

E.IU. VOSKRESENSKAIA

## **The Patterns and Range of Manifestation of the Generation Effect**

*Traditionally the patterns of manifestation of the generation effect (which normally is understood to mean the higher level of memorization of elements that test subjects create (generate) themselves compared with what is simply shown them) are studied when test subjects perform mnemonic tasks. This article explores the generation effect as a result of the operation of the mechanisms of consciousness that determine the performance of all cognitive tasks. The hypothesis that was tested was that the generation effect may manifest itself when test subjects perform a task of perception and thought. It was discovered that the generation of stimuli in advance promotes faster identification (when presented from the subthreshold to the suprathreshold level) and a more accurate evaluation of them, and speeds up the solving of anagrams made up from them. The study of mnemonic activity found a manifestation of the generation effect when test subjects worked with stimuli that could not be either memorized or forgotten—elements of a limited set.*

Usually the generation effect is defined as a psychological phenomenon in which test subjects memorize better what they create (generate) themselves compared with what is simply shown them (see, e.g., Mulligan, 2004). The manifestation of the effect is quite consistent and is observed when test subjects

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perform various mnemonic tasks. When working with words, texts, and diagrams under conditions of purposeful and involuntary memorization, test subjects are better at recalling material that they have thought up themselves.

The tradition of studying the phenomenon as a mnemonic pattern stems in part from the history of its discovery. In effect, the phenomenon was discovered twice.

The generation effect acquired its name and wide recognition in 1978, when Norman Slamecka and Peter Graf (cited in Begg and Snider, 1987) took note of an interesting peculiarity: it turned out that elements that test subjects independently generated on the basis of information presented in part were memorized far better than elements presented in full.

A similar phenomenon, however, had been detected by psychologists earlier. A Russian psychologist, A.A. Smirnov, can probably be considered the original discoverer of the generation effect. In his study, conducted back in 1945, test subjects were shown several phrases, which were based on some rule that could be determined by comparing the phrases. The test subjects' task was to find this rule and make up a new pair of phrases based on it. The next day the test subjects were unexpectedly asked to reproduce the memorized sentences: it turned out that the phrases the subjects themselves had made up were reproduced by them three times better than the phrases on which the rule was based (Smirnov, 1945).

As we can see, in both experiments the level of stimulus memorization was tested. This type of study set the tone for subsequent work in this field. All subsequent research, in effect, was conducted for the purpose of identifying the reasons and conditions for test subjects' higher level of memorization of stimuli that they had previously generated themselves.

But is this interpretation of the effect's boundaries limited?

Since the time the phenomenon was discovered, the manifestation of similar effects has been found in many fields of psychology, both by scientists directly investigating the generation effect and by specialists in allied fields. Moreover, it has now been shown that test subjects' use of material that they generated themselves influences the performance of various types of cognitive tasks. The generation of stimuli not only results in more efficient reproduction and recognition of them but also changes the subjects' evaluation of these stimuli (such stimuli seem "better," subjects are more confident about them), and sometimes even helps to restore speech.

For example, in a study by Thomas Hyde and James Jenkins (cited in Anderson, 2002) test subjects were shown word groups at a rate of three seconds per word. Participants in the control group were asked to check whether each of the words had the letter "e" or "g," while the test subjects in the experimental group were asked to rate the pleasantness of the words. The results of the study

showed that the participants in the experimental group recall almost twice as many words as the subjects of the control group. For all practical purposes, rating the words required more profound processing of the stimuli, while the letter search was an almost automatic process that did not require reorganization of the words.

In clinical psychology it was discovered that persons with aphasia may no longer experience difficulty in naming an object shown in a picture or in reading its name if that name or the object itself was written or drawn by their own hand a few days ago (cited in Bzhalava, 1966).

In social psychology, C.W. Huntley (1940) discovered that if test subjects are asked to rate texts that include short stories that they themselves previously wrote, but the test subjects are not aware of this, they rate such compositions significantly higher than the others. If, however, the subjects recognize their compositions, then, as a rule, they lower the ratings (cited in Shibutani, 2002). A study by Martin F. Davies (1997) found that if a task at a generation stage requires test subjects to identify a nonexistent pattern and the test subjects believe they have detected it, then after the “study” ends and the fact that there are no actual patterns is revealed, the subjects remain more confident about the explanations that they made up themselves than about those proposed by the experimenter.

The manifestation of the generation effect during research in such varied fields of psychology would seem to allow us to assume that this phenomenon is a universal mechanism for organizing human psychic activity. Current researchers, however, merely say that the generation effect is observable when test subjects perform mnemonic tasks, narrowing the explanations of the diverse patterns that have been found to a higher level of memorization of generated material. All traditional definitions of the generation effect sound alike. “The generation effect is *better memory* for stimuli that participants themselves have produced than for stimuli that they have been provided in ready-made form” (Geghman and Multhaup, 2004 [retranslated from the Russian]). “Self-generated stimuli *are remembered better* than stimuli that are merely perceived” (Mulligan, 2002 [retranslated from the Russian]). “The generation effect is a phenomenon in which stimuli composed by test subjects using some rule *are remembered better* than stimuli that are merely read” (Smith and Healy, 1998 [retranslated from the Russian]).

This interpretation of the essence of the generation effect reflects the specific nature of the theoretical approaches to the study of the phenomenon. The principal frameworks for explaining the causes of the generation effect—the “effort theory” of Jacoby (1978), the “two-factor theory” of Hirshman and Bjork (1988), and the approach of McDaniel, Waddill, and Einstein (1988)—do not

assume that the effect manifests itself outside the bounds of human mnemonic activity (although, we should note, they do not preclude this possibility).

It is surprising that, even though researchers tend to view the generation effect only as a memory phenomenon, many of them refer to the effect as a side product of other human cognitive activities. But if that is the case, then why does the execution of other operations affect the performance quality only of mnemonic tasks?

For example, Begg and Snider (1987) state that “the generation effect is not determined by the generation process itself but is a result of processes running in parallel,” and surmise that recognition of generated stimuli always requires greater activation of knowledge already in hand, which defines the advantage of the reproduction. In a similar vein, McNamara and Healy (2000) say that the generation of stimuli, more than the reading process, brings about the execution of the operations that make it possible to compare the generated stimulus with information already stored in memory, and can therefore subsequently be retrieved in the test stage. But why is the activation of knowledge and the comparison of the generated stimuli with it associated only with increased efficiency in their reproduction?

One gets the impression that the traditional, historically entrenched approach to the study of the generation effect is making it difficult to transpose and generalize the patterns that have been found.

This article, in line with V.M. Allakhverdov (2000) hypothesizes that all human cognitive activity is defined by a common logic of cognition, so it makes no sense to cite the specific features of performance of a certain class of tasks (e.g., mnemonic). It is important to establish the general principles of cognitive activity.

Actually, the manifestation of the generation effect is viewed as a particular result of a more general pattern of the activities of consciousness, which in turn already determine the work of the memory. According to Allakhverdov, people constantly generate hypotheses regarding the structure of their surroundings, and their consciousness seeks to test and confirm these hypotheses. It is assumed that no object in the outside world can be perceived as it is: what is consciously perceived are our assumptions about these objects rather than the objects themselves. In fact, there is nothing besides hypotheses in consciousness. But only some of the hypotheses find their way into consciousness. These hypotheses are selected for testing out of a multitude of various other assumptions, which are created automatically in the process of apprehending some phenomenon. The more difficult the choice of a hypothesis for testing and the harder it is to put it forth, the more important it is for the consciousness to justify the choice made and to confirm the efficacy of

the hypothesis (after all, this will be evidence that it is working correctly!), and hence to memorize it. This is precisely what accounts for the high level of reproduction and recognition of stimulus material that is observed when stimuli are generated by the test subjects themselves (i.e., when certain hypotheses are chosen from a host of options). If according to the terms of the task the test subjects have to put forth some assumptions on their own (e.g., to guess words, presented with interference, and memorize them) and choose one of them for testing, then the result of this generation lasts for a long time in consciousness. If, however, the material is simply displayed for memorization and, therefore, the solution to the problem is provided to the subject in advance or is not surmised at all (e.g., words are presented for memorization without noise), then the work of the mechanism for choosing a hypothesis is not needed, and hence the solution need not be stored in consciousness, either. This is precisely why studies of the generation effect show a high level of forgetfulness of material in the control group (where the solution is merely displayed to the test subjects).

The assumption, therefore, is that the manifestation of the generation effect is determined by the aftereffect of the choice of hypotheses: the choice of a hypothesis for testing (i.e., for it to make its way into consciousness) promotes its subsequent conscious acquisition (accordingly, hypotheses not chosen for testing most likely will not be consciously acquired).

The aftereffect-of-hypotheses phenomenon itself is not only manifested in the study of mnemonic patterns: researchers managed empirically to record the aftereffect phenomenon when test subjects performed both memorization tasks and tasks of perception, thought, and so forth.

For example, a study by Allakhverdov (1993) showed the manifestation of the aftereffect of choice when test subjects performed a task of memorizing fifteen series of five- to seven-digit numbers. The subjects' task was to reproduce the numbers from each series in random order. Nearly every series was structured so that two or three numbers in it duplicated numbers from the preceding series. It turned out that the frequency of correct reproduction of identical digits in two contiguous trials was significantly greater than the frequency of reproduction of digits that had not been presented before and, accordingly, had not previously been reproduced ( $p < 0.001$ ). The numbers that are reproduced better are those that were reproduced before.

In a study of decision-making patterns in psychophysical tasks, Okoneshnikova (2007) presented visual stimuli (horizontal line segments) to test subjects on a computer for them to discriminate. Altogether 110 pairs of segments were presented; in each of them one of the segments was always constant, while the other, conversely, changed both within the nondiscrimination zone

and outside it (the method of constant stimuli). During the experiment the same pairs were presented several times each. The test subjects' task was to determine as rapidly as possible whether the left stimulus was shorter than, equal to, or longer than the right one. It turned out that, despite the fact that the participants subjectively could not distinguish between the stimuli (the stimuli lay in the subjective nondiscrimination zone), they tended to repeat their previous responses (chi-square,  $p < 0.01$ ). In other words, the same responses were consistently chosen for certain pairs in the process of their perception and evaluation.

A similar pattern emerges when test subjects perform arithmetical tasks. A study by Naumenko (2006) consisted of two stages. In the first stage, test subjects were presented, for no more than five seconds, forty arithmetic examples of the calculation of the cube root of a five- or six-digit number with two choices for responses to each of them (the correct answer and a wrong answer). Test subjects were supposed to choose the correct answer as quickly as possible. In the second stage the procedure was repeated. Test subjects were again asked to solve the same examples, but this time not two but three possible answers were offered for each example (another incorrect answer was added to the two old ones). The results of the experiment confirmed the aftereffect of the choice of hypotheses in the process of performing the tasks: it turned out that the probability of choosing the same correct answer in both stages of the study was substantially higher than if the choice were random ( $p < 0.05$ ).

We should note that such results occur quite often, but are not always analyzed by writers in terms of the manifestation of the laws of aftereffect (if only because the name of these laws was given to them relatively recently and had not previously been included in the conceptual framework of psychologists).

As has already been noted, the manifestation of the generation effect is caused by the aftereffect of the choice of hypotheses. This interpretation of the nature of the origin of the generation effect makes it possible to take a truly different look at the domain of the effect's potential manifestation. Since the manifestation of the generation effect is determined by the mechanism of consciousness, and it in turn does not only control the work of memory, the generation effect must manifest itself when test subjects perform the most diverse experimental tasks, not directly related to mnemonic activity. If the laws of aftereffect manifest themselves when test subjects perform tasks of reproduction, perception, and problem-solving, we should also expect to observe a generation effect when studying these processes.

The purpose of this study is to find new aspects of the generation effect

within the scope of studying the mechanisms of memorization and investigating the boundaries of the manifestation of the generation effect when test subjects perform tasks of perception and thought.

## Experiment 1

*Introduction:* The purpose of the experiment is to detect new patterns of the manifestation of the generation effect when test subjects perform memorization tasks.

A modification of a classic procedure was devised for the experiment. Its distinguishing feature was that the issue of reproducing each of the generated elements did not apply at all: elements of a finite series well known to participants in the experiment (St. Petersburg metro stations) were used as stimulus material. Can the generation effect occur with respect to elements that cannot be forgotten? Which elements will test subjects remember better if they take turns with a partner in naming them? And if either the test subject or his partner makes errors in the generation process, whose errors will the test subject remember better?

*Hypothesis:* The experiment tested several hypotheses at once.

First, the assumption that test subjects remember the very fact that the stimulus was generated was tested. The generation effect is determined by the patterns of the aftereffect of hypothesis choice. The generation of stimuli involves the creation of a multitude of hypotheses and the subsequent choice of only one of them, while the perception of stimuli, conversely, assumes almost no creation of hypotheses. Consequently, it will prove important for consciousness to confirm and remember the result of its own generation. It is therefore assumed that test subjects will remember the fact itself of naming the elements generated by them and will not have a tendency to name them a second time.

On the other hand, the confirmation of hypotheses that have been made is based on the fact that the consciousness seeks to protect even poor (i.e. incorrect) hypotheses from rejection and therefore operates as if it does not notice that they are erroneous. In this case the fact of the generation of stimuli exerts a negative influence and tends to reduce efficiency in working with them. The assumption is that when the test subjects name the stimuli a second time they will not notice the errors they made, although the fact itself of the generation of stimuli initially aided their memorization.

*Participants:* The test subjects were nineteen undergraduates at St. Petersburg State University, along with residents of St. Petersburg.

*Stimulus material and equipment:* The following was used in the experiment: (1) the names of St. Petersburg metro stations (the full alphabet made

up fifty-four stations) and (2) a list of stations printed on a sheet of paper in alphabetical order, where half of the stations were erroneously named several times during the experiment; the second half of the stations were added in a random manner. The entire experiment was recorded on a voice recorder.

*Procedure:* The task in the first stage of the experiment was done in the form of a game. A test subject and his partner (the experimenter) took turns naming stations of the St. Petersburg metro (the alphabet). Participants in the experiment were required not to repeat stations already named (elements of the alphabet) and to name them not in a particular order (e.g., sequentially along lines) but haphazardly. Instructions were presented verbally.

The total number of elements was fifty-four (for transfer stations, only one name was used: any according to choice of the participant in the experiment who first named the station). The experiment ended after the fifty-fourth reproduction, regardless of the number of erroneous repetitions.

In this stage an analysis was done on the number and composition of the erroneous repetitions, that is, the elements that were reproduced during the experiment more than once. For test subjects, two types of erroneous repetitions were highlighted: (1) errors that occurred when test subjects repeated elements that had previously been reproduced by the subjects themselves (hereinafter, “self-repeated errors”); (2) errors that occurred when test subjects repeated elements that had previously been reproduced by their partner. For the partner, the total number and composition of errors were determined.

In the second stage (a week after the first stage), the test subjects who participated in the first stage were shown the list of metro stations in writing. Half of the list consisted of self-repeated errors and errors made by the partner, while elements of the second half (which were named only once) were added in a random manner. All elements of the list were in alphabetical order. The instructions were presented verbally. They informed the test subjects how the list was drawn up and described the task, which was to note the repeat errors and indicate who made them. An analysis was done on the number of correct and incorrect identifications of repeat errors that were made by the test subject and his partner. The test subjects’ work consisted of two aspects: finding the repeat errors and determining who made them. The following series of parameters was defined: (a) test subjects correctly pointed out their errors and recognized them (hereinafter, “correct identification of self-made errors”); (b) test subjects correctly pointed out their errors but attributed them to their partner (hereinafter, “attribution of their own errors to partner”); (c) test subjects did not point out their own errors either as their own errors or as their partner’s errors (hereinafter, “failure to identify self-made errors”); (d) test subjects correctly pointed out their partner errors and recognized that

he made them (hereinafter, “correct identification of partner errors”); (e) test subjects correctly pointed out their partner’s errors but attributed the errors to themselves (hereinafter, “self-attribution of partner errors”); and (f) test subjects did not point out their partner’s errors either as their own errors or as errors by their partner (hereinafter, “failure to identify partner errors”).

*Expected results:* The assumption was that the test subjects would better remember the fact that they generated the elements they named—and therefore repeat them, making repeat errors, less often. The number of self-repeated errors was expected to be substantially less than the number of the partner’s repeat errors.

It was also assumed that the test subjects would notice their own errors less, as manifested by the fact that the share of correctly identified errors by the partner in total repeat errors actually made by him would be significantly greater than the share of correctly identified self-made errors in total errors made by the test subjects.

*Results:* The results of the experiment were consistent with the hypotheses.

It turned out that the test subjects indeed remembered better the fact that they named the elements that they had generated themselves. It was found that the total number of errors made by test subjects repeating their partner (fifty-seven) was indeed far greater than the total number of self-repeated errors made by test subjects (twenty) (Student’s *t*-test for dependent samples,  $p < 0.001$ ).

Results were also obtained indicating that the consciousness seeks to protect its own hypotheses. Test subjects were asked to identify both their partner’s errors and their own errors, that is, including acknowledgment that their own previous hypotheses were false. It turned out that the share of correctly identified self-made errors in the total number of errors actually made by test subjects (34 percent) was substantially less than the share of correctly identified errors by the partner in all errors actually made by him (56.7 percent) ( $p = 0.03$ ). In addition, the number of self-made errors unidentified by test subjects (thirty-seven) was significantly greater than the number of partner errors unidentified by test subjects (fifteen) ( $p = 0.03$ ). These data are indisputable evidence supporting the hypothesis (see Table 1).

*Conclusions:* Thus, it was established that the generation effect manifests itself even in a situation in which the elements themselves fundamentally cannot be either forgotten or recalled, since they are elements of a limited set. The principal condition for it to occur is the possibility of creating one’s own hypotheses and subsequently choosing one of them. It turns out that test subjects better remember the fact of naming the elements they generated themselves, choosing them among many others (compared with elements

Table 1

**Results of Identification by Test Subjects of Repeat Errors According to Who Made Them (%)**

Person who made error in first stage/Result of identification by test subjects in second stage	Correct identification	Attribution	No identification
Test subject	34	16	50
Partner	57	17	26

generated by their partner), and therefore repeat them as elements of errors significantly less often.

If test subjects do make an error by repeating their own elements, that is, those that they generated themselves, they later consciously perceive them (their errors) significantly less often than errors made by their partner. This is how the tendency of the consciousness to confirm its own hypotheses manifests itself.

These results are consistent with the data found by other researchers. For example, it was previously shown that test subjects better remember the fact of the generation of stimuli that they generated themselves (Voss and Vesonder, 1987). Our work, however, found for the first time that this pattern can manifest itself when test subjects work with stimulus material of a fundamentally different type: elements of a limited set that cannot be forgotten.

A study by Daneman and Stainton (1993) indicates that test subjects are able to detect a larger number of errors in essays that they previously wrote themselves. But it is possible that these results are not directly related to the manifestation of the generation effect and are evidence of another pattern. When they made an error, test subjects would choose an incorrect hypothesis about a word spelling. It is highly likely that the unchosen, correct hypothesis was subsequently not chosen again by the test subjects (and therefore they did not consciously perceive it and did not correct the error). In both the first and the second stages of the experiment the test subjects checked word spellings and did not consciously perceive the correct version, even though the conditions of the study assumed this possibility (the test subjects saw the text and could have noticed errors). On the other hand, the performance of the task in the second stage of our experiment differed from the task in the first stage. Test subjects worked with a list of stations of which half were errors that were given in random order. The situation itself in which the study was conducted (unlike Daneman and Stainton's experiment) did not contain information that

participants in the study could have used to evaluate whether some station had been named in the previous stage several times or not. In this sense they could not have repeated a previously made error and again have failed to consciously perceive the correct version. All they could do was recall errors that had been made. By not recognizing their own errors in the second stage, the test subjects not so much failed again to choose the correct version as reaffirmed their previous choice and tried to prove that it was valid.

## Experiment 2

*Introduction:* The purpose of the second experiment was to investigate the possibility that the generation effect occurs when test subjects perform a perceptual task (different from the standard task of reproduction that is used in most studies of the generation effect).

*Hypothesis:* The assumption was that elements first generated by the test subjects would subsequently be perceived more quickly by them.

*Participants:* Thirty-seven people (ages sixteen to fifty) took part in the experiment.

*Stimulus material:* The experiment used thirty words that were made up of six letters and three syllables, began with consonants, and consisted of alternating vowels and consonants. Fifteen of the words were spelled correctly, while fifteen had their first two vowels omitted (they were replaced with blanks, e.g., *m-l-ko* [*moloko*, milk—Trans.]). The words presented in the reading condition (in complete form) and in the generation condition (with missing letters) were listed in random order, but not more than two consecutive words were in the same condition. A personal computer was used to present the stimuli.

*Procedure:* The experiment was conducted in two stages. In the first stage the test subjects were presented a column of thirty words on the computer monitor, half of which were presented in the generation condition (with missing letters) and the second half in the reading condition (in complete form). Participants in the study were instructed to read out in sequence, clearly and loudly, all the words in the list in their complete form.

In the second stage, which followed directly after the first one, all thirty words that the test subjects had read in the first stage were shown in sequence on the computer monitor, one by one, from the subthreshold to the suprathreshold level. This time all of the words were presented in complete form. The stimuli were presented by changing the color of the text—from pale gray to deep black. The test subjects' task was to identify the presented word as quickly as possible and press the "Enter" key. After that the word would disappear, and the test subject would enter the word he saw in a special column.

The time until “Enter” was pressed for each word and the response given by the test subjects was recorded.

*Expected results:* The assumption was that the test subjects would more quickly identify words that they generated in the previous stage, and hence for each test subject the mean time for identifying words presented in the first stage in the generation condition would be shorter than the mean time for identifying words presented in the first stage in the reading condition.

*Results:* Based on the results of the experiment, it turned out that the test subjects indeed more quickly recognized the information that they had generated in the first stage. The mean time for correct identification of such words was 8.7 seconds, while for words presented in the reading condition it was 9 seconds. The difference was statistically significant at a very high level, a  $p < 0.001$  ( $t$ -test for dependent samples). It is important to note that this result was very unexpected. Despite the fact that in the second stage the words were presented to test subjects in complete form, those that had been previously presented in a different form—with missing letters (the generation condition)—rather than in exactly the same form (the reading condition) were identified more quickly!

Furthermore, another result was obtained that had not initially been hypothesized but is more than appropriate to the proposed interpretation of the phenomenon. It turned out that while performing the second-stage task some test subjects made errors and did not see the words that were actually presented to them. There were not many such instances across the sample—a total of nineteen errors were made—but their ratio is extremely interesting. It turned out that a total of five errors were made in words presented in the first stage in the generation condition, while fourteen were made in the reading condition: there were nearly three times fewer of the former than of the latter!

*Conclusions:* Thus, the results of this experiment allow us to state that test subjects indeed identify more quickly and accurately the stimuli that were presented in the first stage in the generation condition.

### **Experiment 3**

*Introduction:* Experiment 3 was conducted in order to test the conclusions based on the results of the previous study (Experiment 2).

Is it possible that the greater number of instances of faster identification of stimuli presented in the first stage in the generation condition derives from the fact that the test subjects remembered the generated words better than those they read (as is predicted from the perspective of the traditional interpretation

of the generation effect) and therefore specifically expected them to appear in the second stage and, consequently, worked with them more rapidly?

To test this hypothesis, an experimental task was devised in which the test subjects' recall or forgetting of the stimulus material used in it could not influence how efficiently it was performed. The test subjects drew line segments of different lengths, which varied within a predefined range. Therefore, if the generation effect was detected when test subjects performed this task, one could definitely state that the manifestation of the phenomenon derives not only from a higher level of recall of generated material but also from its more accurate evaluation and perception.

*Participants:* A total of twenty-two people took part in the experiment, and they were divided into eleven pairs.

*Stimulus material:* The test subjects worked with line segments that were multiples of 2 mm in length and did not exceed 4 cm. Paper cards with dimensions 7.4 cm x 2 cm were used for drawing the segments.

*Procedure:* The experiment consisted of two stages. In the first stage, two test subjects took turns using a ruler to draw line segments that were multiples of 2 mm in length and did not exceed 4 cm. The test subjects were told that there were only twenty different lengths that were multiples of 2 mm in the range between 2 mm and 4 cm and were offered a stack of twenty blank cards. The task of the pair of test subjects was to draw all twenty line segments, that is, to produce every possible length. The task was made more difficult by the fact that the test subjects were also asked to draw the segments as haphazardly as possible, that is, not according to any rule, and not to use any mnemonic devices to recall the sequence of segments already drawn. Each segment was drawn on a separate card. After a test subject drew a segment, he would turn the card over so that the drawing itself was no longer visible. Test subjects were also told to keep silent and not to ask their partner questions about the length of segments he had drawn. If necessary, they could independently measure the last segment drawn by their partner.

The second stage followed directly after the first one. This time each of the test subjects, who were asked to sit a little further from one another, was given ten blank cards, on each of which they drew one line segment and reported its length to the experimenter. The special feature of this stage was the fact that the test subjects used rulers without scale divisions. The lengths of the segments ranged from 1.2 to 3 cm and were multiples of 2 mm. The sequence of segments for both subjects was different, but each of them drew all ten segments in this range, which were presented in random order. The two test subjects drew the segments simultaneously: the experimenter told each subject by turns what length to draw. As in the first stage, as soon as a

segment was drawn, the card containing it was turned over so that the drawing itself was no longer visible.

In effect, the test subjects in the second stage were asked to draw segments of which some had been drawn by them in the first stage and some had been drawn by their partner.

*Expected results:* Since the choice and drawing of a segment in the first stage presupposes more difficult work in constructing hypotheses than for observing the drawing of a segment by the subject's partner, it was expected that in the second stage the test subjects, seeking to protect the choice of the preceding hypothesis, would be more accurate in drawing the segments that they had previously drawn themselves.

*Results:* This assumption was confirmed in the processing of the experiment's results. It turned out that the test subjects were indeed 90 percent more accurate ( $p = 0.03$ , Wilcoxon  $t$ -test) in drawing segments that they had drawn in the previous stage themselves than segments that their partners had drawn in the previous stage.

*Conclusions:* The discovery of this pattern confirms the idea that the generation effect may manifest itself when a task of perception, not only reproduction, is performed. Line segments that were previously drawn by the test subjects themselves are subsequently drawn more accurately.

## Experiment 4

*Introduction:* Analogously to Experiment 2, the purpose of the fourth experiment was to investigate the possibility that the generation effect manifests itself when test subjects perform a task that is also different from a task of simple reproduction—a thinking task.

*Participants:* Twenty-six people (ages sixteen to fifty) took part in the experiment, and it was also conducted in two stages.

*Stimulus material:* In the first stage of the experiment, thirty words consisting of seven letters and three syllables and beginning with consonants were used. Fifteen of the words were written correctly, and fifteen were written with vowels omitted (they were replaced with blanks, e.g., *sv-b-d-* [*svoboda*, freedom—Trans.]). The alternation of words was determined by the same rules as in Experiment 2. In the second stage of the experiment, the test subjects worked with anagrams made up from the words presented in the first stage. A personal computer was used to present the stimuli.

*Procedure:* The experiment was conducted in two stages. In the first stage, the test subjects were presented a column of thirty words on the computer monitor, half of which were presented in the generation condition (with missing letters)

and the second half in the reading condition (in complete form). Participants in the study were instructed to read out in sequence, clearly and loudly, all the words in the list in their complete form.

In the second stage, which followed directly after the first one, anagrams of the thirty words that the test subjects had read in the first stage were presented in sequence, one by one, on the computer monitor. The subjects' task was to solve each anagram as quickly as possible and press the "Enter" key. Then the set of letters would disappear, and the test subject would enter the word he had composed in a special column. If the test subject was unable to compose the word within 100 seconds, the program automatically presented the next set of letters. The time until "Enter" was pressed for each word and the response given by the test subject was recorded.

*Expected results:* The assumption was that the anagrams made up from words presented in the first stage in the generation condition would be solved more rapidly, and therefore the mean solving time for anagrams made up from words presented in the first stage in the generation condition would be shorter than the solving time for anagrams made up from words presented in the first stage in the reading condition for every test subject.

*Results:* Based on an analysis of the results of the experiment, it turned out that they confirmed the initial assumption. The share of total correctly solved anagrams made up from words presented in the first stage in the generation condition out of all anagrams presented in this condition (82 percent) exceeded, at a statistically significant level, the analogous figure for anagrams made up from words presented in the first stage in the reading condition (77 percent),  $p = 0.03$  (Student's  $t$ -test).

*Conclusions:* Thus, the results of this experiment allow us to state that the test subjects indeed solve more quickly and accurately the anagrams that were made up from words presented in the first stage in the generation condition.

## General conclusions

Based on the results of these experiments, it was discovered that:

- the generation effect can be detected when test subjects work even with stimulus material that cannot be either forgotten or recalled: in this case the phenomenon manifests itself in the recall of the fact itself that the test subjects generated the stimuli;
- test subjects tend not to notice errors they have made in the process of generation, and this stems from the orientation of the consciousness toward confirming its own hypotheses;
- test subjects identify both more rapidly and more accurately stimuli

that they have generated in the previous stage, which means that the generation effect manifests itself when test subjects perform a perceptual task. This result is not obvious in terms of conventional logic; after all, it turns out that stimuli presented in complete form are identified more rapidly and accurately if in the first stage they are displayed with omissions (the generation condition) rather than in their complete form (the reading condition);

- the generation effect manifests itself in the performance of perceptual tasks even when the recall or forgetting of the stimulus material used in the experiment cannot influence the quality of task performance. This means that the more efficient performance of a perceptual task in working with previously generated stimuli (compared with those previously read) cannot be reduced to the fact that they are better remembered; and
- test subjects solve both more rapidly and more accurately anagrams that have been made up from words the test subjects have generated in the previous stage, which means that the generation effect manifests itself when test subjects perform a task related to activation of the thought process.

## Summary

The generation effect has a long history of being studied. Its manifestation has been detected when test subjects work with various experimental material in studies conducted in many fields of psychology. The use of Allakhverdov's theory makes it possible to take a new look at the generation effect and the boundaries of its manifestation. In terms of his approach, the generation effect is a result of the operation of the mechanism of consciousness. It is therefore hypothesized that, on the one hand, the study of the generation effect should turn up the psychic patterns that result from the operation of these mechanisms and, on the other, the generation effect itself can manifest itself in a broader range of conditions (at all levels of organization of the psychic related to the operation of the mechanisms of consciousness). The results of the experiments that were conducted support these hypotheses. It turns out that the boundaries of the generation effect are broader than its classical definition: first, it involves not only a higher level of reproduction of stimuli that were previously generated by test subjects but also, at the very least, a higher level of recall of the fact of their generation; and second, we can state with confidence that the previous generation of material subsequently facilitates not only the process of its recall but also both identification and problem-solving (which means that the generation effect is observable when test subjects perform

not only mnemonic tasks but also tasks such as those involving perception and thought). To be sure, we are not saying that because some information was generated the physiological thresholds of its perception change or the thought process in working with it accelerates. Just as any limitations in working with information, any “bonuses” are added only by the logic of the work of the consciousness. Once it has been created, a hypothesis must be confirmed: having generated material in some specific manner, the consciousness seeks to justify its choice and repeats it exactly, operating this time according to an efficient procedure and not spending time on going through the other options. Thus the result is that if it has occasion to work a second time with previously generated information, it does so with particular gusto.

## References

- Allakhverdov, V.M. 1993. *Opyt teoreticheskoi psikhologii (v zhanre nauchnoi revoliutsii)*. St. Petersburg.
- . 2000. *Soznanie kak paradoks. (Eksperimental'naia psikhologika. T. 1)*. St. Petersburg.
- Anderson, J. 2002. *Kognitivnaia psikhologiya*. St. Petersburg.
- Begg, I., and A. Snider. 1987. “The Generation Effect: Evidence for Generalized Inhibition.” *Journal of Experimental Psychology: Learning, Memory, and Cognition*, vol. 13, no. 4 (October), pp. 553–63.
- Bzhalava, I.T. 1966. *Psikhologiya ustanovki i kibernetika*. Moscow.
- Daneman, M., and M. Stainton. 1993. “The Generation Effect in Reading and Proofreading: Is It Easier or Harder to Detect Errors in One’s Own Writing?” *Reading and Writing*, vol. 5, no. 3 (September), pp. 297–313.
- Davies, M.F. “Belief Persistence after Evidential Discrediting: The Impact of Generated versus Provided Explanations on the Likelihood of Discredited Outcomes.” *Journal of Experimental Social Psychology*, vol. 33, no. 6 (November), pp. 561–78.
- Geghman, K.D., and K.S. Multhaup. 2004. “How Generation Affects Source Memory.” *Memory and Cognition*, vol. 32, no. 5 (July), pp. 819–23.
- Hirshman, E., and R.A. Bjork. 1988. “The Generation Effect: Support for a Two-Factor Theory.” *Journal of Experimental Psychology: Learning, Memory, and Cognition*, vol. 14, no. 3 (July), pp. 484–94.
- Huntley, C.W. 1940. “Judgments of Self Based upon Records of Expressive Behavior.” *Abnormal Social Psychology*, vol. 35, pp. 398–427.
- Jacoby, L.L., and U.H. McMaster. 1978. “On Interpreting the Effects of Repetition: Solving a Problem Versus Remembering a Solution.” *Journal of Verbal Learning and Verbal Behavior*, vol. 17, no. 6 (December), pp. 649–67.
- McDaniel, M.A.; P.J. Waddill; and G.O. Einstein. 1988. “A Contextual Account of the Generation Effect: A Three-Factor Theory.” *Journal of Memory and Language*, vol. 27, no. 5 (October), pp. 521–36.
- McNamara, D.S., and A.F.A. Healy. 2000. “Procedural Explanation of the Generation Effect for Simple and Difficult Multiplication Problems and Answers.” *Journal of Memory and Language*, vol. 43, no. 4 (November), pp. 652–79.

- Mulligan, N.W. 2002. "Positive and Negative Generation Effects, Hypermnnesia, and Total Recall Time." *Memory and Cognition*, vol. 30, no. 7 (October), pp. 1044–53.
- . 2004. "Generation and Memory for Contextual Detail." *Journal of Experimental Psychology: Learning, Memory, and Cognition*, vol. 30, no. 4 (July): pp. 838–55.
- Naumenko, O.V. 2006. "Neosoznannyi protsess resheniia arifmeticheskikh i logicheskikh zadach." In *Ekspierimental'naia psikhologiiia poznaniia: kognitivnaia logika soznatel'nogo i bessoznatel'nogo*, pp. 48–62. St. Petersburg.
- Okoneshnikova, N.P. 2007. "Reshenie psikhofizicheskikh zadach v zone nerazlicheniia." In *Psikhologiiia XXI veka: Materialy mezhdunarodnoi mezhvuzovskoi nauchno-prakticheskoi konferentsii studentov, aspirantov i molodykh spetsialistov "Psikhologiiia XXI veka" 19–21 aprelia 2007 goda*, pp. 73–75. St. Petersburg.
- Shibutani, T. *Sotsial'naia psikhologiiia*. Rostov-on-Don.
- Smirnov, A.A. 1945. "O vliianii napravlenosti i kharaktera deiatel'nosti na zapominanie: eksperimental'noe issledovanie." *Trudy Instituta psikhologii AN GSSR, T. 3*, pp. 395–426. Tbilisi.
- Smith, R., and A.F. Healy. 1998. "The Time-Course of the Generation Effect." *Memory and Cognition*, vol. 26, no. 1 (January), pp. 135–42.
- Voss, J.F., and G.T. Vesonder. "Was the Item Recalled and If So By Whom?" *Journal of Memory and Language*, vol. 26, no. 4 (August), pp. 466–79.

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