# Research on the "Uznadze Effect" in the Works of Jean Piaget and Contemporary Scholars

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How is the perceptual image of objective physical reality formed? The interpretation of sensory information happens so quickly and seemingly by itself that typically we do not think about how difficult this task can be. Studying any system during its smooth operation can be hard, so it is more convenient to study it when it makes mistakes or its operation is hindered. Therefore, when studying the information processing system, scientists often investigate it when perception faces challenges, such as during the threshold intensity of stimuli – when noise or many other stimuli are simultaneously present. Studying visual illusions is one of the most efficient ways to study the perception processes. Illusory perception provides us with false information about the environment, which is why it often helps us unravel the puzzles of the perception mechanisms (Kolers, 1974). Illusions can provide important data for psychological theories. Interest in perceptual illusions dates back to as early as 99-55 BC and is still ongoing, although, remarkably, scholars are often interested not in illusions per se, but rather in the fact that knowledge about illusions can shed light on the research into perception processes.

That was exactly how Jean Piaget, a well-known Swiss scholar, employed perceptual illusions in his research. He was the founder of the genetic approach in contemporary cognitive psychology. One of the central focuses of his research involved the development of cognitive – including perceptual – processes (Piaget & Fraisse, 1978). A considerable part of Piaget's experimental research was focused on studying perceptual errors and the so-called deformations, that is, illusions. In one of his works, he wrote:

> One might be surprised by the huge number of "illusions" selected for these experiments […]. One might think that, on the one hand, there are the mechanisms of perception itself, and, on the other hand, there are the mechanisms of its deformations […]. An individual cannot differentiate between his or her own systematic errors and perception itself. In fact, illusions can be determined by the

> perceptual mechanism itself […]. Just as studying child's systematic errors helps us demonstrate the operational structures, studying illusions is a first step toward researching perception and its development mechanisms (Piaget & Fraisse, 1978).

In the classification of illusions, Piaget distinguishes between primary and secondary illusions. According to him, primary illusions are the optical-geometric illusions that are presented to a person simultaneously, such as the Müller-Lyer, Ponzo, and Delboeuf illusions, among others. They are primary, because they occur through the direct effect of the perceptual field, as a result of its brief influence (Piaget & Lambercier, 1944) without any prior training. Under such circumstances, scanning eye movements, acts of comparing, or information seeking, and other perceptual activities are impossible. An individual is entirely under the influence of the field. These perceptual actions develop with one's age. This is why optical-geometric illusions are more prominent among children than among adults. In particular, their magnitude gradually decreases from ages 5–6 through adulthood, although they never entirely disappear. Piaget always explained deformations through the contrast phenomenon, arguing that

> Perception does not work similarly to copying or simply exact measurement. It is akin to a selection process in which not every dot or micro-segment of a figure is encoded, but rather those that are selected. Next, these selected microelements are compared with the rest and are reevaluated […]. Any kind of knowledge – whether it is perception or imagination – is inherently deformed by different types of "centrations", and only "centration" can lead to objective perception (Piaget & Fraisse, 1978).

As noted above, Piaget differentiated between primary and secondary illusions – the latter being successive events in time that are formed through preliminary fixation training. To illustrate these secondary illusions, Piaget draws on the illusion of the fixed set studied by Dimitri Uznadze. He dubs this phenomenon the "Uznadze Effect" (Piaget & Lambercier, 1944). Interestingly, Piaget devoted considerable research to studying the illusions of the set (he uses the German term *Einstellung*), the findings of which were published in his 1944 paper, "Essay on the Set Effect in the Course of Visual Perception (Usnadze Effect)" (Piaget & Lambercier, 1944). In this work, Piaget reviews Uznadze's experiments on the fixed set in detail, which, presumably, he read in Uznadze's work published in 1931 in German, "Concerning the Size-Weight

Illusion and its Analogues" (Uznadze, 1931). In turn, this work by Uznadze was preceded by substantial efforts at the Georgian Psychological School.

Dimitri Uznadze received his education in psychology in Germany and worked in Wilhelm Wundt's laboratory of experimental psychology. In 1909, he received his PhD in Germany. Returning to Georgia, in 1918, Uznadze established the department of psychology and the laboratory of psychology at Tbilisi State University, which served as the basis for the development of experimental psychology in Georgia. *The Foundations of Experimental Psychology,* Uznadze's monograph published in 1925, had played a crucial role in establishing the Georgian School of Experimental Psychology. This work is important also because it was the first step toward addressing certain principles of the general psychological theory of set. However, the nature of the set encompassing an entire person was revealed later through extensive research, the findings of which were published in 1931 in the German journal *Die psychologische Forschung, volume XIV* (pp. 366–379) in the form of a paper titled "Über die Gewichtstäuschung und ihre Analoga" ("Concerning the Size-Weight Illusion and its Analogues"). In the same year, in the German language again, the basic rule of set-changing was published in the proceedings of the Ninth International Congress of Psychologists. Through this work, Uznadze's set experiments and his theory of set reached a broader audience of psychologists globally (Uznadze, 2009).

This work served as an inspiration for Piaget's monograph. He not only thoroughly reviewed Uznadze's experiments on the fixed set occurring in the visual field, but he replicated these experiments with the precision and meticulous control of variables characteristic of him. Piaget's research had two main goals:

1. To study the fixed set, which interested him in terms of the development of children's cognitive processes.
2. To analyze the mechanisms of the "Uznadze Effect" in relation to his theory of perception development proposed by him earlier.

Interestingly, in this 1944 paper, Piaget noted that he was the first scholar to study the "Uznadze Effect" in children (Piaget & Lambercier, 1944); however, representatives of the Georgian Psychological School had been conducting fixed set experiments with children much earlier. Most likely, these works by Georgian

researchers were not accessible to Piaget. Barnab Khachapuridze, one of the Georgian scholars who devoted many of his experiments to studying the fixed set among children, wrote about this: "The fourth problem discussed in this work by Piaget addresses the research of the set in terms of its genetic basis and the comparative description of the set processes in children and adults […]. Our first publication concerning this topic dates back to 1939[1] and 1941[2]." The first work mentioned by Khachapuridze was published in the German language in the Netherlands (Khachapuridze, 1976).

In the first chapter of this article, Piaget briefly reviews the history of the research on the successive, so-called secondary illusions and argues that one of the most significant insights of Uznadze – the one that sets him apart from other scholars – is his view of *Einstellung* as a more general phenomenon, rather than as merely an occurrence in the motor or kinesthetic realm. He writes:

> It is not at all impossible that the term *Einstellung* corresponds to a general mechanism and is, along with the rest, present in the visual and auditory realms. This is what Uznadze thought about his own studies on the weight illusion; he was interested in whether, during a visual comparison, we obtain an effect similar to the one produced by the illusion generated through the interplay of weight and size.

Participants in Piaget's experiments were 5–7-year-old children and 20–32-year-old adults. He reached several interesting findings, which had previously been demonstrated by the 1940–1941 experiments of Georgian scholars (Khachapuridze, 1976):

1. The "Uznadze Effect" is less prominent in younger children then in adults; specifically, the magnitude of the illusion is smaller among children: it is the smallest in 5–6-year-olds, increases in 6–7-year-olds and is the highest among adults.
2. The process of extinguishing the "Uznadze Effect" also takes different forms in children and adults. While in children, despite its weakness, the effect does not

[1] Uznadze, D. (1939). Untershcungen zur Psychologie der Einstellung [Investigations of the psychology of set]. *Acta Psychologica, 4*(1), 214 – 256.
[2] Khachapuridze, B. I. (1941). Nekotorie osobennosti ustanovki u detei [Several characteristics of set in children]. *Trudi Gosudarstvennogo Universiteta Tbilisi, 17*.

disappear easily and the retention process is salient, in adults, by contrast, it disappears more quickly, although the retention process is also prominent.

3. The cases of contrast comparisons of equal circles provided in a critical trial are higher among adults compared with assimilation comparisons, whereas the opposite is true for children. Piaget argues that since contrasting effects, as typical field effects, decrease with age, the increase in the contrasting phenomenon observed here may be caused by temporary connections between the three expositions of non-equal circles and the expositions of equal circles. All this leads the author to conclude that perseveration, rather than anticipation, is more characteristic of children's behavior. During perseveration, children simply repeat the reaction they experienced while evaluating small-large circles presented to them in the set trial, continuing the same response pattern when presented with equal circles. On the other hand, anticipation involves a relatively higher level of intellectual development, which occurs later in life. An adult might also exhibit the same reaction to the subsequent expositions, but this would be a repetition produced by anticipation (that is, the act of foreseeing events), rather than as a result of automatic perseveration.

4. Piaget also conducted the so-called shape transposition experiments that are known as the "set generalization" experiments in the psychology of set. Specifically, after forming a set in the participants toward different sizes of circles, in the critical trial, instead of providing equal circles, he presented them with equal objects of other shapes (such as squares or black-colored circles), and he observed the "Uznadze Effect" again. Additionally, when observing this phenomenon in terms of age, he discovered that "given the absolute magnitude, the transfer in children is smaller than in adults, similar to what had occurred in the trials of the effect formation itself" (Piaget & Lambercier, 1944).

Curiously, Khachapuridze obtained identical results in his earlier experiments conducted with children between 1940 and 1941, which were presented in the work titled "Some of the Characteristics of Children's Set". This work addressed the phenomenon of irradiation too – the transfer of the set effects formed for one modality to another. In particular, the study participants had their set formed for assessing weights, and in the critical trials they were exposed to equal circles through a tachistoscope. The results of the set irradiation are similar to the "Uznadze Effect" demonstrated by Piaget's experiments with children: preschoolers tend to exhibit fewer contrast and more assimilation illusions – a phenomenon that changes with age.

Irradiation and generalization experiments played an important role in understanding the set as a non-local phenomenon encompassing the whole person.

Interestingly, Canadian scholars discovered the same mechanisms of set formation in children. Scientists from the University of Alberta's Department of Psychology conducted several studies on the "Uznadze Effect". One of them, Jansen, wrote:

> The behavior model presented by Uznadze belongs to the dynamic model of interaction between an individual and the environment; Uznadze's concept of set is, to some extent, similar to Piaget's concept of adaptation, which involves the notions of accommodation and assimilation and their relationship to the internal schema.

Generally, the author considers the fixed set as an impulsive process, occurring at the physiological level, whereas he views objectivization as occurring at the psychological level. His study showed that children were more likely to form illusions in the haptic modality (90%) compared with the visual modality (50%). This, according to him, is linked to different rates of development of the nervous system; therefore, the development of different senses is related to set formation (Jansen, Maguer, & Boersma, 1976).

Despite the common findings, Piaget emphasizes the number of methodological differences present in his replication of Uznadze's experiments. Piaget criticizes Uznadze for not conducting control trials in his experiments and for not examining how an individual perceives equal objects since he or she may experience these equal objects as unequal in any case. Piaget writes:

> Uznadze does not explain whether he took precautions to ensure that two equal circles are not perceived unequal when *Einstellung* is not formed, nor does he explain whether the difference between circles ranging from 25 mm to 26 mm is within the individual's sensitivity threshold (1 mm for 25 mm, that is, 4%).

Piaget begins his set formation experiments with this so-called preliminary phase to determine the subject's sensitivity. However, arguably, this is not Piaget's original insight either, given that in the studies conducted at the Georgian Psychological School in 1940–1941, led by Khachapuridze, the set experiments were always preceded by control trials in which the participants' "sensory asymmetry" was tested.

Khachapuridze later expanded on this phenomenon in his separate work, "Sensory Asymmetry and the Fixed Set". In his later works, Uznadze underscores the important role of studying this issue in supporting the set phenomenon. He wrote that, without these preliminary studies, "it is impossible to be sure what determines a participant's account in each individual case – an objective assessment of the situation or merely the subject's personal characteristics, their asymmetry." Uznadze assumes that this natural asymmetry may be a manifestation of the so-called naturally fixed set (Uznadze, 1977).

One of the significant methodological differences between the classic experiments of Piaget and Uznadze was the way the dependent variable – the so-called effect – was measured. In his experiments, Uznadze provided the study participants with equal objects and observed the instances of reevaluation; that is, the strength of the fixed set in a critical trial was determined through the frequency of manifestations of illusory perception, specifically through the number of contrasting illusions, while in his critical trials, Piaget exposed his participants first to equal objects and then – if the reevaluation was confirmed – to a series of non-equal, slightly different objects; when the participants perceived these unequal objects as equal, Piaget termed this difference between the diameters of two circles the "Uznadze Effect." In other words, in his experiments, Piaget measured the magnitude of the set illusion in millimeters, rather than the number of expositions required to extinguish the effect. Interestingly, this method was employed in 1940–1941 in the Khachapuridze-led experiments, which he later mentioned when criticizing Piaget's studies. This issue did not go unnoticed among other Georgian scientists as well, who conducted numerous insightful studies prior to Piaget's publication of the results of his experiments. These findings by Georgian authors are outlined in Natadze's and Avalishvili's works published in 1941 and 1942, respectively (Avalishvili, 1942; Natadze, 1941).

That said, scholars of the psychology of set identify many flaws in this method. The main flaw with this methodological approach is highlighted by Piaget himself, who argues that exposing participants to non-equal objects in turn creates a risk of forming a new fixed set. Piaget wrote, "However, this issue is problematic. If two circles, for example, of 22 mm and 24 mm in size, appear identical when they are encoded in their actual sizes into the primary optical centers, would that lead to a new *Einstellung*?" He addressed the challenges of solving this issue experimentally, while

also arguing that the small difference between the circles exposed in the critical trial would not significantly affect *Einstellung*, viewing this, in part, as a solution to the problem in question. "This difference would be relatively minor and would not sustain *Einstellung*." Nevertheless, it is evident that controlling the additional variables occurring during this process is impossible, making this method used by Piaget considerably flawed.

This approach to measuring the magnitude of the fixed set illusion later became the focus of scholars and remains relevant. However, the method they used was different from that of Piaget. First, the scholars incorporated motor activity into the process of set evaluation. In this type of experiments, in the critical trials, study participants were asked to make unequal objects equal using a hand movement. In one of the experiments, circles were exposed through a so-called illusion-meter. A participant was able to change the sizes of the circles displayed on the screen by moving specific buttons. When a participant perceived equal circles as non-equal in a critical trial, he or she made them equal using a specific switch, that is, by increasing the diameter of the circle he or she perceived smaller. Typically, the circle perceived as smaller was on the side of the screen where the larger circle had previously been exposed (a contrast illusion). In other words, a participant's action was assimilative: he or she sought to see the large circle again on the side of the screen where a large circle had previously been displayed, thereby causing the circle positioned in place of a larger circle to be perceived as smaller in size, leading a participant to increase it to make it equal to the other circle. In this process, a researcher observed these changes in millimeters, making it possible to measure the magnitude of the set illusion (Kintsurashvili, 1967). Numerous similar experiments were conducted by Georgian psychologists such as Bzhalava, Chkhartishvili, Tabidze. The set formation occurring in the sensory-motor field also became a focus of experiments by Shota Nadirashvili, who used a different approach to interpreting the set effect. When describing the set processes in the sensory-motor field, Nadirashvili states:

> This set affects an individual's pattern of assimilative action and contrasting evaluation of this action; when an individual has to perform a task inconsistent with his or her set, under the influence of the set, instances of assimilative actions and contrasting experience occur in nearly 100% of cases (Nadirashvili, 1983).

What matters more is not the methodological differences between Piaget's and Uznadze's experiments, but rather the differences in the interpretations of the set effects themselves. How does Piaget explain the set effects? When analyzing the "Uznadze Effect", Piaget concludes that *Einstellung* is a so-called false transposition. According to Piaget, transposition, in turn, is one of the forms of perceptual actions characteristic of preoperational stage of children's development (Kiria, 2003). Piaget writes:

> Transposition is an act by which a gaze, when moving from one object to another, transfers the traits of the former (size, shape, etc.) to the latter […]. *Einstellung* is the false transposition […]. The temporal transfer and transposition that occur in the Uznadze Effect should be regarded as preoperational actions.

In Piaget's view, just as other perceptual processes develop with cognitive development, it is easy to conclude that this transposition develops with age; thus, this explains why the Uznadze Effect increases with age. As for the fact that it extinguishes quickly in adults while persisting longer in children, Piaget explains this by the specific nature of the transposition, arguing that the transposition

> […] has the quality of receding in cases of inconsistency with objective facts […]. When a movement fails, it transforms into a reverse movement so that the transposition and subsequently the anticipation (that is, when this transposition becomes a conscious expectation) are being canceled during backward movements, failure, or failed expectations (Piaget & Lambercier, 1944).

Uznadze proposes a different explanation for the same phenomenon. His experimental research on the set demonstrated that the set illusions are caused by the fixed set, with the set determining the perceptual process just like any mental activity. Uznadze's set is an unconscious state, which involves the whole person, is produced by the correspondence between a person's needs and an actual situation, and is responsible for all kinds of psychophysical activity. In certain cases, the set formed in this manner transforms into a preserved, fixed form.

> The fixation mechanism of the set, according to Uznadze, is generally a mechanism for gaining and retaining experiences. Since the fixed set involves all the essential attributes that are characteristic of the set in general, his research facilitates the

> planning and studying the certain general or differential psychological principles characteristic of the set phenomenon (Imedadze, 2008).

Discussing the long history of the debates surrounding Piaget and the theory of set, spanning several decades of the past century, is beyond the scope of this paper. However, it is worth noting that the research on the fixed set illusions is still ongoing, and scholars, to Piaget's credit, often refer to it as the "Uznadze Effect." In recent years, the scientific focus has shifted strikingly toward refining methods to study the set and perception illusions in general, providing researchers with more opportunities to conduct these experiments using computer-based and more precise technological means, which was a necessary step, given that controlling time, objects, sizes and other external variables is crucial in these experiments.

An interesting attempt at measuring the "Uznadze Effect" was performed by Saint Petersburg scholars. In their experiment, they used a method well-tested at the Georgian Psychological School, that is, the measurement of the set illusion in the process of sensory-motor activity. However, the method was implemented using a computer. After the fixation of the Müller-Lyer and Ponzo illusions in the set trial, participants in the critical trial were asked to draw equal lines using a touchscreen. During the presentation of one of the versions of a geometrical-optic illusion, a weak illusion occurred. As in classic experiments, the illusion was measured by the length difference (in millimeters) relative to a benchmark. The authors argue that these effects can be applied in sports psychology. Several studies suggest that athletes are better at aiming at a target if the circle at which they are aiming is perceived as smaller than it actually is; thus, this effect is easy to achieve using the visual illusions (by drawing an additional circle, for example – the phenomenon known as the concentric circles illusion) (Lyakhovetskii & Karpinskaia, 2017).

The interest in searching for physiological correlates of the set illusions has not slowed down either. Professor Guivi Kiria led the studies at Tbilisi State University's experimental laboratory. The original device designed by him allowed for accounting for the perception constancy phenomenon and, by varying the distance of the set objects, created the conditions where a participant's set was fixated on either the objects' retinal differences (when consciously perceiving them as equal) or objects with phenomenologically different sizes (when the retinal images were equal) or on

both levels – with both physiological and phenomenological differences occurring. It became possible to experimentally compare the specifics of the set fixated on only sensory, phenomenological non-equality with those of the set fixated on the classic perceptual non-inequality in terms of robustness, the dynamics of the set extinguishment phases, and the type of the set exhibited. Statistical analysis of the data revealed that the set formed during the retinal non-equality is far more stable and involves more contrasting illusions than the set formed during the phenomenologically experienced non-equality. The author concludes,

> […] that the mechanisms and formal-dynamic characteristics of the set fixated through retinal non-equality of objects and the set formed through the classic, Uznadze-style procedure have more in common than the set fixated through phenomenologically non-equal objects.

The findings support the idea about the pivotal role of the retinal factor in generating the fixed set illusion (Robakidze, 2009). Interestingly, Piaget mentioned this issue in his paper, writing: "We assume that the correction of perception occurs in the secondary centers, but we are not sure whether it is produced as a result of the primary and secondary centers influencing each other." As this analysis shows, Piaget touches upon the question of peripheral or central determinants of perception illusions in general. However, he also adds that studying this question experimentally would be very difficult (Piaget & Lambercier, 1944).

It should be noted that the experimental method of studying the fixed set known as the "Uznadze Effect" remains popular among researchers of cognitive processes. Today's technological means makes it easier to plan an experiment in a more accurate manner, and, while Piaget considered studying the questions of peripheral or central determinants of perception illusions as an insurmountable challenge, the interest of contemporary scholars in perception illusions is inspired precisely by this topic. A recent study (Ucceli, Pisu, Riggio, & Bruno, 2019) by Italian authors is one such example. The experiment was focused on set phenomena in the haptic domain, in which participants were visually presented with figures and were asked to evaluate these objects through the movement of their fingers (by bending the index finger and thumb as if they were trying to grasp an object). The experiment revealed a set phenomenon similar to that showed in Uznadze's intermodal irradiation experiments. The authors note that the findings are interesting in that the set formed in one

modality also manifests in another modality (specifically, in the haptic domain). The authors use their findings as empirical evidence against the two-components theory of visual information processing, which posits that there are two visual systems, ventral and dorsal, where the former is responsible for visual content, identification and recognition, while the latter transforms the visual information for sensory-motoric activity. Building on their experiments, the authors conclude that both systems use "the same global contextual information" and tend to regard perception illusions as determined by a single central factor.

At the same research center, in the neuroscience department of the University of Parma, Italy, scholars conducted experiments (Bruno, Garofolo, Daneyko, & Riggio, 2018) on set generalization using the three-dimensional figures exclusively. The shape, color, brightness and the angle of rotation were the independent variables of the study. The results supported the findings on the generalization phenomenon demonstrated in Uznadze's and Piaget's studies. The authors explain this phenomenon through the generalization of inter-relations: the number of contrasting illusions decreases with a decrease in similarities between the figures in the set-trials and critical trials, as in classic set experiments. In these experiments, a change in the intensity of color and brightness also contributed to the reduction of contrasting illusions.

The search for physiological correlates of the set phenomenon has been an important question not only for psychologists but also for neurophysiologists. Both at the Georgian Psychological School (Bzhalava, 1961) and beyond Georgia, scholars remain interested in the practical application of the set phenomenon in medicine for addressing diagnostic problems. Experiments by Tibor Magos, a researcher at Hungary's National Institute of Neural and Mental Diseases, revealed a negative correlation between the firmness of the set and MAO (Monoamine Oxidase, an enzyme of neural tissue that affects the inactivation of neurotransmitters) activation. It is known that the activation of MAO influences the operation of visual cortex – a fact that was supported by the firmness of the set in the visual domain. Interestingly, the author replicated exactly the procedure used in Uznadze's classic experiments, obtaining the results consistent with those demonstrated by Uznadze in his classic experiments on the extinguishment phases and types of contrasting illusions. Regression analysis also showed that MAO activation predicts the set firmness by 13%

($F(1, 28) = 4.258$, $p < .05$, $R^2 = 0.13$). It also notable that MAO disfunction is associated, to some extent, with mental disorders such as schizophrenia, depression, and others. Experiments on the extinguishment of Uznadze's set illusions and the diagnostics of the type and firmness of the set extinguishment are considered a useful, non-invasive method for biological studies on individuals in this fied (Magos, 2002).

It is important that the findings of the experimental studies by Uznadze and Piaget, two eminent scholars of the 20th century, coincide. Although statistical methods were not used to test hypotheses at that time, the quantitative data obtained in the experiments led both scientists to similar conclusions, while later these conclusions have been supported by contemporary scholars, who used more advanced methods of inferential statistics. Following the publication of Piaget's work, experiments on the fixed set have been known as the "Uznadze's Effect" outside Georgia, and research on it continues. However, sadly, a considerable portion of the works by Uznadze and his colleagues is not available to the international community, with scholars conducting fixed set studies and supporting the 1930's–1950's research findings of the Georgian scholars without being familiar with a large body of their work.

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