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INSIGHT PROBLEM OR INSIGHTFUL SOLUTION: IS IT STILL WORTH USING INSIGHT PROBLEMS TO INVESTIGATE INSIGHT?

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Инсайтная задача или инсайтное решение: стоит ли использовать инсайтные задачи для изучения инсайта?

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Abstract

Traditional insight studies assumed that there is a special class of problems called "insight problems" whose solution would cause feelings of insight. However, it has been previous shown that insight problems can be solved in both insightful (with Aha! experience) and step-by-step (without Aha! experience) ways, and exactly the same is observed for analytical problems. The present work addresses the question whether it is sufficient to use the problem types to detect insightful feelings or whether it is necessary to use the solution types. For this purpose we collected the dataset of previously published open data which used Danek and Wiley's questionnaire

Резюме

Традиционные исследования инсайта предполагают, что существует особый класс так называемых инсайтных задач, чье решение приводит к переживанию инсайта. Однако было показано, что инсайтные задачи могут быть решены как инсайтным (с ага-переживанием), так и пошаговым путем (без ага-переживания), и точно такая же ситуация наблюдается для решения аналитических задач. Данная работа посвящена вопросу, действительно ли достаточно использовать типы задач для определения инсайтных переживаний или же необходимо использовать тип решения. Для этой цели мы собрали базу ранее опубликованных открытых данных, использующих опросник А. Данек и Дж. Вайли с различными

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for subjective ratings of insight phenomenology. Joint analysis showed that using solution types provided greater benefits for insight investigation than using problem types: insightful solutions were more pleasant, sudden, and relieving than step-by-step solutions, but insight and analytical problems differed from each other on only suddenness scale. We concluded that relying only on the problem type is not the best strategy for investigation of insight, because insight and analytical problems are quite similar in terms of the Aha! experience. The use of solution types is much more fruitful and distinguishes various situations in the process of problem solving. The obtain results were interpretated in the context of relationships between the Aha! experience and representational change.

Keywords: insight, Aha! experience, phenomenology, insightful solution, step-by-step solution, subjective rating, joint analysis

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субъективными шкалами для оценки феноменологии инсайта. Совместный анализ показал, что использование типа решения дает больше преимуществ для изучения инсайта, чем использование типов задач: инсайтные решения были более приятными, внезапными и облегчающими, чем пошаговые решения, при этом инсайтные и аналитические задачи отличались друг от друга только по шкале внезапности. Мы пришли к выводу, что полагаться исключительно на тип задач – не лучшая стратегия для изучения инсайта, поскольку инсайтные и аналитические задачи достаточно похожи в терминах ага-переживания. Использование типов решения гораздо более плодотворно и позволяет различать разнообразные ситуации в процессе решения задач. Полученные результаты были проинтерпретированы в контексте взаимоотношений между ага-переживанием и изменением репрезентации.

Ключевые слова: инсайт, ага-переживание, феноменология, инсайтное решение, пошаговое решение, субъективные шкалы, совместный анализ.

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For many years, one of the central issues of the psychology of thinking has been the search for specific characteristics of insight. The studies of insight are usually associated with the use of a special problem type — insight problems. According to the Representational Change Theory (RCT), the main difference between insight and analytical problems is that the latter do not require a representational change, which occurs when the initial problem representation is incorrect and does not allow the answer to be found (Ohlsson, 1992). The result of a successful representational change can be an Aha! experience that is described as a pleasant feeling of "‚seeing' the complete solution in the mind's eye" (Ibid., p. 5). Thus, it is assumed that the Aha! experience can only occur in insight problems. Meanwhile, it has

become evident that insight problems can sometimes be solved in a step-by-step way, i.e., without the Aha! experience (Weisberg, 2015; Danek et al., 2016; Webb et al., 2016, 2018), and analytical problems can be solved with the Aha! experience (Webb et al., 2018; Lazareva & Vladimirov, 2019).

However, several questions arise at this point. Firstly, suppose that the Aha! experience is strictly associated with and occurs only after a successful representational change. Is it possible to say that a representational change can only occur in insight problems? It is much more logical to assume that — due to the specific participants' knowledge or due to preliminary experimental influences — "analytical problem" may involve a representational change, i.e., it becomes insightful and is solved with the Aha! experience. In this case, it makes no sense to talk about insight problems, rather than about insightful solutions. Another implication is that insight studies should not be limited to insight problems, they can include a wide variety of experimental material containing a representational change (jokes, modern arts, recognition of noisy or double images, etc.).

This is not a new question, but many authors still use insight problems to study insight (Chuderski, Jastrzębski, & Kucwaj, 2021; Korovkin et al., 2021; Salmon Mordekovich & Leikin, 2022), because this problem type has a wide theoretical background and explanation why pure insight problems can cause the Aha! experience (e.g., Ohlsson, 1992, 2011; Weisberg, 1995, 2015). From this point of view, it is not clear why analytical problems can be solved by insightful strategy, because they do not have all the necessary features. This adherence does not allow us to dot the i's on the issue of using problem types instead of switching to solution types.

Secondly, suppose that the Aha! experience is not strictly associated with a representational change, and then even deeper methodological questions arise: What is more important for investigation of insight — the presence of a representational change or the presence of the Aha experience? Can a solution be considered as insightful if it does not involve the Aha! experience? What causes the Aha! experience? We will not devote this paper to attempts to answer these questions, but they are actively discussed and studied in modern works (e.g., Ammalainen & Moroshkina, 2021; Becker et al., 2020; Becker et al., 2021; Danek et al., 2020).

Even if we assume that the Aha! experience is strictly associated with a representational change, we are faced with a contradiction. On the one hand, there is RCT, which posits that problem types cause certain metacognitive feelings (the Aha! experiences) due to the presence or absence of a representational change in the solution (Ohlsson, 1992, 2011). On the other hand, there is some empirical evidence showing that the problem type does not always uniquely predict the presence of the Aha! experience in a solution (Danek et al., 2016; Webb et al., 2018; Lazareva & Vladimirov, 2019). In this regard — with a help of joint analysis — we want to check how often insight and analytical problems are accompanied by the Aha! experience. We also want to know whether it makes sense to completely abandon the dichotomy of problem types in favor of using solution types: insightful solutions for cases with the Aha! experience and step-by-step solutions for cases without the Aha! experience.

Thus, two contradictory hypotheses can be constructed:

1. According to RCT, insight and analytical problems generally differ from each other. Insight problems score higher on the most subjective scales of the Aha! experience compared to analytical problems.

2. According to previous empirical data, problem types do not differ from each other, but there are differences between insightful and step-by-step solutions. Insightful solutions are evaluated higher on the most subjective scales of the Aha! experience than step-by-step solutions.

Method

To test our ideas, we decided to conduct joint analysis of previous studies, because it provides two significant advantages: a large sample size and — inasmuch as used studies were conducted in different countries — control of such factors as the influence of an experimenter, translation of a questionnaire, and cross-cultural differences. Post-experimental self-reports are commonly used to measure the Aha! experience, and there are different variants of them (Novick & Sherman, 2003; Jung-Beeman et al., 2004; Bowden et al., 2005; Wong, 2009). Currently, the questionnaire on the Aha! phenomenology (Danek et al., 2014; Danek & Wiley, 2017) seems to have received the greatest prevalence and can be considered as the most developed and tested on various problem types, because a substantial pool of experimental data has been accumulated. According to Danek and Wiley's (2017), the Aha! experience is understood as a multi-dimensional construct that consists different aspects: pleasure, surprise, suddenness, relief, certainty and drive. The dataset was collected from studies where this questionnaire was used to evaluate the solvers' subjective experiences.

Selection of Studies

Using Google Scholar we analyzed published studies that cited Danek and Wiley (2017). At the time of dataset creation (January 2022), 114 papers were found. We selected papers with the data publicly available and full, not aggregated data. We used only empirical papers and papers without priming or hints in experimental design. Only control groups were included in the joint analysis. Thus, data were obtained from 9 studies, including 9,274 rows of data or 990 unique participants. It is worth noting that the available data were very heterogeneous, so they required some changes or exclusions for the unity of the final dataset. Clarifications of excluded data can be found in OSF at https://osf.io/j6s38/. The full list of studies is presented in Table 1.

Characteristics of the Dataset

A number of characteristics in the collected dataset were identified and each data row was evaluated for compliance with them. The following characteristics were used:

Table 1

List of the Studies Included

Reference	Sample	Problem types	Available scales	Excluded data
Bilalić et al., 2021	74 participants (59 females), aged 17–62 years (M = 24, SD = 6.1)	Classical insight problems	Pleasure[1], surprise[2], suddenness[3], certainty[4]	Participants with no experience in playing chess were taken. Besides, we used successful solutions, because participants evaluated subjective ratings only after successful solution attempts
Chuderski, Jastrzębski, & Kucwaj, 2021	200 participants (139 females), aged 18–38 years (M = 23.5, SD = 4.3)	Classical insight problems	Pleasure, suddenness, relief[5], certainty	
Chuderski Jastrzębski, Kroczek et al., 2021	100 participants (73 females), aged 18–32 years (M = 22.6, SD = 2.94)	Analytical problems, classical insight problems, Raven matrices (as analytical problems)	Pleasure, suddenness, certainty	
Danek & Wiley, 2017	70 participants (48 females), age range is not specified (M = 19.6, SD = 2.8)	Magic tricks	Pleasure, surprise, suddenness, relief, certainty, drive	
Danek & Wiley, 2020	127 participants (56 females), aged 17–42 years (M = 19.04, SD = 2.1)	Magic tricks	Pleasure, surprise, suddenness, relief, certainty, drive[6]	We used only the Experiment 2, because in the Experiment 1 only two subjective parameters were measured: overall aha! experience and certainty of the solution

[1] At the moment of solution, my feelings were... (unpleasant — pleasant).

[2] The moment of solution was... (not surprising — surprising).

[3] This solution came to me... (in steps — all at once).

[4] How certain are you that your solution is correct: (uncertain — certain).

[5] At the moment of solution, I felt... (tense — relieved).

[6] I am looking forward to the next problem... (no — yes).

Table 1 (end)

Drążyk et al., 2020	279 participants (173 females), aged 17–51 years (M = 21.75, SD = 4.42)	Analytical problems, classical insight problems	Pleasure, suddenness, relief, certainty	We used only the control group of Experiment 2, because it contained scales of Danek & Wiley's questionnaire, and the control group did not include additional factor as the ego-depletion
Korovkin et al., 2021	Experiment 1: 40 people (31 females), aged 12–72 years (M = 34.83, SD = 18.43) Experiment 2: 40 people (28 females), aged 14–63 years (M = 30.05, SD = 14.26)	Classical insight problems	Pleasure, surprise, suddenness, relief, certainty, drive	
Spiridonov et al., 2021	40 people (35 females), age range is not specified (M = 19.1, SD = 1.4)	CRA	Pleasure, surprise, suddenness, relief, certainty, drive	We used only the data of Experiment 2
Vladimirov et al., 2021	20 people (17 females), aged 18–21 (M = 20.5, SD = 1.6)	Analytical problems, classical insight problems	Pleasure, surprise, suddenness, relief, certainty, drive	

• Experiment: it indicates authors of the original article of the obtained data.

• Problem type: analytical problems, compound remote associate problems (CRA), classical insight problems, magic tricks, Raven matrices.

• Solution type. Some authors assume that problems can be solved by the insightful way or a step-by-step way. The insightful solution is a solution with the representational change, which is accompanied by specific feelings and metacognitive experiences (an Aha! experience, frustration from an impasse, etc.). The step-by-step, or analytical, solution is a solution without the representational change and special feelings, but it is performed through successive steps. In some cases, authors indicate the solution type based on the answer given by the participant. For example, in Korovkin and colleagues' experiment (2021) participants who gave a star-shaped answer were assigned to the insightful solution group, and any other answers were assigned to the step-by-step group. However, the most of works are based on an additional scale assessment — the Aha! experience scale (Danek &

Wiley, 2017; Danek et al., 2020), strategy scale (Chuderski, Jastrzębski, Kroczek et al., 2021), enlightenment scale (Vladimirov et al., 2021) or insightfulness scale (Spiridonov et al., 2021). In our opinion, all of these scales are similar and are designed to find out how a participant has solved the problem. We used all of this information to determine the solution type, insightful or step-by-step.

• Subjective rating scales: pleasure, surprise, suddenness, relief, certainty and drive (Danek & Wiley, 2017).

• Solved. We indicated how the problem was solved. There are two options: "yes" — successfully solved by the participant, or "no " — solved by the experimenter who gave the correct answer to the participant.

These characteristics are described in more detail at https://osf.io/j6s38/.

A Unified System of Subjective Ratings

The studies differed in the types of scale used for subjective ratings. Some of the studies used a scale from 0 to 100 points (for example, Danek & Wiley, 2017; Danek et al., 2020); others used a scale from 1 to 19 (for example, Drążyk et al., 2020) or a scale from 1 to 4 points (Vladimirov et al., 2021). However, this variation was unsuitable for statistical analyses, and all points were transformed to z-scores taking into account the characteristic of "Experiment".

Design & Statistical Analysis

We wanted to investigate how insight and analytical problems, as well as insightful and step-by-step solutions, are different in terms of subjective feelings of the Aha! experience. Different sets of dependent and independent variables were used. The dependent variables were the subjective ratings of the questionnaire (pleasure, surprise, suddenness, relief, certainty, drive). The independent variables were the problem type and the solution type. The data that support the findings of this study are available in OSF at https://osf.io/j6s38/. The data were also derived from the public domain.

Results

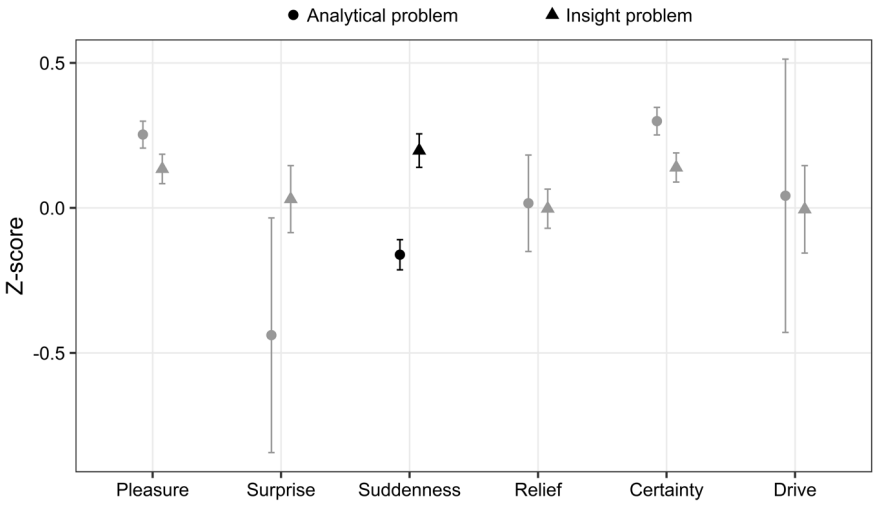
Comparison of insight and analytical problems

This section presents results regarding the question whether insight and analytical problems generally differ from each other, i.e., the impact of the problem type on a subjective solution experience. Insight problems (only classical insight problems), analytical problems and Raven matrices (analytical problems and Raven matrices were combined into one group which was labeled as "analytical") were compared. Only successfully solved problems were used (see Figure 1) (N = 2751).

We used Linear Mixed Models with the method of Satterthwaite test. Subjective scales were used as dependent variables, the problem type was used as a fixed effect variable, and the characteristic "Experiment" as a random effect grouping factor. All

Figure 1

Comparison of Insight and Analytical Problems



Note. Vertical bars denote 95% confidence interval (CI). Significant differences are marked in black, insignificant in grey.

analyses were computed using JASP, v. 0.18.3.0. Insight problems are evaluated as more sudden than analytical problems, $t(1, 7.96) = -9.75$, $p < .001$, VS-MPR = 3011.3 ($\beta = -0.255$, SE = 0.026). However, we did not find any significant differences in remaining scales.

Comparison of Insightful and Step-by-Step Solutions

The comparison of insightful and step-by-step solutions was carried out for the data containing the labels "insight" and "step-by-step" in the "Solution type" column. Only successfully solved problems were used (see Figure 2) (N = 4,717). We used Linear Mixed Models with the method of Satterthwaite test. Subjective scales were used as dependent variables, the solution type was used as a fixed effect variable, and the characteristic "Experiment" as a random effect grouping factor.

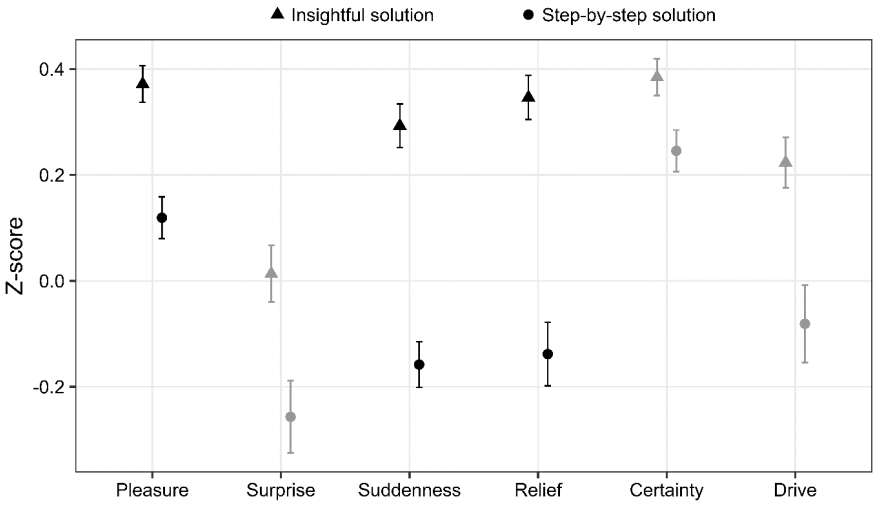
The insightful solution has a higher point on the pleasure scale than the step-by-step solution, $t(1, 8.97) = 2.28$, $p = .048$, VS-MPR = 2.5 ($\beta = 0.206$, SE = 0.090). The insightful solution is also evaluated higher on suddenness, $t(1, 8.67) = 3.22$, $p = .011$, VS-MPR = 7.4 ($\beta = 0.242$, SE = 0.075), and relief, $t(1, 6.88) = 2.37$, $p = .050$, VS-MPR = 2.4 ($\beta = 0.191$, SE = 0.081).

Relationship between the Problem Type and the Solution Type

A Chi-square test of independence was performed to examine the relation between the problem type (insight and analytical) and the solution type (insightful

Figure 2

Comparison of Insight and Step-by-Step Solutions



Note. Vertical bars denote 95% confidence interval (CI). Significant differences are marked in black, insignificant in grey.

and step-by-step). Only successfully solved problems were used. The relation between these variables was significant, $\chi^2(1, 2664) = 702.2, p < .001$. Insight problems were more likely than analytical problems to be labeled as insightful solutions (see Table 2). However, there are many cases when insight problems were solved step-by-step (29.3%), and analytical problems were solved by insight (19.6%).

Discussion

In this work, we wanted to find whether it is enough to use problem types to detect insightful feelings or it is necessary to use solution types. To test this idea, we collected a dataset of previous studies and conducted a joint analysis. The dataset included measurements of the Aha! experience in different problem types.

Possible differences between problem types and solution types were addressed. Results showed that the difference between insight and analytical problems is significant only for one scale: insight problems are evaluated as more sudden in comparison to analytical problems. A comparison between solution types (insightful or step-by-step) gave significant results in three subjective scales: insightful solutions score higher in pleasure, suddenness and relief. The Chi-square test showed that the problem type and the solution type are related to each other: insight problems are more likely to be solved with insight, and analytical problems are more likely to be solved by step-by-step way. At the same time, there is a large number of solu-

Table 2

Contingency Tables for the Problem Type and the Solution Type

Problem type		Solution type	
		Insightful solution	Step-by-step solution
Analytical problem	Count	259.0	1064
	Expected count	599.4	723.6
	% within row	19.6%	80.4%
Insight problem	Count	948.0	393.0
	Expected count	607.6	733.4
	% within row	70.7%	29.3%

tions where insight problems are solved step-by-step, and analytical problems are accompanied by an Aha! experience.

The findings support the previous empirical evidence that insight problems can be solved without insight (Weisberg, 2015; Danek et al., 2016; Webb et al., 2018), and analytical problems, on the contrary, can be solved with an Aha! experience (Webb et al., 2018; Lazareva & Vladimirov, 2019). However, our data contradict the Representational Change Theory (RCT). According to RCT, the Aha! experience is a consequence of an impasse, and a representational change is needed to break the impasse. At the same time, a representational change is perceived as an attribute of insight problems, but not — with rare exceptions — of analytical problems. Since in our sample almost 30% of classical insight problems were solved using a step-by-step strategy, and almost 20% of analytical problems were solved with an insight, we cannot define this situation as rare or accidental.

How can we interpret the obtained results? The first and most obvious interpretation is that RCT is mistaken in its predictions. The representational change is not related to the problem type and can occur much more frequently in different problem types than it was originally thought.

The second interpretation is that the discrepancy between the problem type and the solution type is related to the term of Aha! experience. As we wrote earlier, at the moment the relationship between the Aha! experience and the representational change is an open question (Ammalainen & Moroshkina, 2021; Becker et al., 2020; Becker et al., 2021; Cranford & Moss, 2012; Danek et al., 2016; Danek et al., 2020). It is unclear whether the Aha! experience occurs in response to a representational change or whether it reflects some other process: finding the correct solution unexpectedly quickly (Dubey et al., 2021); an unexpected result or a path of finding it (Savinova & Korovkin, 2022); changes in information processing fluency (Ammalainen & Moroshkina, 2021; Moroshkina et al., 2024). Another question also remains unanswered: is the presence of both the Aha! experience and a representational change a necessary condition for recognizing a solution as insightful, or is one attribute necessary and sufficient for this purpose?

The third interpretation is that existing contradictions are associated with the questionnaire of the Aha! experience. Firstly, the Aha! experience is understood as

a multi-dimensional construct that consists of different scales in Danek and Wiley's questionnaire (2017). According to the nonspecific approach to metacognitive processes, a multi-dimensional division is unnecessary, because metacognitive feelings perform a signaling function reporting the result of unconscious processes rather than the specific source and content of information (Tikhonov et al., 2018). Probably, the variety of metacognitive feelings within the Aha! experience arises from the influence of the measurement procedure: asking to rate the Aha! experience on six different scales forces participants to look for and attribute feelings that they did not initially have. Secondly, the questionnaire can give too high a score to analytic problems, preventing us from finding more differences between problem types and solution types. If we look closely at those scales on which insightful and step-by-step solutions do not differ, we will see that there are some problems with their logic or interpretation:

• Surprise: The moment of solution was... (not surprising — surprising). The scale can be interpreted in various ways. On the one hand, it can be understood as intended by the authors: "I feel surprised that I have understood something" (Danek & Wiley, 2017, p. 4). On the other hand, the scale has other interpretations: "I found the answer at unexpected moment", "I found the answer by accident", "I don't know how I was able to find the answer, the path to it is unknown to me". Depending on the interpretation of the scale, participants will give different answers, which ultimately reduces power of scale.

• Certainty: How certain you are that your solution is correct (uncertain — certain). The scale is understood unambiguously, but participants can be certain in both solution types, insightful and step-by-step. It is easy to imagine a situation where, after solving a simple analytical problem (e.g., 2 + 7 + 4 = 13), the participant reports that they are certain in the solution.

• Drive: I am looking forward to the next problem... (no — yes). The inclusion of the scale in the questionnaire of the Aha! experience is due to the fact that there should be an "energizing effect on problem solving behavior" (Ohlsson, 1984, p. 70). However, nothing says that the energetic effect should arise precisely from insightful solution, and not from finding the correct answer.

It may be worth taking a critical look at some scales of the questionnaire and conducting psychometric testing not only on the material of magic tricks, but also on classical insight problems. Besides, there was an attempt in this direction (Shumilov et al., 2023).

Finally, we would like to answer the question of how appropriate the term "insight problem" really is. Despite all of the above, we can conclude that relying only on the problem type is not the best strategy for investigation of insight, because insight and analytical problems significantly differ from each other only in one subjective scale of the Aha! experience. The use of solution types is much more fruitful and allows better distinguishing different situations in the process of problem solving. We recommend that subjective questionnaires are applied to determine that a solution has been achieved through insight, i.e., with an Aha! experience.

Limitations

Our joint analysis has limitations. First, not all interesting parameters were explicitly and clearly represented in the data. For example, not all studies used all scales of the questionnaire, and not all of them measured the solution time or noted the solution type (insightful or step-by-step). Second, some of the problem types included in this joint analysis were represented by only one experiment (for example, CRA problems) or were not present at all (for example, anagrams), since the multidimensional questionnaire does not contain them in the most studies. Thereby, some results may be distorted, because they are only related to those problems that we were able to find, rather than to the problem type as a whole. Thirdly, although we used various experimental data in the joint analysis, we could not control the diversity of such parameters as gender, age, profession, etc. Finally, our results show that there is an interaction between the problem type and the solution type, which could also influence the final results because these characteristics were not completely independent of each other. All these factors constitute significant limitations in the selection and data analyses, which narrows down the explanatory possibilities of this work.

Conclusions

Our joint analysis allows us to formulate the following conclusions and future directions:

1. Using solution types provides more benefits for investigation of insight than using problem types. Insightful solutions are more pleasant, sudden and relieving compared to step-by-step solutions.

2. It is necessary to explore the connection between a representational change and an Aha! experience more carefully. At present it remains unclear whether a representational change may be the cause of an Aha! experience and how essential both attributes are for recognizing a solution as insightful.

3. It is worth paying more attention to subjective questionnaires of the Aha! experience, since the accuracy of insight studies significantly depends on the accuracy of measurements. We propose to take a critical look at some scales of Danek and Wiley's questionnaire and to conduct psychometric testing not only on the material of magic tricks, but also on classical insight problems.

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