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Involuntary Remembering of Words in Various Attentional Demands

Theoretical accounts of attention and its role in involuntary remembering are discussed within the frameworks of P.I. Zinchenko and levels of processing by Craik and Lockhart. A levels-of-attention framework is proposed on the grounds of the ideas discussed. In the experimental study participants had to perform orienting tasks with words under four different instructions implying different attentional demands with subsequent recall of words, font colors, and spatial locations. Instructions corresponded to hypothetical levels of attention. The fifth condition including voluntary remembering was also used. Recall and confidence rates were measured. Taken together, these two measures revealed a gradual increment in objective (correct recall) and subjective (confidence-related) memory representations of words with hypothetical levels of attention. Nevertheless, voluntary remembering was found to yield maximum recall and confidence rates.

One of the most significant aspects of P.I. Zinchenko's work in the field of involuntary remembering turned out to be the fact that he demonstrated the elaborative and active nature of this process, in contrast to the mechanical and random quality that early researchers attributed to it. For Zinchenko, involuntary memory is a natural result of cognitive activity that is driven by the content of a cognitive task [5]. Based on this idea, Zinchenko discovered, and provided the interpretation for, a number of impressive memory effects that were later rediscovered and given memorable names in cognitive psychology [6].

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One such striking feature is the depth effect. That is, the more deeply a subject is "immersed" in the meaning of the task-relevant items, the more these items will subsequently be recollected. Zinchenko discovered this effect in the items from a task that involved matching pictures (1) according to a phonetic criterion, and (2) according to a semantic criterion. Based on the results of this experiment, participants recalled several times more items in the second case than in the first one. Similar results were obtained in numerous other tasks—so-called orienting tasks (see [11] for review). In addition, Craik and Tulving showed that the depth effect is manifested not only in involuntary but also in voluntary remembering [14]. The depth effect became one of the principal empirical findings underlying the levels-of-processing (LOP) cognitive approach, first expounded in an article by Craik and Lockhart [13] who regarded their approach as an alternative, on the one hand, to the three-component model of memory [10], and on the other, to theories that view involuntary remembering as random, incidental learning (see [16] for review).

However, the approaches by Zinchenko, on the one hand, and by Craik and Lockhart, on the other, have different theoretical emphases. Central to the LOP theory is the concept of information encoding, which was originally interpreted as a sequence of stages of analysis of incoming information—from shallow sensory to deep semantic analysis—while its later version extended all the way to personal self-reference [12, 13]. In the initial view of Craik and Lockhart, information processing follows a *linear* sequence of stages, or levels (i.e., the product of each preceding level of analysis is transmitted to the next one). Recall efficiency will depend on how deep the material "penetrates" into the level-based structure.[1] For Zinchenko, the activity principle was central and primary, and it underlies explanation of both the depth effect and the other effects he discovered.

Illustrating the fact that the fundamental cause of the effects of involuntary remembering is their activity-driven nature, Zinchenko critically examined the concept of "attention" as a scientific explanation. In his view, pointing out that the subject involuntarily remembers some items because attention is directed at them is not satisfactory. Attention itself, contends Zinchenko, is a concept that should be explained with reference to the category of activity [5].

At the same time, the idea of level-based organization of the performance of a cognitive task has also been developed within the framework of the activity-oriented approach. The issue here, however, is less about levels of processing than about levels of activity [1, 3]. It is customary in the Russian level-oriented tradition to speak of a hierarchy of components of action that is predefined by the semantic structure of the action. In particular, N.A. Bernstein [1] postulated that any complex motor acts are organized through coordination of several evolutionary levels that control various motor components "under the aegis" of one of these levels, which is responsible for the semantic aspect of the action to be performed, that is, its purpose. The semantic level is termed leading level, while all the others, which are coordinated to perform the current action and are responsible for the operational contents of the action, are termed background levels. The most important aspect of the functioning of the level-based system is a clear awareness of the leading level's content while there is faint awareness or unawareness of the background levels' content. In other words, while the action is being carried out the subject knows what he is doing and what he wants to accomplish, but hardly knows how he is doing it. This important statement of the level-oriented approach to activity is also important for interpreting the results of Zinchenko's experiments with involuntary remembering.

We now return, however, to a discussion of the concept of attention, already touched upon above. The fate of this concept with regard to the problem of this article, as in psychology in general, has been quite complicated and dramatic. If we look at the relationship between attention and involuntary remembering under the LOP cognitive model, attention appears in it in its traditional cognitive interpretation. It is no accident that among the sources of the levels-of-processing model, as Craik acknowledges [12], are the experimental data and theoretical views of Treisman, who in the 1960s studied the effects of sensory and semantic characteristics of stimuli on focusing auditory attention and proposed one of the depth-of-processing models. The response of the levels-of-processing theory to the question concerning the relationship between attention and involuntary remembering can be formulated as follows: Attention can be viewed as a quantitative or resource measure of depth of processing. In other words, from the perspective of the LOP theory, the more deeply material is processed, the more attention it requires and, consequently, the more efficiently it will be encoded (possibly because it will be reflected in several specific subsystems of memory at once). From Craik's standpoint, the opposite is also true: the more attentional resources can be allocated to processing of stimuli, the more deeply they can be processed and, consequently, the better they can be recalled. By way of support, data are cited from the dual-task paradigm, which compares the efficiency of activity under conditions of focused and divided attention [12].

I have already mentioned Zinchenko's thesis regarding attention. This concept by itself cannot be used to explain the phenomena of involuntary memory, since it in turn has to be explained through activity [5]. This notion is typical for the entire level- and activity-oriented approach to cognition. For example, in the context of an analysis of the performance of perceptual tasks, Gippenreiter proposed a definition of attention in terms of levels of activity as a phenomenal and productive manifestation of the leading level of organization of activity [3]. This definition contains a heuristic idea that concerns, among other things, an activity-based methodology for studying attention—the idea of consolidating the phenomenal and behavioral aspects of the analysis of the phenomena of attention, and the starting point for this consolidation must be the objective and/or subjective semantic structure of the task.

The same methodological article by Gippenreiter, in my opinion, also maps out interesting directions for resolving the issue of the relationship between attention and involuntary remembering and bringing the relevant lines of inquiry together. We can see these directions in the classification of criteria of attention proposed by Gippenreiter. She defined five such criteria: (1) phenomenal; (2) productive; (3) mnemic; (4) the criterion of external reactions; and (5) the criterion of selectivity [3]. In my view, involuntary memory as it was studied by Zinchenko's school and under the levels-of-processing approach combines a whole host of properties that correspond to criteria of attention. For example, the indicators of recall efficiency directly pertain to the productive and mnemic criteria of attention. Abundant data regarding the influence of the orientation of activity on involuntary remembering, including data obtained by Zinchenko's school, touch on the criterion of selectivity. The traditional research methodology, however, which is based only on measurement of the objective efficiency of remembering, fails, for all practical purposes, to address the phenomenal aspect[2]—the aspect of consciousness, specific internal experiences that characterize the state of attention and, perhaps even more important, the conscious level of reflection of the contents of the current action. Therefore, one direction of developing a methodology for investigating involuntary remembering, in my view, should be, in addition to objective testing of recall or recognition of items, the use of self-report–based indicators of the subjective accuracy of memory output, which characterize the phenomenology of involuntary remembering. In the study presented below, we chose a confidence rate index as such an indicator.

In closing this section, I would like to say a few words about my attempts to apply the heuristic idea of levels of activity (i.e., Bernstein's version of the level-oriented approach) to the processes of attention. I planned and interpreted the experimental study of involuntary remembering that is presented below on the grounds of this idea.

Attempts have been made by various authors to interpret the concept of attention in terms of levels of activity. One such attempt may be found in Gippenreiter [3], whose ideas in this field have already been mentioned. Bernstein's model is directly developed in the work of Velichkovsky (e.g., [2, 18]), who tried to expand the five-level configuration of the structure of motions to a whole cognitive architecture by adding a sixth, metacognitive level to it. Perceptual attention in Velichkovsky's model appears in overt form, as at least two levels of perceptual activity—ambient, or location-based, and focal, or object-based.

In developing the above-mentioned level-based models of activity (e.g. Bernstein [1]) and current concepts on types of attention (e.g., [15]) I defined the main principles of organization and five hypothetical levels in the structure of the attentional system (for more detail, see [9]):

1. The tonic level, related to an interpretation of attention as a functional condition closely associated with motivation and emotions;
2. The level of alerting, which provides a nonspecific preparation for the reception of external information and a reaction to it;
3. The level of orienting, which gives priority to the processing of information from a specific spatial source;
4. The level of object attention is related to the selection of objects and events according to certain perceptual and perhaps semantic criteria; and
5. The level of control, related to control of actions involving conscious perception of complex relationships between objects and events, for example, the fulfillment of complex algorithms (which is necessary, in particular, in many thinking tasks), and the resolution of informational conflicts (e.g., when resisting color-word interference in a Stroop task) [17], and so forth.

I should emphasize again that my interpretation of the level-based organization of attention follows the principles of the levels-of-activity approach. In other words, depending on the requirements of an attentional task, one of the levels should be viewed as a leading one while the others are considered background levels. The conscious perception and remembering of items that the subject encounters while performing such a task, therefore, will depend on the semantic (to use Bernstein's terminology) aspect of the action to be performed.

Rationale

This study deals with the depth effect in attentional tasks. The conceptual design of the study is based on the orienting-task paradigm used in Zinchenko's works (e.g., [5]) and in experimental studies conducted within the levels-of-processing framework (e.g., [14]). However, as a result of the specific hypotheses and specific methodological position involving the need to use categories of phenomenal experience for analysis of the processes of attention and involuntary remembering, the procedure had a number of distinctive features.

First, a special set of orienting tasks was used in the study. To test the hypothesis that the level of attention itself influences remembering, *the level of information encoding was kept relatively constant* and orienting tasks were selected to keep the perceptual level of encoding shallow. Four tasks were devised, each was aimed at one of the above-mentioned hypothetical levels of attention (except the tonic level, for which such a task is hardly possible), and a fifth control task of voluntary remembering, which was compared with the other four conditions. The target stimuli themselves varied according to three characteristics: semantic (different words), color, and spatial. It was assumed that the recall efficiency for these characteristics (attention was not directly focused on any of them) would permit differentiation among leading levels in terms of their specific qualitative character. The main hypothesis, meanwhile, was that, on the whole, *recall efficiency for the items should increase as the leading level progresses from level of alerting to level of control.*

The second special feature of the procedure for the orienting task was the use, in addition to testing remembering, of a rating of the participants' subjective confidence in the accuracy of their memory judgments. This indicator, in my view, embodies elements of two criteria of attention at once. The concept of subjective confidence has many interpretations and is studied in various scientific fields such as sensory psychophysics (e.g., [8, 11]), decision, and in various sections of the psychology of memory (e.g., [4]). Among all of the numerous aspects of confidence examined in these fields, the one that pertains to the criteria of attention, based on Gippenreiter, is most important in the present study. On the one hand, it is a phenomenal criterion: the degree of confidence attests to how subjectively clear, coherent, and credible the perceptual experience was as the task was performed. On the other hand, confidence is an element of the mnemic criterion: it indicates how subjectively durable and accurate the memory resulting from attentional engagement is. As a result, according to my second hypothesis, *at a higher leading level of attention, involving deeper and more detail processing and creative elaboration of "attended" content, confidence in mnemic judgments must also be higher.*

Procedure

Participants

One hundred people (thirty-eight men and sixty-two women, average age nineteen), second-year students in the management and psychology departments of the Higher School of Economics, took part in the study. All participants had normal or corrected-to-normal vision. The subjects were randomly assigned to five groups, which performed an experimental orienting task under various instructions. The subsequent analysis, however, excluded data obtained from eighteen people who had more than a 20 percent error and omitted-response rate in the orienting task (which is evidence of inadequate attention to performing it). In addition, data were excluded for one person who reported after the experiment that while reading the instructions he already guessed that the stimulus material was to be remembered. As a result, data were processed for eighty-one participants.

Apparatus and stimuli

The stimuli were prepared and presented with the graphic design computer program StimMake (created by A.N. Gusev and A.E. Kremlev). The stimuli were presented on a standard VGA monitor at a refresh rate of 85 Hz.

The stimuli were presented on a homogeneous gray field, containing a white fixation cross and two white square boxes in 3 degrees 36 minutes to the right and left from the cross (a side of the square was equal to 4 degrees). A black rhombus that would appear at the fixation point was used as a warning signal for the start of the trial; for the group that performed a spatial attention task, a black arrow pointing right or left was presented instead of a rhombus.

The target stimuli were thirty-two Russian-language nouns, three to six letters long. The words were made equal in terms of frequency of use in speech by using *A Frequency Dictionary of the Russian Language* [Chastotnyi slovar′ russkogo iazyka]. These words were printed in capital letters in arial font, were 1 degree 36 minutes high, and were located on the screen inside either the right-hand or left-hand white box. Sixteen words were printed in white, and sixteen in black.

To give a response, test subjects had to press a button on an LPT-compatible control panel.

Forms prepared in advance were used for subsequent testing of recall.

Procedure

Participants sat at a distance of 60 centimeters from the monitor. One of the five instructions for the orienting task, depending on the group to which the participant had been assigned, appeared on the screen:

1. The first group task was to watch for the appearance of words on the screen. As soon as the participant noticed the appearance of any word, he was to press the key on the control panel immediately. This task was called “Alerting.”
2. In the second group, participants had to respond as quickly as possible

to the word occurrence, and they were also told that they would see an arrow at the fixation point before the word presentation. Arrows indicated the side on which the target would appear with high probability (80 percent). The subjects were specifically advised in the instructions to use this information to respond more quickly. The task was called "Spatial Attention."

3. In the third group, participants had to notice a word and report as quickly as possible whether the word contained at least one letter *O*: if it had an *O,* the subjects were to press the left key on the control panel; if it did not have an *O,* they were to press the right key. This orienting task was called "Letter Search."
4. In the fourth group, participants had to count the number of letters in each word and compare it with a predefined, cyclical algorithm. According to the algorithm, the sequence of presentation of words was to be as follows: a five-letter word, then a four-letter word, a six-letter word, and a three-letter word, and then the cycle would repeat. If the presented word matched the algorithm, the participants had to press the left key on the control panel as quickly as possible; if it did not match, they had to press the right one. The task was called "Algorithm Matching."
5. In the fifth group, which was regarded as the control group, participants were not given an orienting attentional task. Instead, they were asked to remember as many words as they could, as well as information about the font color and the location of the words on the screen (right or left of center). The task was called "Voluntary Remembering."

During the orienting task the participants were exposed to thirty-two trials, one word per trial. A typical trial began with the presentation of a fixation screen—a white cross and two square boxes on a gray background for 500 msec. Then followed the presentation of a warning signal (a black arrow in the Spatial Attention condition or a black rhombus in the other conditions—in all cases in place of the white fixation cross) for 100 msec. Then came an expectancy period of 300 or 700 msec, and then the target stimulus (a word) appeared on the screen for 300 msec. The presentation of the target stimulus was followed by a response interval lasting 1,500 msec. The intertrial interval was 2,000 msec.

As soon as the orienting task was over, a written recall-testing procedure was conducted. For this purpose participants received a form containing three columns: in the first column, participants had to list all words they remembered from the orienting task. In the second and third columns they were to report the color and location of the listed words by a forced choice: "white/black" and "right/left," respectively, with a response of "Do not remember" allowed as well. In fact, the instructions asked participants to use this indeterminate category of responses if they indeed could not remember the characteristic in question, rather than guess at one of the two defined categories. In addition, for each of the three types of responses (word, color, and location) the participants had to rate their degree of subjective confidence by using one of three categories: 50 percent (not at all confident), 75 percent (medium degree of confidence), and 100 percent (absolutely positive). All "Do not remember" responses were assigned a 50 percent confidence rating, reflecting the fact that it was impossible to choose between "white/black" and "right/left," which is technically equivalent to complete doubt.

The principal *independent variable* was the Instructions for the Orienting Task (five levels: Alerting, Spatial Attention, Letter Search, Algorithm Matching, Voluntary Remembering).

The *dependent variables* are two sets of parameters. The first set is related to recall efficiency: (1) the percentage of words recalled; 92) the percentage of words recalled correctly; (3) the relative percentage (i.e., the share of correctly named words) of correct responses on the color; and (4) location of the words. The second set of parameters is related to confidence in the mnemic judgments, that is, the probabilities of choosing the 50, 75, and 100 percent confidence ratings for words, colors, and locations.

Results

The key results of the experiment are presented in Tables 1 and 2 and in Figures 1 and 2.

One-way ANOVA revealed significant differences among the groups in the total percentage of words recalled [$F(4.76) = 23.42$, $p < 0.001$] and the percentage of correctly recalled words [$F(4.76) = 24.51$, $p < 0.001$]. Additional a posteriori tests of the paired differences between the groups showed that this effect stems from the difference between the Alerting and Spatial Attention groups and the Letter Search and Algorithm Matching groups, and between all four of the above groups and the Voluntary Remembering group. Meanwhile, no significant differences were found between the Alerting and Spatial Attention groups or between the Letter Search and Algorithm Matching groups (Figure 1). Accordingly, in terms of the absolute number of elements the average memory span in the first two groups was about three or four correctly recalled elements, and in the second two groups, six or seven. Memory span in the Voluntary Remembering condition averaged eleven or twelve correctly recalled elements.

Table 1

Mean Values for Words, Font Color, and Location Recall Under Different Instructions

	Total words, %	Correctly named words, %	Correctly named colors, relative %	Correctly named locations, relative %
Alerting	14.34	11.76	36.97	46.85
Spatial Attention	13.46	10.82	46.76	41.61
Letter Search	21.09	18.36	36.3	36.87
Algorithm Matching	21.31	19.03	35.88	44.21
Voluntary Remembering	38.28	36.52	57.88	68.69

As Table 1 shows, the relative percentage of correctly recalled colors and locations did not exceed chance level in any group except the Voluntary Remembering group. The latter significantly exceeded this level and only in the number of correctly named word locations [$t(15) = 3.92$, $p < 0.01$].

One-way ANOVA also revealed significant differences for words in the probabilities of confidence rates of 50 percent [$F(4.76) = 2.50$, $p < 0.05$], 75 percent [$F(4.76) = 3.56$, $p < 0.01$] and 100 percent [$F(4.76) = 8.25$, $p < 0.001$]. As Figure 2A shows, when moving from the Alerting condition to the Voluntary Remembering condition in the order described above, the number of confident responses (100 percent) gradually rises while the number of medium-confidence (75 percent) and nonconfident responses (50 percent) declines, although the downward trend is somewhat less pronounced than the increase in confident responses. Furthermore, according to the results of the a posteriori tests, the transition from the Spatial Attention condition to the Algorithm Matching condition shows no significant change in the probabilities of any of the confidence rates. In addition, the only difference between the Algorithm Matching and Voluntary Remembering conditions was in the 100 percent confidence category, but that only reached the trend level.

ANOVA also revealed significant between-group differences in the probabilities of the use of the 100 percent category to rate confidence in the recall of colors [$F(4.76) = 3.86$, $p < 0.01$]. This effect stems from the increase in the percentage of confident responses in the Spatial Attention and Voluntary Remembering groups over the other groups (Figure 2b).

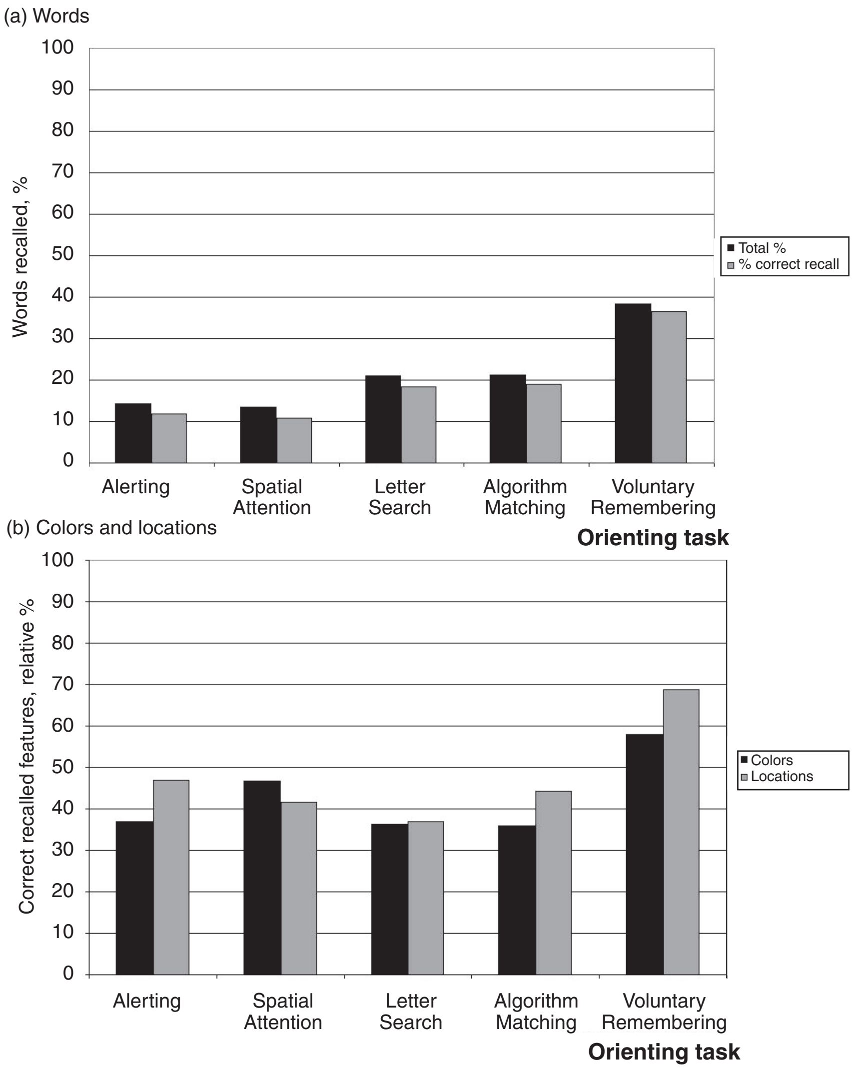
The differences between groups in the parameters of confidence in responses to the location of stimuli turned out not to be significant.

Table 2

Probabilities of Choice of Confidence Categories in Responses as a Function of Instructions (% of total responses)

	Words			Font colors			Locations		
	50%	75%	100%	50%	75%	100%	50%	75%	100%
Alerting	23.92	33.73	42.35	49.65	39.08	11.27	42.61	27.31	30.08
Spatial Attention	6.83	30.32	62.86	32.18	37.94	29.88	26.92	33.83	39.25
Letter Search	8.47	27.47	64.07	40.64	47.15	11.79	45.79	32.62	21.59
Algorithm Matching	6.82	12.08	81.10	45.15	36.67	18.18	48.29	25.79	25.92
Voluntary Remembering	3.82	5.48	90.70	31.49	31.26	37.35	32.43	24.69	42.88

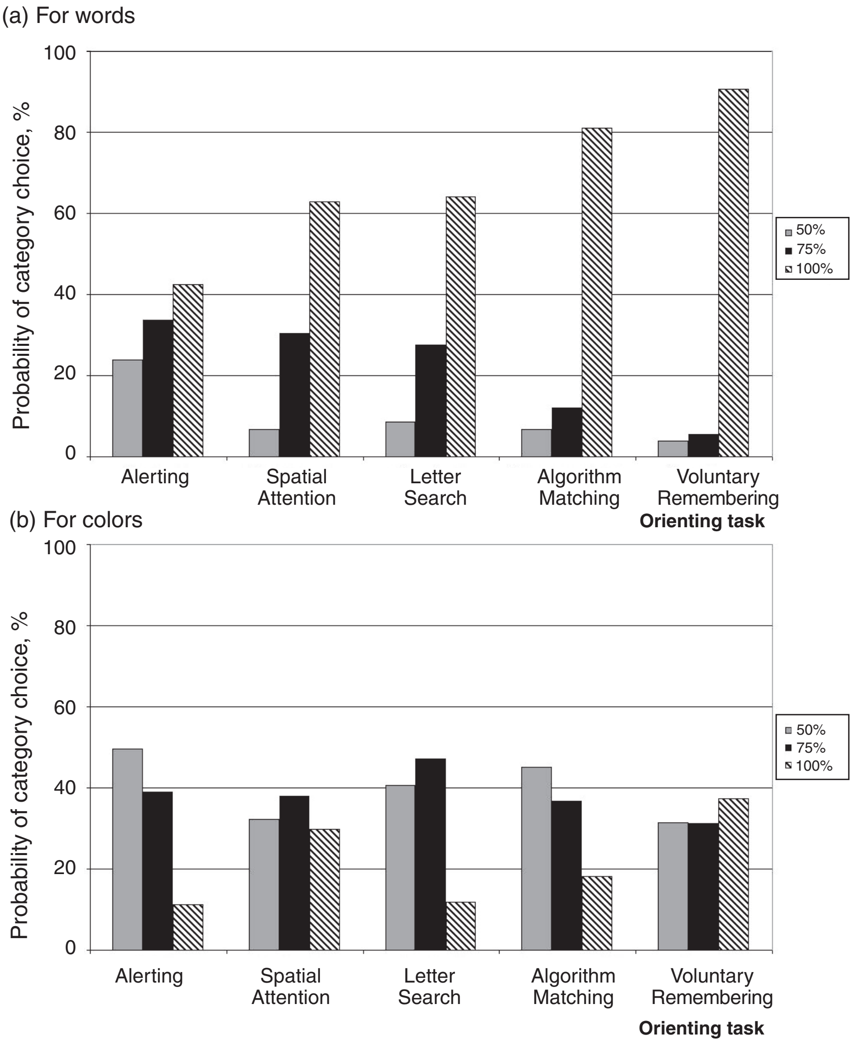
Figure 1. **Effects of Instructions on Recall**



Discussion

As the results show, among the three characteristics used in the experiment to test recall and confidence, almost the only informative one proved to be the semantic characteristic, that is, the words themselves. Color and location are reliably reproduced only with a set toward voluntary remembering. Con-

Figure 2. **Effects of Instructions on Confidence Rating in Mnemic Judgments**



sequently, the testing of hypotheses regarding the specific character of mnemic output under different instructions based on our data proved to be impossible.

Despite the fact that in all four groups that performed the orienting task not related to remembering, the average result for word recall was low—no more than short-term memory span—in the Letter Search and Algorithm Matching groups it proved to be roughly 70 percent higher than in the Alerting and

Spatial Attention groups. This result seems logical from the standpoint of the level-oriented approach. Thus, the levels of object attention and control, which are assumed to play the critical role of leading levels in the Letter Search and Algorithm Matching tasks, are more oriented toward operating with verbal and semantic characteristics than the lower levels of alerting and spatial attention. I should note that in terms of the indicators of word-recall efficiency we observed a differentiation not of the four hypothetical levels but of only two; and this differentiation was much smaller in quantitative terms than was obtained in similar experiments by Zinchenko [5], Craik and Tulving [14], and other authors. This fact is quite logical: In the above studies, the depth effect was achieved by manipulating the target characteristics—from perceptual to semantic—whereas in the present experiment I tried to keep the hypothetical level of processing relatively constant. The fact that the participants in all four experimental groups did not go beyond the short-term memory span suggests that while performing the orienting tasks they did not try to find a semantic connection between the words or use any other strategies not mentioned in the instructions, that is, they remained within the bounds of a relatively shallow level. Consequently, the differences resulted mostly from the specific nature of the demands that the task presented for attention.

Further differentiation of levels of attention became possible on the grounds of the confidence rates. As is clear from the results, a transition from one hypothetical level to another is accompanied by an increase in confident reports and a decrease in nonconfident reports about the words, which on the whole is consistent with the second hypothesis. For example, despite the equal results for recall efficiency in the tasks of alerting and spatial attention, in the latter there is more confidence than in the former. In my view, this is based on the specific functional features of the leading levels activated in the tasks. For instance, the set of the alerting function toward a simple detection of an event and instantaneous reaction leads to a rather rough and not very stable perceptual representation, which is then expressed in a large number of nonconfident mnemic judgments.[3] But when the task incorporates the leading level of spatial attention, then despite the same requirement of simple detection the representations themselves of the target stimuli (and in most cases these stimuli were localized in the places where attention was to be directed according to the instructions) probably turn out to be clearer and more stable, which results in a higher number of confident responses. It is surprising that the same effect manifested itself in the confidence ratings regarding the "color" responses, even though in the spatial task it was expected more for the responses on location. The latter effect, for now, is not explained within the scope of the configuration proposed here.

Another substantial jump in confidence occurs with the move from the hypothetical object level (Letter Search) to the level of control (Algorithm Matching), despite the equal results in word-reproduction efficiency. In terms of content, one can hypothesize many different mechanisms for this effect—for example, a longer process of word analysis or the heightened role of verbalization (neither of these hypotheses precludes an interpretation in terms of attentional levels) in the Algorithm Matching task—but it is impossible to express a preference for any explanation here, since there are not enough data to do so. What is important is that at the level of control, which is higher under my classification and which links attention to thought, the contents of consciousness that form are probably clearer and more stable than at the object level. It is also worth noting that the level of confidence in the Algorithm Matching task is almost the same as in voluntary remembering, although the objective efficiency indicator for the latter is higher.

Summarizing the study, it is necessary to reemphasize the most important results. On the one hand, having activated various leading levels in orienting tasks, we detected differences in word-recall efficiency, which, however, proved insufficient to differentiate among the four levels. But such differentiation did prove possible with the aid of ratings of confidence in the mnemic judgments, which attested to different degrees of subjective clarity, elaboration, and accuracy of the images and traces of the target stimuli. We consider it especially important that the differentiation of levels not only according to the objective criteria of recall efficiency but also the subjective criteria of accuracy, such as confidence in mnemic judgments, is of great significance for future studies of both attention and involuntary remembering.

Notes

1. A later version of the levels-of-processing theory, however, (e.g., [12]) allows that the relationship between levels of information processing can be more flexible than was assumed in the 1970s. I should also note that previously the idea that there is interpenetration of the contents of lower and higher levels of organization of activity was explicitly formulated by Zinchenko's pupil G.K. Sereda in his principle of the "reversible semantic funnel" [7].

2. To be fair, I should note that addressing the phenomenal aspect is more of an exception than the rule for most current attentional studies as well.

3. The quite rough character of the representation is illustrated by the finding that three participants in the Alerting group failed to notice while performing the orienting task that the font color of the words being presented varied.

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