Chapter 6
Development of Sensory Images

Outline of Lecture 6

In this lecture, Galperin presents a case study of the development of *sensory images* in learners by tasking them with the analysis of medieval Armenian churches. Both target and control groups participated in the study. In the control group, the students were presented with photographs of typical examples of medieval Armenian architecture. The students had to compare and contrast the photographs to identify the characteristic features of Armenian churches and outline the differences and similarities between Armenian and other churches. In the target group, the phases of the development of mental actions were applied. The learners were introduced to the functions of Armenian churches: (i) temples of religion, (ii) places for public meetings, and (iii) fortresses to protect the city's inhabitants from enemy attacks. The construction of the churches and the building materials used were also explained to the students. They were also introduced to the historical circumstances of the construction of Armenian churches. In analysing this information, the students identified the characteristic features of medieval Armenian churches. When the students had identified the characteristic features of Armenian churches, these features were presented to them on the orienting cards in a distinct order. The learners analysed the images of the churches by using the list of characteristics and then concluded whether the church was Armenian or not.

At the end of the learning process, the students in both the target and control groups were able to identify Armenian churches. However, in the control group, the students' ability to recognise Armenian churches was unstable: the students were unsure about their analysis, and they could not justify or explain their answers. A different situation was observed in the target group: the students could enhance and explain their answers, which they expressed with confidence. Galperin concludes that when they are exposed to spontaneous comparing and contrasting, learners develop conceptual understanding; however, the process of learning remains unstructured and invisible to them. Learners in the control group could identify the characteristics

© The Author(s) 2021

I. Engeness, *P.Y. Galperin's Development of Human Mental Activity*,
Cultural Psychology of Education 14,
https://doi.org/10.1007/978-3-030-64022-4_6

of the target concept; however, they demonstrated uncertainty in their choices. In addition, the learners were unable to justify and explain their answers, and they did not develop an understanding of the learning process.

Galperin provides another case study of learning to recognise different objects, which was conducted by A. Podolskiy, N. Nechaev, and G. Lerner. A target group and a control group participated in the experiment. In the control group, the participants were exposed to traditional teaching, and in the target group, the participants followed the phases of the development of mental actions. The outcome of the experiment was that an unexpectedly fast speed of recognition of the objects was achieved in the target group, and the participants were insensitive to any interferences or changes in the experimental conditions. In addition, the participants in the target group required considerably less time to achieve the required speed of object recognition than those in the control group did.

Finally, based on the results of these two case studies, Galperin discusses a method of psychological research. He argues that a system of psychological conditions should be created to develop actions with the required properties. In the absence of such a system, the development of the desired phenomenon cannot be ensured. Galperin points out *that human mental activity* has material grounds and originates in a real external process. The transfer of the external process to the mental plane of the learner is also a real process that can be traced. If we do not ensure the successful transfer of the activity from the external to the internal plane, a psychological action with the desired properties cannot be developed in learners.

Lecture 6

Previously, I discussed the process of the development of concepts, because this process is, to some extent, algorithmic and fairly simple to explain. Today, I will discuss the development of perception images, or sensory images. In order to trace the development of sensory images, we have to engage with objects that are quite unusual. This is because we have developed sensory images of a great variety of objects and to develop a new sensory image, we have to engage with an object that we have not engaged with previously.

In the experiment on the development of new sensory images conducted by our researchers, medieval Armenian churches were chosen as a research topic, which were unfamiliar to most Russian students. These churches were presented to the students as large pictures, so that they could review these buildings in small detail. First, the students examined the pictures of the churches; however, they could not identify any of the buildings' characteristics. This was because the learners had not developed an image of medieval Armenian churches. We (the team of researchers) took on the task of assisting the students in developing a generalised image of Armenian churches in two ways, by using a target and a control group of students.

The students in the control group were presented with photographs of typical buildings of medieval Armenian architecture. The teacher introduced these buildings with the aim of students developing their sensory image of typical Armenian churches, and confidently recognising these churches, among others. The students were presented with pictures of Armenian and other churches, and had to compare, contrast and identify the characteristics of the Armenian churches, and outline the similarities and differences between these and the other churches.

We started our experiment by presenting the students with the pictures of different Armenian churches. Then, among these pictures and in a certain order, the students were presented with very similar but still different pictures of other churches. These were medieval Georgian and Russian churches. In fact, the students were supposed to compare the Armenian, Georgian and Russian churches of the same medieval period (some of these churches were very similar). In addition, pictures of other churches that were very different from Armenian ones, were also presented to the students. These were, for example, West Gothic churches and buildings of Muslim architecture, specifically mosques of different types. As I have mentioned previously, first, the students in the control group were presented with several pictures of typical Armenian churches and asked to carefully examine these churches. Then, the students were presented with the pictures of other churches and told to examine the images, concluding if the churches were Armenian or not. The experiment facilitator approved or disapproved the students' answers by saying, "That's right, this is an Armenian church", or, "No, this is not an Armenian church". Such a procedure continued until the participants were able to identify Armenian churches confidently and without any mistakes.

In the target group, we used the method of the phases of the development of mental actions and the learning process was totally different. First, the learners were introduced to the purposes of Armenian churches: they were temples of religion and, therefore, expressed a religious idea. Second, the Armenian churches were places for public meetings and third, were used as fortresses, where people could hide from enemy attacks. Armenian churches were built to serve these three purposes and as such they had to fulfil certain criteria. The construction process of the churches and the building materials used were also explained to the students and they were introduced to the historical circumstances of the construction process of Armenian churches.

By analysing this information, the students identified the characteristics of medieval Armenian churches. On the one hand, these characteristics were an expression of ideology and on the other, the churches were also used as fortresses to protect the city inhabitants. The ideology of that time was embodied not only in external forms, but also in how the churches were built. Both Russian and Armenian churches were built with the contours of the building erected in the shape of a cross. The proportions of typical Armenian churches are also worth mentioning, as medieval Armenian churches are wider and higher than Russian churches, specifically in the part called the drum, which is located under the roof. In Armenian churches, the drum is particularly wide and the roof therefore low. The windows and doors of Armenian churches are also a very specific shape: The churches were used as fortresses to

protect their inhabitants, so the windows are narrow and high. The doors were also made as narrow as possible, so that enemies could not break through. The construction material used to build Armenian churches was also specific—this is the famous Armenian tuff. This is a magnificent building material, durable but easily shaped. The churches were built from large stones, carefully processed to fit precisely to each other. These were not just boulders found in Western Europe, which were used to build walls and gaps between the stones and filled with mortar. In the Armenian churches, the stones fit well together, because they were carefully shaped for this purpose. The final characteristic of the Armenian churches is minimal décor. Sometimes ornaments are used, but they are not dominant. Although there were some differences among the churches, in general, Armenian medieval churches have less décor than, for example, Georgian or Russian churches. Once the students identified the characteristics of Armenian churches, the characteristic features were presented to the learners on the card in a distinctive order. The learners were to analyse the images of the churches by using the list of characteristics, and to conclude if the church was Armenian or not.

In the control group, the research team and the teacher did not interfere in the learning process; the learners performed the analysis of the church images independently. The teacher only approved or disapproved the students' answers. In the target group, the learning activity was carefully designed by the research team in collaboration with the teacher: the learners analysed the images of the churches according to the list of characteristics presented on the card (materialised action). When the learners transferred to the out-loud speech phase (communicated thinking), the card was removed and the learners analysed the churches against the characteristics of the Armenian churches in a distinctive order: to start, against the first characteristic feature, then against the second, against the third and so on. In the dialogical thinking phase the teacher only said the number of the characteristic (not naming it) to the students and the learners analysed if it was present in the church. In the last phase—acting mentally—the teacher did not interfere with the learning process and the learners could analyse the churches presented on the pictures independently.

What were the outcomes of the learning processes in the target and control groups? As it were, we achieved quite similar results in both groups—the students were able to identify Armenian churches. However, in the control group (where the students were exposed to traditional learning), the students' ability to recognise Armenian churches was very unstable. In a traditional approach, the learning process remains hidden and invisible for the students and, therefore, it is sensitive to various factors. The students in the control group could perform the analysis and achieve the correct answer, but they were not completely sure about their answers. For instance, if the teacher looked at them in a puzzled way, the learners became hesitant about their answers. They turned to the images of the churches again, looking, thinking and resonating; in short, they were very unsure about their analysis and answers. In addition, the students in the control group could not explain or justify their answers. When asked, they also could not draw a typical Armenian church, even schematically. Although they could draw the church they analysed, the students were totally confused when asked to independently draw a typical Armenian church.

Different results were achieved in the target group, where the students were exposed to the phases of the development of mental actions. The students performed their analysis according to the list of characteristics of Armenian churches. Even when the teacher expressed doubt in the students' answers, they could resonate and explain their answers: "This feature is present and that feature is present, therefore, the church is Armenian." To summarise, the students could argue and explain their choice and we believe they could do so, because they had been exposed to a different learning process. When the learners were asked to draw a typical Armenian medieval church, the quality of these drawings was of course different. Conceptually, however, these drawings were correct: the students could draw a simple image of a typical Armenian church. This provided evidence of the students' ability to create a generalised image of an Armenian church, which was very encouraging.

This experiment clearly showed the following. First, the development of concepts with students can be achieved in the learning process; yet, the learning process can have a different structure. It can either follow the phases of the development of mental actions or it can be based on students' spontaneous comparing and contrasting of different objects that belong to the same or different concepts. When exposed to spontaneous comparing and contrasting, the students develop their conceptual understanding; still, the whole learning process is unstructured, and therefore remains invisible to the students. The learning process happens slowly and although the students are able to identify the characteristics of the target concept, the learning process as such remains unconscious.[1] The learners are able to identify some characteristic features but they cannot identify whether these belong to the target concept. The learners use the identified characteristics in their analysis, but still do not develop their understanding of whether these characteristics belong to the target concept or not. Therefore, the learners are not able to explain their answers, and do not develop their understanding of the learning process.

Now, I would like to present recent experiments conducted by A. Podolskiy, N. Nechaev and G. Lerner. These experiments examined the participants' ability to recognise different objects. Such an ability is particularly important for different kind of controllers and operators of machinery. In the experiment, the objects were represented as shaded cells in 4 x 4 matrices (Fig. 6.1). The task was to identify the shaded cells within 0.6 s, which is a very short time for such an operation. This meant that within 0.6 s a participant had to scan all the cells in the matrices, to identify if any cells were shaded and their position in the matrices. It was suggested that a participant should start by examining the cells in the matrices in a clockwise direction. The experiment was conducted in two ways: through traditional teaching and by following the phases of the development of mental actions.

In the experiment using traditional teaching, a participant was presented a matrix, shown examples of shaded cells and given the explanation that other cells (not shaded) might contain some dots; however, the position of these cells should not be identified.

[1] Galperin defines consciousness of an action as a person's ability to give a verbal report of the action (Lecture 2).

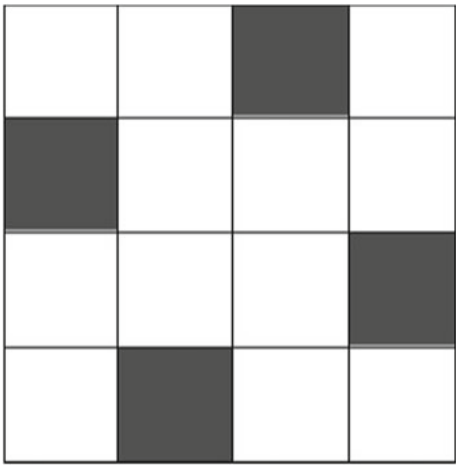

Fig. 6.1 Shaded cells in the 4 × 4 matrix

Then, the participant was presented with several matrices to identify the position of the shaded cells and the time to complete the operation was recorded. On average, the participants had to repeat the operation of identifying the position of the shaded cells 5,000 times to finish the task within the required time. Some people achieved the required time having completed 3,000 operations, while some people had to complete even 7,000 operations. When the required time was achieved by the participant, the experiment stopped.

In the target group, where the phases of the development of mental actions were used, a participant was presented with the same matrices and he or she had to complete the same task: identify the position of the shaded cells. This time, though, one additional element was introduced: the rows in the matrices were labelled with the letters a, b, c and d and the columns were labelled with the numbers 1, 2, 3 and 4. Therefore, each cell had coordinates. The participant had to examine the matrices, recognise the shaded cells, identify the coordinates of the shaded cells and announce them out loud. In addition, the participant had to say out loud whether the cell was shaded or not. At the same time, the materialised action phase was introduced, with the participant given a pen to examine the cells in a clockwise direction by pointing at them one by one, and saying out loud if the cell was shaded or not. The participant used the pen for the whole experiment, and removed the pen from the matrix only when all cells had been examined. It seemed to be a very easy task, with unnecessary details imposed for a grown-up participant, but we achieved quite unexpected results. First, it turned out that to achieve the required speed of recognising the shaded cells, a participant did not need to complete 5,000 operations, as in the control group exposed to traditional learning, but 220–250 operations, which was approximately 20 times less! Second, in the control group the speed of recognition of the shaded cells was very unstable: there were variations in the recognition time for different participants. Third, in the control group, the recognition process was very much sensitive to the slightest changes in experiment conditions. The change of even one factor increased

recognition time by 25%, and the change of two factors by 48%. The change of three factors confused the participants so much that their behaviour looked irrational: the participants were completely lost, and did not know how to approach the task. As a result, we had to stop the experiment.

In the target group that followed the phases of the development of mental actions, an unexpected speed of recognition of the shaded cells was achieved, despite very slow action performance in the initial (material) phase. Such a slow process may seem irrational, but it is important to perform an action correctly from the start, and only then increase performance speed. In our experiment, the participant used a pen to slowly examine all cells in the matrix; this process got faster and faster, though, and by the end the required speed was achieved. Most importantly, the learning process in the target group was insensitive to any interferences or changes in the experiment conditions and the participants stayed focused on the task.

The results of this experiment, in fact, puzzled the researchers, and prompted them to find an explanation for such results. It was decided to track the eye movements in both groups (control and target). This could be done in two ways: by placing a small but noticeable object on the eyeball, or by recording the electrical impulses from the eye muscles that are produced when an eyeball moves. By using these two methods, the researchers attempted to find out what the eyes did while a participant was identifying shaded cells in the matrices.

The results of this experiment in the target and control groups were quite interesting. It turned out that the participants in both groups, when asked how they identified the shaded cells in the matrices, reported a similar process: they examined the matrices to identify the shaded cells. However, their eye movement patterns were different. In the control group, the participants' eyes made movements similar to their movements in everyday situations. Their eyes did not stay focused only on the target object (shaded cells), but made oscillatory movements around the target cell, examining surrounding cells. These movements were unnecessary and time-consuming. In addition, the participants' eyes often made return movements, though the learners were not always aware of these movements. Finally, it turned out that even after the participant had made up his/her mind and announced if a cell was shaded or not, his/her eyes continued uncontrollably to make movements, as if looking for evidence of the announced answer. These additional movements were small, but the majority of participants performed such movements. Such chaotic looking back, sensitivity to any interferences and changes in the experiment conditions made the process difficult and time-consuming. The participants' eyes made many unnecessary movements that required additional time and the whole process was disorganised and chaotic.

In the target group, the learners followed the phases of the development of mental actions and their eyes moved in the shortest, straight trajectory: from one cell to another. The participants' eyes also followed the tip of the pen and did not make any unnecessary additional movements. The participants' eyes were indeed going through the phases of training: material action first, and then out-loud speech (communicative thinking). The eyes were learning to perform new movements, not the way that they move in everyday situations, but the movements that were required by the task.

The ability to examine something visually is developed in the first days of our lives and we receive up to 85% of information from the outside world through visual perception. We develop this ability spontaneously in everyday interactions; however, when we need to perform a visual examination in an effective way, we have to retrain and in fact change the whole structure of this activity. Retraining is always more difficult than the initial training, as it requires a learner to return to the material form of the activity, because otherwise we cannot unfold the activity for the learner so that they are able to trace it. If a person follows the tip of a pen with his/her eyes, and moves the pen along the shortest trajectory, then the eyes follow the most beneficial and economical movement of the pen.

The results of this experiment may outline and give evidence to a new approach to studying mental processes. I have already touched upon a method of psychological research in Lecture 4. I would like to re-emphasise that we need to find a particular method to study psychological processes, but what are psychological processes? Psychological processes comprise the system of conditions that ensures the development and performance of actions, both external and internal. This system of conditions should be created in advance by psychologists. However, traditional education does not use such a system. We believe that the system of conditions that ensures action development and performance may be used as a method to develop psychological phenomena (conceptual understanding, action, etc.), with the required properties. If we do not create such a system, we cannot ensure the development of the desired phenomenon. If the system you have created is complete, then the learner develops the desired action and his/her conceptual understanding. If this does not happen, it means that something is missing in the system you have created (and not that the person is lacking certain abilities).

An idealistic understanding of a mental activity as a spiritual act that a person acquires from his/her birth, and which does not undergo any changes during a person's life, is still quite common. In fact, this spiritual act is nothing but a real action with tools transferred to the learner's ideal plane. We should understand clearly that human mental activity has material grounds and originates as a real external process. The transfer of this process to the learner's internal mental plane is also a real process that can be traced. If we do not ensure the successful transfer of the activity from the learner's external to internal plane, we cannot develop a psychological action with the desired properties.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.