some processes but do not say much about how such processes unfold and which causal factors are

responsible for triggering them. Of course, the use of the filler terms is not necessarily bad. We use them when we aim to roughly sketch the mechanism of a certain phenomenon. By using filler terms we acknowledge the existence of some processes and leave the details of the mechanism to be discovered later. They become a hindrance in the research if we happen to forget that they are not the explanation of the phenomenon and when stop looking for the underlying mechanism they name.

Now, how does this affect nativism? The concept of innate knowledge seems to be a candidate for a filler term while the developmental model that utilizes this concept seems to be a candidate for an explanation sketch rather than a full-blown mechanistic model. This is primarily because the causes, entities, and processes that constitute and activate such knowledge are unspecified in the nativist models. Indeed, nativists hoped that biologists, especially developmental biologists would make sense of it. They have assumed that innate knowledge would be found encoded in genes, localized in particular brain regions, and selected in evolution. That is to say it was left to biologists to uncover the details of the underlying biological mechanisms of an important cognitive capacity (i.e. innate knowledge) required for normal psychological development. In the last several decades all of the assumptions about genes, brain, and evolution (that nativists rely on) have been criticized and put into question. The assumption that there is one-to-one mapping between genes and psychological traits/capacities has been attacked. Evidence that the relationship between our genes and our psychology is far more complex than we used to think has been gathered by many developmental biologists and psychobiologists (Oyama 2000, Gottlieb 2003, Meaney 2001, Bateson 2003). The same happened with the thesis that we can localize our mental functions in the particular brain regions. It has been argued that even if we accept that some kind of localization happens such localization could be result of postnatal development not the innate, genetic program (Karmiloff-Smith, 1992). And, finally, evolutionary accounts of certain psychological capacities have been criticized as 'just so' stories with no independent empirical evidence. Their scientific character has been questioned on this ground (Lewontin 1980).

All of this means that, at best, identifying the underlying biological mechanism of how we have this innate knowledge is further away than nativists have hoped for. But, the situation could be even grimmer for the innate knowledge and nativism. If the critiques of genetic determinism, localization, and evolutionary psychology are right the underlying

mechanism of innate knowledge will not be found at all. This would mean that innate knowledge is not a potentially useful filler term covering some yet to be discovered processes but an empty term covering no real processes whatsoever. There is a number of studies in intersensory perception telling us that the latter is more likely to be the case. These studies indicate that there might be different and far simpler neurophysiological mechanism operating in the early development of perception. Or, to put it differently, based on the findings of these studies it seems that a simpler mechanism from the one proposed by nativists can explain the results of habituation studies; habituation studies that nativists primarily use as the evidence for their claim that infants need to have fairly sophisticated innate knowledge for the successful perceptual learning in early infancy. Furthermore, these studies indicate that the theory of perception presupposed by nativists is not likely to be the right one either. Let me now turn to these studies.

Early perceptual learning and studies in intersensory perception

Recent studies in intersensory perception (see, for example, Bahrick & Lickliter 2000; Bahrick, Lickliter, & Flom 2004) indicate that the intersensory perception of amodal features of objects and events (i.e. features perceived through more than one sensory channel such as synchrony, intensity, rhythm) seems to precede the perception of unimodal features of objects (such as color pitch, timber.)

According to Bahrick and Lickliter's intersensory redundancy hypothesis, an infant's attention is facilitated if certain stimuli are specified through more than one sense. If the child is presented with the same stimuli through only one sensory modality, she is not able to perceptually differentiate the stimuli with the same success as when she is presented through two sense modalities (Bahrick & Lickliter 2000). For instance, if the child is presented with a video of somebody tapping a ball, the child will get habituated to the stimuli and will stop looking in that direction. If we change the rhythm of the tapping ball, the child's attention will be recaptured. However, the child's attention will not be recaptured if the rhythm stays the same while we change the colour of the ball.

This has profound implications for the trajectory of perceptual learning. More specifically, if the child's attention is captured by aspects of

sensory stimulation which come from several sense modalities, it means that multimodal (i.e. intersensory) perception "gives initial advantage to the perceptual processing of, learning of, and memory for stimulus properties that are redundant or amodal (for example, synchrony, rhythm, and intensity) at the expense of modality-specific properties (for example, color, pitch, and timbre) that can be perceived through only one sense" (Bahrick, Lickliter, & Flom 2004, p. 99).

Furthermore, this has important implications for the theories of perceptual development in early infancy. Studies in intersensory perception seem to suggest that the child does not perceive the world as a chaotic mass of stimuli, features, objects, and movements. On the contrary, these studies suggest that the child's perception is organized around synchrony, rhythm, intensity and similar amodal features of objects and that the child is only later able to discern the details of objects and its modality-specific features. This means that the child does not seem to be able to discern the details of the world in the first months of life. But, if this is the case, something seems to be terribly wrong with the nativist theories of early perceptual learning. Let me unpack this a bit.

Studies in intersensory perception are telling us that the world of the child is already structured by her sensory apparatus. If this is the case, the child does not need innate knowledge to help her develop sensitivity to the way objects move or interact. Amodal features such as intensity, synchrony and rhythm characterize the movement of objects and accordingly, the movement of objects is what the child initially perceives. In other words, movement is what drives infants' attention not the colour or the noise. Thus, we can say that the movement of objects is in the foreground of their perceptual field. When we know this it becomes much easier to explain why children become sensitive to the ways objects regularly move or interact so early and so quickly in their development. They simply do not perceive other features of objects and they do not need to discern movement of objects from the way they smell, noise they make, or their colour. These uni-modal features are in the background of their perceptual field and are not something that will capture infants' attention and in that way interfere with the perception of movement.

In the next and the final section I examine far-reaching implications that these insights might have not only for the nativist theories of perception but also for the wider debate between the so-called enrichment

and differentiation theories of perception. As we will see the empiricist/nativist debate originates only within the enrichment theories. However, the aforementioned studies in intersensory perception indicate that the differentiation theories are more likely to be on the right track especially when it comes to perception in early infancy.

Conclusive remarks and a note on the empiricism – nativism debate in the theories of perception

To summarize, the studies in intersensory perception tell us that whatever the underlying mechanics of early perceptual learning is, it needs to be a part of infants' basic physiology rather than a part of some fairly sophisticated innate knowledge. This preliminary conclusion about the nature of the perceptual mechanism, namely that it must be some kind of simpler physiological apparatus, has better chances to fulfil Craver's criteria for a proper mechanistic model. This is mainly for two reasons. Firstly, in the studies in intersensory perception Barick and Lickliter did examine a variety of conditions under which child's attention occurs or fails to occur. This covers a wider spectrum of cases than the habituation studies that nativists rely on. Secondly, in the light of these studies we can make sense of, i.e. we can explain why infants develop early sensitivity to the way objects move and interact. In other words, Barick and Lichliter's intersensory redundancy hypothesis has the potential to account for the narrow range of cases that the nativists examined, focused on, and used as evidence in developing their nativist model of perception. But, it is important to note that the theory of perception that these studies indicate is radically different from the one nativists presupposed in their accounts. More specifically, when nativists postulate innate knowledge to account for the quick and early development of perceptual learning they presuppose that the child perceives the world as chaotic set of discrete stimuli. The child's task is then to categorize properly these stimuli with the help of innate knowledge. However, as we have seen this particular theory of perception that nativists presuppose is substantially undermined by the findings of the research in intersensory perception. This brings me to the last point that I want to make and to conclude with.

So far there have been two dominant kinds of theories of perception: enrichment theories and differentiation theories[4] (Gibson & Pick,

4 This is the distinction that A. Gibson uses in her book *"Ecological approach to perception"*.

2000). Enrichment theories have in common the notion that originally barren reception of stimuli is supplemented by some form of accrual or interpretation. What was thought to be added varied. On one hand, for empiricists (such as behaviourists and connectionsts) we learn how to sort out these stimuli through our encounters with the world. On the other hand, for cognitivists who are often the advocates of stronger or weaker forms of nativism, we already have some kind of organizing cognitive apparatus that enables us to construct the coherent picture from the incoming stimuli. Differentiation theories that were initially formulated in the J.J. Gibson (1958) work, start off with a different assumption. Rather than assuming that the information available from the environment is punctuate, bare, and fleeting, they suggested that information available from the environment is rich, and that perceptual learning involves detecting new information or "responding to variables of physical stimulation not previously responded to" (Gibson & Pick, 2000, p. 34). The process of learning is one of discrimination rather than of association or making inferences.

With this framework in mind it becomes clearer that the entire traditional debate between empiricists and nativists is defined within the boundary of the enrichment theories. The question that both nativists and empiricists pose is: "What do I need to have (if anything) to supplement the barren perception?" That is, both camps are preoccupied with the question of which cognitive apparatus (if any) a child needs to have to be able to sort out certain stimuli into various categories, or to be able to generalize to novel stimuli, or to perceive similarities. However, the aforementioned studies in intersensory perception strongly suggest that enrichment theories do not tell us how perception actually unfolds, at least not in infants. Differentiation theories seem to be doing much better job in that respect. Thus, if infants do not perceive the world as a chaotic set of fleeting stimuli there is no need to look for the cognitive apparatus responsible for imposing order nor do we need to try to come up with the alternative empiricist's accounts within such narrow constraints. What these studies, in fact, suggest is that there might be a way to move beyond the traditional empiricist/nativist debate. Once we do that and begin our inquiry with the differentiation theory of perception we will be in a better position to look for the underlying physiological mechanisms of perception: mechanisms that allow children to quickly form expectations about causal relations among objects by structuring the way they experience the world from the very beginning. Studies in

intersensory perception seem to be the first step in that direction. Indeed, further research is required before we could provide fully explanatory mechanistic model of early perceptual learning, but with these insights in mind the hope is that we'll be looking at the right places now.

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Objašnjenja, mehanizmi i razvojni modeli. Zašto nativistički model nije dobar mehanicistički model

Sažetak

U poslednjih nekoliko dekada više studija posvećenih percepciji novorodjenčadi je ukazalo na to da čak i tek rodjena deca jesu osetljiva na način na koji se objekti pokreću i na prirodu njihove interakcije. Da bi objasnili ranu pojavu ovakve osetljivosti na kauzalne odnose neki psiholozi zastupaju stanovište da postoji urodjeno znanje vezano za objekte (Leslie & Keeble 1987, Carey & Spelke, 1994; Keil, 1995; Spelke et al., 1994). Cilj ovog rada je da preispita ovakva nativistička objašnjenja tako što će da preispita da li ova objašnjenja ispunjavaju uslove koji svaki mehanicistički model mora da ispuni da bi bio uspešan. Craver (2006) je razvio nekoliko takvih kriterijuma kao i distinkciju izmedju odgovarajućeg mehanicističkog modela i mehanicističke skice. Moj cilj je da pokažem da nativistički modeli razvoja ne ispunjavaju ove kriterijume. Prvo, ti modeli samo delimično a ne u potpunosti opisuju fenomen. Drugo, nativisti uključuju u opis fenomena odredjenu teoriju percepcije koja zahteva dodatnu empirijsku evidenciju i ne može biti bezrezervno prihvaćena kao tačna. Ja ću takodje argumentovati da je urodjeno znanje dobar kandidat za ono što Craver naziva 'praznim terminom' (terminom kojim imenujemo procese za koje još nismo sigurni kako se odvijaju) i da će najverovatnije biti napušten. Novija istraživanja koja su ispitivala intersenzornu percepciju ukazuju na to da je mehanizam odgovoran za rano opažanje kauzalnih odnosa najverovatnije deo naše najosnovnije fiziologije i da kao takav ne uključuje sofisticirane kognitivne strukture niti urodjeno znanje. Takodje, ova istraživanja ukazuju na to da je standardna debata izmedju nativista i empirista pogrešno postavljena i da bi je trebalo napustiti.

Ključne reči: Mehanizam; razvoj; eksplanatorni modeli; nativizam; učenje percepcijom