THE PATH TO INSIGHT: DEVELOPING METHODS TO INCREASE THE EFFECTIVENESS OF INSIGHTFUL SOLUTION DETECTION

T.V. SHUMILOV[a], A.V. CHISTOPOLSKAYA[a], I.YU. VLADIMIROV[a,b]

[a] *P.G. Demidov Yaroslavl State University, 14 Sovetskaya Str., Yaroslavl, 150000, Russian Federation*
[b] *Institute of Psychology, Russian Academy of Sciences, 13 build. 1, Yaroslavskaya Str., Moscow, 129366, Russian Federation*

Путь к озарению: разработка обучающего видео и опросника для повышения эффективности детекции инсайтности решения

Т.В. Шумилов[a], А.В. Чистопольская[a], И.Ю. Владимиров[a,b]

[a] *Ярославский государственный университет им. П.Г. Демидова, 150000, Россия, Ярославль, ул. Советская, д. 14*
[b] *ФГБУН «Институт психологии РАН», 129366, Москва, ул. Ярославская, д. 13, к. 1*

Abstract

This paper presents the results of a study on the effectiveness of instructional video as a tool for forming the most comprehensive concept of insightful solutions for a solver; test results of the new scales for evaluating insightful solutions; and finally, the ratio of objective criteria of insightful solutions measured against the formal structure of the problem. We hypothesized that watching an instructional video with a visual image of an insightful solution prior to solving a problem

Резюме

В данной работе представлены результаты исследования эффективности обучающего видеоролика как инструмента для формирования наиболее полного понимания концепции инсайтного решения у решателя; результаты тестирования новых шкал для оценки инсайтности решения; и, наконец, отношение объективных критериев инсайтности решения к формальной структуре задачи. Мы предположили, что предварительный просмотр обучающего видео с визу-

might increase the accuracy of insightful solution detection when compared to a textual definition of insight. We expected that the new scales for assessing insightfulness of a solution will be more accurate than the scales set up by the classic Danek's questionnaire. Evidence from this study shows the effectiveness of the instructional video in forming a comprehensive concept of an insightful solution. A visual and complex image of an insightful solution with a display of its various criteria can improve the accuracy of an insightful solution detection. This study demonstrated that the assessment with the new scales is more consistent with the formal structure of the problem than the assessment made with the Danek's questionnaire. The procedural-resultative and cognitive-affective measurements of the new scales more accurately provide differentiate insightful and non-insightful solutions. At the same time, we have found that the objective criteria of an insightfulness of the solution generally correlate with the formal structure of a problem.

Timofey V. Shumilov — MA student, Department of General Psychology, Faculty of Psychology, P.G. Demidov Yaroslavl State University.
Research Area: cognitive psychology, insight problem solving, insight.
E-mail: shum.timotheo@gmail.com

Alexandra V. Chistopolskaya — Associate Professor, Department of General Psychology, Faculty of Psychology, P.G. Demidov Yaroslavl State University, PhD in Psychology.
Research Area: cognitive psychology, insight problem solving, insight, embodied cognition.
E-mail: chistosasha@mail.ru

Ilya Yu. Vladimirov — Lead Research Fellow, Laboratory of Psychology and Psychophysiology of Creativity, Institute of Psychology of the Russian Academy of

альным изображением инсайтного решения может повысить точность обнаружения данного решения по сравнению с текстовым определением инсайта. Мы ожидали, что новые шкалы оценки инсайтности будут более точными, чем шкалы классического опросника А. Данек. Данные исследования показывают эффективность обучающего видео в формировании понимания концепции инсайтного решения. Наглядное и комплексное изображение инсайтного решения с отображением различных его критериев может повысить точность обнаружения инсайтного решения. Исследование показало, что оценка по новым шкалам более соответствует формальной структуре задачи, чем оценка по опроснику А. Данек. Процессуально-результатное и когнитивно-аффективное измерения новых шкал позволяют более точно дифференцировать инсайтные и неинсайтные решения. В то же время мы обнаружили, что объективные критерии инсайтного решения в целом коррелируют с формальной структурой задачи.

Шумилов Тимофей Владимирович — магистрант, факультет психологии, Ярославский государственный университет им. П.Г. Демидова.
Сфера научных интересов: когнитивная психология, решение инсайтных задач, инсайт.
Контакты: shum.timotheo@gmail.com

Чистопольская Александра Валерьевна — доцент, кафедра общей психологии, Ярославский государственный университет им. П.Г. Демидова, кандидат психологических наук.
Сфера научных интересов: когнитивная психология, решение инсайтных задач, инсайт, воплощенное познание.
Контакты: chistosasha@mail.ru

Владимиров Илья Юрьевич — ведущий научный сотрудник, лаборатория психологии и психофизиологии творчества, Институт психологии Российской академии наук;

Sciences; Associate Professor, Department of General Psychology, Faculty of Psychology, P.G. Demidov Yaroslavl State University, PhD in Psychology, Associate Professor.
Research Area: cognitive science, psychology of thinking and problem solving, insight.
E-mail: kein17@mail.ru

доцент, кафедра общей психологии, Ярославский государственный университет им. П.Г. Демидова, кандидат психологических наук, доцент.
Сфера научных интересов: когнитивная наука, психология мышления и решения задач, инсайт.
Контакты: kein17@mail.ru

An insightful solution is sudden and obvious; it involves a representational change, a drastic shift in emotions, and may include a perceived impasse during the solution process (Bowden et al., 2005). Researchers of the insight phenomenon typically employ designated problems that should produce insight solutions. For an overview of the different types of such problems, including examples and comparisons with non-insight problems, one can refer, among others, to the work of Webb and colleagues (2018).

This approach has its own shortcomings, the greatest being the lack of criteria to assess the degree of insight in each case. For example, in the aforementioned study, Webb and colleagues demonstrated that different types of insight problems activate the affective component of insight with varying intensity (2018). Anagrams and the Remote Associates Test caused the most intense Aha! experiences among solvers compared to classical insight problems. For this latter type of problems, the Aha! experience was not much different from the experience of solving non-insight problems.

Since the structure of the problem is not definitive in this regard, researchers look for other criteria to evaluate insight in specific solutions. The most popular method today uses self-reports based on a set of scales developed by Danek and Wiley (2017).

However, it should be noted that the wording of these scales was subject to change both in the authors' further research (e.g., Ibid.) and in the Russian translation which the authors of this article referred to (e.g., Korovkin et al., 2021; Chistopolskaya et al., 2021).

Various studies use different sets of insight dimensions. Therefore, instead of forming a unitary concept of insight as a complex phenomenon, the solver is presented with a number of separate dimensions. Moreover, a successful solver does not necessarily experience all the dimensions of insight included on the rating scales. The question remains open whether the researchers and the solvers share their understanding of the scales that characterize insightful solutions, i.e., whether the solvers interpret these unambiguously, exactly as the researchers implied. In addition to that, specific shortcomings of subjective self-reporting include the dependence of insight evaluation on the theoretical approach that drives the selection of scales; possibilities for varying interpretations of the scales by the solver; the dominance of affective dimensions over cognitive ones; the necessity to separately evaluate the solution process and its result; the correlation

between insight problem type and the intensity of individual insight experience, as evaluated by the solver.

At the same time, if the problem structure is taken as a definitive criterion of its insightfulness, this criterion ceases to be universal if insightfulness is detected in every individual solution.

To assess the nature of the solution of a specific problem, it seems reasonable to use the solvers' self-reports and the formal structure of the problem not as stand-alone criteria, but in conjunction with the subjective and objective criteria of insights. Moreover, it is advisable to promote among solvers a comprehensive understanding of insight that would not be reduced to separate dimensions and that would be universal.

Bétrancourt and Benetos' (2018) analysis of existing studies proved the superiority of instructional videos over static teaching materials to focus the learners' attention on the relevant aspects of demonstration. The authors specifically discuss animated videos of phenomena that change over time.

This leads one to assume that a video demonstration of the key aspects of an insight solution (that would include an insight solution prototype) could be more effective in forming a generalized concept of an insightful solution in the solver's mind than the conventional textual prompt presented at the start of an experiment.

To remove the abovementioned shortcomings of subjective self-reporting, to avoid the pitfalls of assessing insightfulness based on the formal problem structure only, and to promote a generalized understanding of an insight solution that the solvers and the researchers would share, the authors of this study propose the following steps:

1) The solvers preliminarily familiarize themselves with the concept of *insightful solution* by watching an instructional video that reflects the main aspects of insight solution dynamics.

2) The researchers assess the insightfulness of the solution pattern by tracking changes in the solvers' rating of words presented together with the problem (Danek et al., 2020).

3) The solvers assess the insightfulness of their solutions using our scales that improve on the classical Danek self-reports.

Therefore, this study was carried out with the purpose of assessing whether the proposed procedure would allow for greater precision in detecting insight solutions.

Methods

Instructional video development

An animated video (*https://disk.yandex.ru/i/fa18I58SlGsnvQ*) was created and tested to demonstrate the features of insight and non-insight solutions (Chistopolskaya et al., 2022). The main criteria and stages of insightful solutions were identified in a preliminary study aimed at collecting features of insight as defined by naive participants (Chistopolskaya et al., 2021). This short video presents,

in a narrative form, the stages and features of an insight and non-insight solutions of the same problem by different groups of characters (see Figure 1). The story is based on the invention of Velcro by George de Mestral, who got the idea for Velcro when he used a microscope to look at cockleburs that his dog had caught in its fur during a walk. In this video, two teams (Rabbits and Bears) are trying to fix a broken zipper on a backpack. The Rabbits come up with an insight solution, inventing a completely new way of connecting the sides with Velcro. The Bears make a new zipper, following an algorithm to solve this problem.

As a control condition, we used a neutral video (*https://disk.yandex.ru/i/8cmaYfhp718zOw/*). It used the same characters and the same style, and was the same length as the instructional video (see Figure 2). This video did not present a problem nor the ways of solving it.

Detecting a Representational Change during the Solution Process

This study used nouns as markers of different solution patterns. Changes in the importance-to-solution ratings of these nouns indicate that a representational
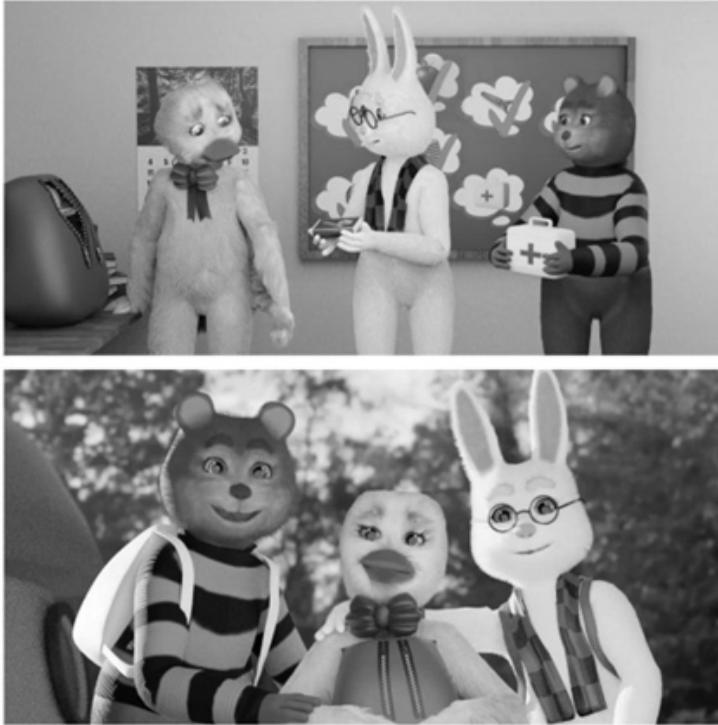
Figure 1

Stills from the instructional video. The Bears solved the problem of fixing the broken zipper on the Duck's backpack by making a new zipper. The Rabbits invented a Velcro clasp
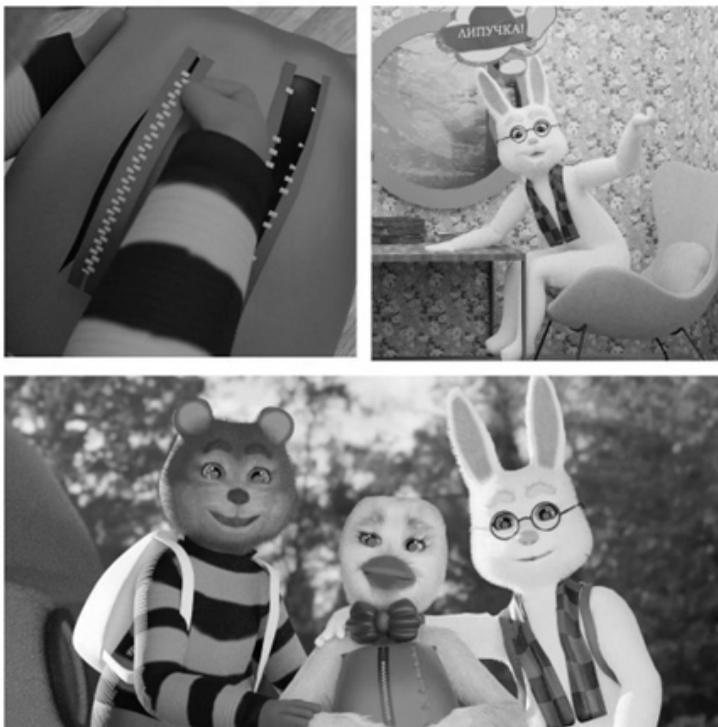
Figure 2

Stills of the neutral video. The Bears and the Rabbits together help the Duck to pack for a hike

change during the solution process is the key aspect of insight. The following types of nouns were included: distractors, which correspond to an erroneous representation; facilitators, which correspond to a representation that aligns with the solution; and neutral words (see Figure 3). Therefore, the method was similar to that of Danek and colleagues (2020). It should be noted that distractors were not used for non-insight problems, since the solver of these problems acts within a single fixed representation.

Comparative analysis of the effectiveness of Danek's Scales and our new scales

The solvers' general reports on the nature of their solutions (both insightful and non-insightful) and the ratings they had given using either the classical scales developed by Danek and colleagues (hereinafter: Danek's questionnaire) or the new scales developed by the authors of this paper (hereinafter: the new scales) were used as subjective criteria for assessing the insightfulness of a solution.

The following self-reporting methods were used:

1) a Russian adaptation of the Danek & Wiley questionnaire (2017);

2) new scales for assessing insight, developed with the following principles in mind: multiple registered dimensions of insight; an unambiguous interpretation of the scales; a focus on affective and self-assessment components; and clear terminology.

Figure 3
Examples of an insight and non-insight problems, and the words presented with these problems

Insight problem	Non-insight problem
For all the time he lived in the city, a man married 20 women. He and all these women are still alive, and the man has never been divorced. He's not a polygamist, and he's not a Mormon. He didn't even break a single law. How is this possible?	Next week, I want to have lunch with my friend, visit the new art gallery, drop by the insurance office and go to the dentist for a check-up. My friend can't meet me on Wednesday; the insurance office is closed on weekends; the dentist makes appointments on Tuesdays, Fridays and Saturdays; the art gallery is closed on Tuesdays, Thursdays and weekends. On what day can I do everything I need to?

Nouns

Fraud (distractor)	Errands (facilitator)
Cat (neutral)	Banana (neutral)
Winter (neutral)	Ocean (neutral)
Field (neutral)	Office (facilitator)
Certificate (facilitator)	Moon (neutral)

This set of scales includes affective and cognitive as well as process and result dimensions.

Our methodology uses the following dimensions:

1. Representational change (cognitive, result): The final solution to the problem differs from what I originally thought, from what I imagined it to be at the beginning of the solution.

2. Impasse (cognitive, process): While I was solving the problem, at some point it seemed that I had exhausted all my ideas and had no clue what to do next.

3. Suddenness (cognitive, result): I solved the problem suddenly and unexpectedly. I did not develop an idea step by step.

4. Surprise (affective, result): When I found the solution, I thought: "I should have known this at once!"

5. Representational change (cognitive, process): To solve this problem, I had to take a step back and look at it from a different angle.

6. Pleasure (affective, result): Finding the solution gave me pleasure.

7. Frustration, affective impasse (affective, process): While trying to find the solution, I often felt frustrated and helpless.

8. Confidence (cognitive, process): I wasn't sure of the solution until the last moment when I discovered the final answer.

9. Aha! experience, insight (affective, result): I had an insight — I suddenly understood how the elements of the problem are connected and felt exuberant joy on this account.

10. Cleverness (affective and cognitive, result): The solution I found seems clever to me.

Procedure

Participants were asked to familiarize themselves with the definition of insight and watch the video (instructional or neutral in nature), then solve three insight problems and three non-insight problems, defined as such by their formal structure. Hereinafter in this paper we will use the abbreviation FIP for "an insight problem defined as such by its formal structure (formally insight problem)" and FNIP for "a non-insight problem defined as such by its formal structure (formally non-insight problem)". Participants had 3 minutes to solve each problem. While doing it, they were asked to rate, from 0 to 100, the importance of distractors, facilitators, and neutral words presented with each problem. The solvers were presented with these words at different points throughout the solution: between reading the problem and starting to solve it; in the middle of the allotted time (90 seconds after the solution start); immediately after finding the solution (if no solution was found, the words were presented 180 seconds after the start, immediately after the correct solution was revealed). For each problem, participants assessed the general nature of their solution ("Was your solution insightful?") and rated, on a scale from 0 to 100, its individual dimensions, using either Danek's questionnaire (e.g., Pleasure: "The moment I found the solution, my experience was... (unpleasant— pleasant)") or the new scales (e.g., "Finding the solution gave me pleasure."). If no solution was found, the correct answer was revealed and the participant was asked to rate its correlation with the problem, using the same questionnaires with modified wording: "The moment I learned the solution, my experience was... (unpleasant — pleasant)"; "Learning the solution gave me pleasure."

Independent variables were as follows: the formal problem type (insight vs. non-insight), the video type (instructional vs. neutral), the solution stage (beginning/middle/end), and the word type (distractor/facilitator/neutral). Dependent variables were as follows: general subjective assessment of solution insightfulness (insight vs. non-insight solution), assessment of insightfulness (using Danek's questionnaire vs. using the new scales) (from 0 to 100), importance-to-solution rating of words (from 0 to 100).

Hypotheses

1) For FIPs, word ratings would change during the solution process: facilitator words would be rated higher, distractor words would be rated lower; the rating of neutral words would not change significantly. For FNIPs, word ratings would not change noticeably at any stage of the solution.

2) The solution of FIPs would be subjectively described as "insightful" more frequently than the solution of FNIPs.

3) FIPs would be rated higher on Danek's questionnaire and the new scales than FNIPs.

4) Participants who watched the instructional video would assess their solution of insight problems as "insightful" more frequently than those who watched the neutral video.

Statistical analysis was performed using ANOVA analysis of variance using Fisher criterion, Pearson's chi-square, and the method of paired comparison using Student's t-criterion. Cohen's d was the measure of an effect size.

Participants

Ninety-five volunteers (14 males, 81 females, aged 18 to 55, M = 20.37, SD = 6.44) took part in the study. They were randomly assigned to one of the four groups:

1) Watching the instructional video and assessing the insightfulness of their solution with Danek's questionnaire.

2) Watching the instructional video and assessing the insightfulness of their solution using the new scales.

3) Watching the neutral video and assessing the insightfulness of their solution with Danek's questionnaire.

4) Watching the neutral video and assessing the insightfulness of their solution using the new scales.

The study was conducted in a group format. Due to time constraints, both successful solutions and cases where the answer was presented to the solver by the researcher were included in the subsequent analysis. Incomplete evaluation of the elements presented together with the problem was excluded from further analysis.

Results

This section presents the results obtained by statistical analysis.

### Changes in Word Rating and the Formal Problem Type

Data analysis proved that the rating of words of different types changed at different stages of the solution more drastically in FIPs than in FNIPs (see Figure 4).

For insight problems, the rating of facilitator words was significantly lower, $t(82) = -8.587$, $p < .001$, Cohen's $d = -0.943$ before the solution process began (M = 23.38, SD = 21.47), then after a solution was found (M = 52.54, SD = 30.54). Conversely, the rating of distractor words in insight problems was much higher, $t(82) = 10.406$, $p < .001$, Cohen's $d = 1.142$ before the solution process began (M = 53.53, SD = 27.48), then after a solution was found (M = 16.64, SD = 24.25). Neutral words in insight problems were also rated higher, $t(82) = 9.060$, $p < .001$, Cohen's $d = 0.995$ before the solution process began (M = 18.26, SD = 11.63), then after a solution was found (M = 7.32, SD = 10.49).

Neutral words in non-insight problems were also rated higher, $t(82) = 4.400$, $p < .001$, Cohen's $d = 0.483$ before the solution process began (M = 3.50, SD = 5.11), then after a solution was found (M = 1.15, SD = 3.95). Facilitator words were also rated higher, $t(82) = 3.911$, $p < .001$, Cohen's $d = 0.429$ before the solution process

Figure 4

Distribution of the ratings of different types of words at different stages of insight and non-insight problem solving
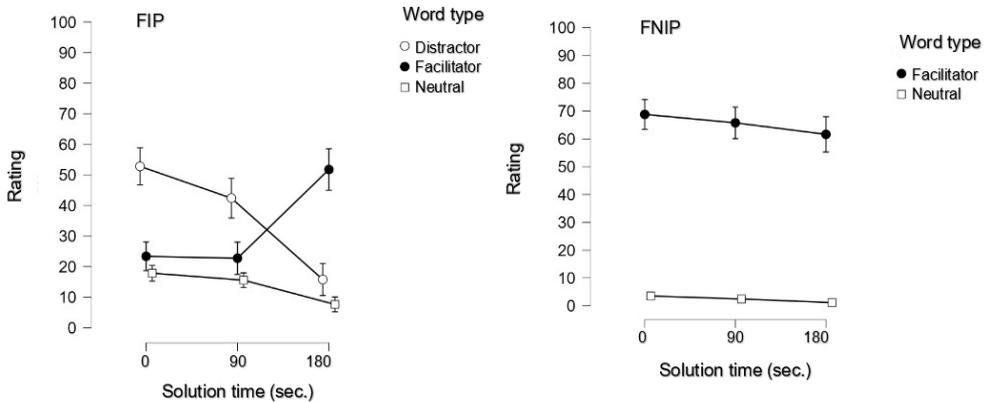
began (M = 68.78, SD = 24.58), then after a solution was found (M = 61.61, SD = 29.16).

Analysis of variance showed significant, $F(2, 972) = 31.492$, $p < .001$, $\chi^2 = 0.024$, differences between the facilitator and neutral words' ratings in insight versus non-insight problems, as well as considerable, $F(2, 240) = 40.827$, $p < .001$, $\chi^2 = 0.254$, differences between the ratings of distractor words in insight problems.

Based on the type of change in the facilitator rating, several patterns of problem solving can be identified: sudden (a sharp upward change between two consecutive facilitator ratings), gradual (a smooth upward change between facilitator ratings), flat (no significant change in ratings), descending (a noticeably decreasing facilitator rating), other (patterns that fall outside of these categories). This study analyzed 86 patterns of FIP solving and 86 patterns of FNIP solving. The analysis yielded 34 cases of sudden and six cases of gradual solution of FIPs. For FNIPs, 13 cases of gradual solution were identified, but no cases of sudden solution. We discovered significantly, $\chi^2(3) = 30.82$, $p < .001$, different numbers of sudden and gradual solutions of FIPs versus FNIPs. This is in line with the results obtained by Danek and colleagues (2020), who demonstrated that insight problems tend to have sudden solutions, whereas non-insight problems lean to gradual solutions.

Accordingly, it seems reasonable to subject to further analysis exclusively those solutions that fit the sudden and gradual patterns. However, since we obtained only a small number of sudden and gradual solution cases, we will rely on the previously identified pattern and use the formal problem type as a predictor of insightfulness.

Subjective Assessment of Solution Insightfulness and the Formal Problem Type

We analyzed 113 subjective assessments of FIP solutions (insightful vs. non-insightful), and 156 subjective assessments of FNIP solutions.

In 69 cases, solvers subjectively assessed their solution of an insight problem as insightful; in 44 cases, as non-insightful. This is compared to only 17 reported cases of an insightful solution to a non-insight problem, whereas in 139 cases solutions of non-insight problems were subjectively assessed as non-insightful.

Statistical analysis showed that solvers subjectively assess their solutions as insightful significantly more often, $\chi^2(1) = 75.82$, $p < .001$ if they are solving FIPs than FNIPs.

Subjective Assessment of Insightfulness and the Type of Scales

Analysis of the results showed significant rating variance for FIPs versus FNIPs on most of the new scales (see Table 1).

This analysis demonstrated that Pleasure and Frustration were the only dimensions with negligeable differences.

When Danek's questionnaire was implemented, only the Surprise, Suddenness, and Relief dimensions displayed significant variance between insight and non-insight problems (see Table 2).

The new scales show considerable differences between the variance of the subjects' evaluations of FIPs versus FNIPs, in the following dimensions: Representational change, result, F(1) = 16.30, $p < .001$, $\eta^2 = 0.16$, Impasse, F(1) = 9.21, $p < .003$, $\eta^2 = 0.10$, Suddenness, F(1) = 16.96, $p < .001$, $\eta^2 = 0.17$), Surprise, F(1) = 40.13, $p < .001$, $\eta^2 = 0.32$, Representational change, process, F(1) = 65.46, $p < .001$, $\eta^2 = 0.44$, Aha! experience, F(1) = 12.27, $p < .001$, $\eta^2 = 0.13$, Cleverness, F(1) = 50.60, $p < .001$, $\eta^2 = 0.38$.

Table 1

Ratings on the new scales for measuring the insightfulness of the solution,
for insight and non-insight problems

Dimension	FIP		FNIP		*t*	*p*	Cohen's *d*
	M	SD	M	SD			
Representational change, result	57.06	22.22	33.57	31.01	5.04	<.001	0.77
Impasse	30.72	23.39	17.50	16.38	3.66	<.001	0.56
Suddenness	42.83	22.05	22.67	23.32	4.53	<.001	0.69
Surprise	38.62	20.32	14.73	14.08	6.79	<.001	1.04
Representational change, process	56.03	26.54	16.17	18.42	8.06	<.001	1.23
Pleasure	47.36	28.30	43.76	27.13	0.88	.192	0.13
Frustration	17.25	17.09	15.65	17.67	0.54	.295	0.08
Confidence	41.81	26.47	34.48	23.73	1.72	.047	0.26
Aha! experience	42.08	22.01	25.52	21.84	3.58	<.001	0.55
Cleverness	50.52	25.96	18.42	14.20	8.15	<.001	1.24

Table 2

Ratings according to Danek's questionnaire for measuring the insightfulness of the solution, for insight and non-insight problems

Dimension	FIP		FNIP		t	p	Cohen's d
	M	SD	M	SD			
Pleasure	66.66	19.15	65.07	22.07	1.50	.070	0.22
Surprise	45.51	14.51	37.72	17.20	4.49	<.001	0.64
Suddenness	40.30	15.38	27.22	14.02	7.71	<.001	1.10
Relief	67.26	20.22	65.39	22.93	1.94	.029	0.28
Confidence	64.85	20.56	63.63	21.84	0.68	.251	0.10
Drive	70.17	27.02	71.50	27.29	−1.24	.889	−0.18

Yet, when Danek's questionnaire was implemented, significant differences between the variance of the subjects' ratings for FIPs versus FNIPs were registered only in the dimensions of Surprise, $F(1) = 5.59$, $p = .020$, $\eta^2 = 0.16$, and Suddenness, $F(1) = 18.58$, $p < .001$, $\eta^2 = 0.06$.

Ratings given on the new scales have more variance for insight (M = 42.43, SD = 25.99) versus non-insight (M = 24.25, SD = 23.22) problems when compared to insight (M = 58.94, SD = 23.0) and non-insight (M = 55.09, SD = 26.81) problem ratings in Danek's questionnaire.

Variance analysis showed significant, $F(1) = 116.96$, $p < .001$, $\eta^2 = 0.12$, differences in ratings for FIPs and FNIPs on all the new scales. Conversely, when Danek's questionnaire was implemented, these differences were much smaller, $F(1) = 3.45$, $p = .064$, $\eta^2 = 0.006$. See Appendix 1 for a complete table of variance for each of the new scales and each of Danek's questionnaire scales.

The graphical representation of the results yielded by the analysis of variance for all new scales (see Figure 5) and Danek's questionnaire scales (see Figure 6)

Figure 5

Assessment of the insightfulness of the solution for FIPs and FNIPs on all new scales
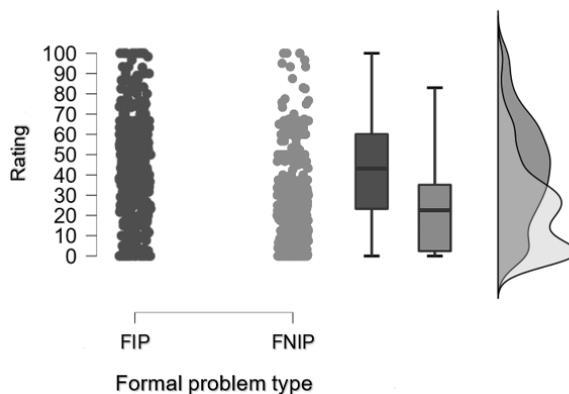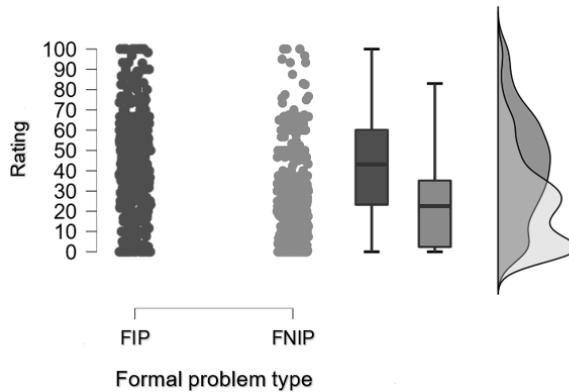
Figure 6

Assessment of the insightfulness of the solution for FIPs and FNIPs using Danek's questionnaire

shows that the spread of scores between insight and non-insight problems is greater on the new scales than on Danek's questionnaire scales.

Subjective Insightfulness Assessment and the Video Type

This study analyzed 45 cases of FIP solutions and 77 cases of FNIP solutions by participants who were shown the instructional video, as well as 68 cases of FIP solutions and 79 cases of FNIP solutions by participants who were shown the neutral video. In the instructional video groups, 36 FIPs were subjectively assessed to have been solved insightfully, while nine were assessed to have been solved non-insightfully. For FNIPs, four were subjectively assessed to have been solved insightfully, and 73 non-insightfully. In the neutral video groups, 33 FIPs were subjectively assessed to have been solved insightfully, while 35 were assessed to have been solved non-insightfully. For FNIPs, 13 were subjectively assessed to have been solved insightfully, and 66 non-insightfully.

Therefore, in the group that was shown the instructional video, 80% of subjectively insightful solutions correlated with FIPS. In the group that was shown the neutral video, this percentage amounted to 49%. It should be pointed out that the instructional video group assessed 95% of FNIP solutions as non-insightful. For the neutral video group, this percentage amounted to 85%.

Statistical analysis revealed significant, $\chi^2(3) = 18.45$, $p < .001$, differences between subjective assessments of solution insightfulness depending on the video type (instructional vs. neutral) and the problem type (FIP vs. FNIP).

Discussions

In this paper, we aimed to assess the degree to which the solver's solution pattern and their subjective assessment of solution insightfulness (implementing the new scales in comparison with Danek's questionnaire) correlate with the formal

structure of the problem. We also wanted to test the effectiveness of the instructional video as a tool for creating a comprehensive idea of an insightful solution in the solver's mind.

The formal structure of an insight problem influences the change in the word ratings, i.e., the structure of an insight problem triggers representational change for the solver. The increase in facilitator words ratings and the decrease in distractor words ratings in the process of FIP solutions reflect the presence of a representational change that is essential for finding the solution. The absence of such pronounced changes in the average ratings of facilitator words in FNIPs demonstrates that solvers follow an algorithm that is established at the very start and does not entail sudden changes in the direction of a solver's thinking process.

Based on the changes in the facilitator words ratings, it can be observed that sudden solutions of FIPs happen 5 times more frequently than gradual ones. Yet, no sudden solutions are observed in FNIPs, where a change of representation is not required for successful solution.

Because of the group format of data collection, the solution stages (the beginning, middle, and end of the solution), which were essential for configuring the solution dynamics, were set up by the researchers based on the maximum time allotted for the solution of a problem.

This study design also allowed us to follow closely the research procedure of Danek and colleagues (2020) to identify objective patterns of problem solving.

The results obtained may indicate that the formal structure of a problem, although it is an important predictor for a certain type of solution, is not an exhaustive basis for classifying a solution as insightful or non-insightful. A more flexible indicator of whether the problem was solved insightfully is the solution pattern.

In most cases, solvers subjectively evaluated the solution of FIPs as insightful, and the solution of FNIPs as non-insightful. This serves to prove our hypothesis that there is a link between the formal structure of the problem and the solvers' general assessment of the nature of their solution.

The above is consistent with the results obtained by Danek and colleagues, who demonstrated that any problem may be solved suddenly or gradually, with or without the subjective experience of insight. However, if the solution process involves a sudden restructuring, the solver is more likely to assess the problem as having been solved insightfully. Danek postulates that researchers should evaluate the subjective assessment of solution insightfulness and also track the solution process dynamics for each solver (rather than assuming that all insight problems have been solved insightfully by all solvers, simply because they are considered "insight problems").

Additionally, there is a stronger correlation between the formal structure of the problem and the ratings on the new scales than on Danek's questionnaire scales. Subjective insight in FIPs is more pronounced on the set of new scales than in Danek's questionnaire. This is expressed in greater variance of ratings on the new scales compared to Danek's questionnaire (depending on the type of a problem). It is reasonable to assume that the criteria selected for our scales are more relevant to

the solver's experience and are in line with their concept of insight solution process and its associated components.

The wording of the new scales facilitates unambiguous interpretation, which in turn increases the accuracy with which the solver can detect the insightfulness of their own solution. At the same time, the dichotomous space of the set of new scales (affective-cognitive and result-process dimensions) makes them more sensitive to the solvers' ratings relative to the specifics of insight. It also allows to highlight the various criteria of insightful solution in the most comprehensive way.

The results of this study also demonstrate the effectiveness of the instructional video as a tool for creating a comprehensive idea of an insightful solution in the solver's mind. In the instructional video group, subjective insightfulness assessments match the formal problem structure (85% for FIPs and 95% for FNIPs). In the control group, where participants read a textual prompt about insight and watched the neutral video, the subjective assessment of solution insightfulness matched the FIP problem structure in 49% of cases, and the FNIP problem structure in 85% of cases.

These figures corroborate the fact that the instructional video developed for the purposes of this study is highly effective in teaching solvers to detect insightful solutions and in delineating the subjective notions of insightful and non-insightful solutions.

Conclusions

1. The structure of an insight problem triggers a representational change for the solver.

2. The solution of insight problems is subjectively described as "insightful" more frequently than the solution of non-insight problems.

3. New scales for assessing solution insightfulness are more closely linked to the formal problem structure than the classical scales of Danek's questionnaire.

4. The instructional video is effective in teaching solvers to detect the insightfulness of their solutions.

To sum up, although the formal structure of a problem predicts the insightfulness of the solution quite reliably, it need not be the only reference. Another important factor is the solving pattern (sudden or gradual), which largely depends on the solver's experience. The accuracy of a solver's subjective assessment of the solution insightfulness is directly related to their correct and comprehensive understanding of insightfulness criteria. The training video developed by the authors of this study promotes a deeper and better understanding of these criteria.

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Difference in the variance of ratings of FIPs and FNIPs

Difference in the variance of ratings of FIPs and FNIPs on the new scales

Dimension	SS	MS	SS (residuals)	MS (residuals)	F	p	η^2
Representational change, result	11861.86	11861.86	61122.32	727.65	16.30	<.001	0.163
Impasse	3757.65	3757.65	34255.23	407.80	9.21	.003	0.099
Suddenness	8734.32	8734.32	43251.73	514.90	16.96	<.001	0.168
Surprise	12262.86	12262.86	25666.28	305.55	40.13	<.001	0.323
Representational change, process	34154.04	34154.04	43829.32	521.78	65.46	<.001	0.438
Pleasure	278.17	278.17	64561.25	768.59	0.36	.549	0.004
Frustration	55.072	55.072	25377.52	302.11	0.18	.671	0.002
Confidence	1155.54	1155.54	53089.24	632.02	1.83	.180	0.021
Aha! experience	5896.85	5896.85	40366.65	480.56	12.27	<.001	0.127
Cleverness	22149.96	22149.96	36772.36	437.77	50.60	<.001	0.376

Difference in the variance of ratings of FIPs and FNIPs on the scales implemented in Danek's questionnaire

Dimension	SS	MS	SS (residuals)	MS (residuals)	F	p	η^2
Pleasure	49.25	49.25	40926.04	430.80	0.11	.736	0.001
Surprise	1428.27	1428.27	24272.60	255.50	5.59	.020	0.056
Suddenness	4056.28	4056.28	20740.87	218.33	18.58	<.001	0.164
Relief	82.99	82.99	44865.96	472.27	0.18	.676	0.002
Confidence	32.09	32.09	43162.57	454.34	0.07	.791	<0.001
Drive	90.58	90.58	69945.62	736.27	0.12	.727	0.001