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ARE PEOPLE ABLE TO DISENTANGLE PERCEPTUAL AND CONCEPTUAL FLUENCY? EVIDENCE FROM ARTIFICIAL GRAMMAR LEARNING EXPERIMENT

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Способны ли люди различать перцептивную и концептуальную беглость? Исследование на примере методики научения искусственной грамматике

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Abstract

The heuristic of information processing fluency plays an important role in making judgments. Some sources of processing fluency can be relevant or irrelevant to the content of a judgment. In this study, we aim to check whether individuals can distinguish different sources of fluency or fluency has a general effect on judgments. We used an artificial grammar learning paradigm (AGL) and tested the effects of different fluency sources (grammaticality and perceptual noise) on the judgment of grammaticality or of subjective ease of reading. It was found that both grammaticality and perceptual

Резюме

Важную роль в вынесении суждений играет эвристика беглости обработки информации. Беглость обработки может происходить как из релевантных, так и из нерелевантных источников и, следовательно, помогать в вынесении суждения или, напротив, приводить к ошибкам. Основной вопрос настоящего исследования — могут ли люди различать беглость обработки, производную из концептуального или перцептивного источников. В исследовании использовалась методика научения искусственным грамматикам. Мы варьировали грамматичность и перцептивную зашумленность стимулов, а также инструкцию классификации стимульных строк по грамматичности или

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noise affected grammaticality judgements: the grammatical and the less noisy strings were evaluated more often as grammatical. However, only the perceptual noise affected judgments of subjective ease of reading. The results obtained provide evidence that fluency may contribute to the effects of implicit learning. It is possible that the processing fluency heuristic is the additional factor of judgement in the lack of explicit knowledge. Perhaps, perceptual noise provided almost complete explicit information for judgment of ease of reading; hence there was no need for additional heuristics. Another possible explanation is that perceptual fluency sources affect the early stages of information processing in a mandatory manner, unlike the conceptual ones. Overall, results are better explained by the non-specificity fluency hypothesis supporting the impossibility to distinguish between different fluency sources.

Keywords: implicit learning, information processing fluency, metacognitive experiences, artificial grammar learning.

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субъективной легкости их прочтения. Было обнаружено влияние обоих факторов на суждения о грамматичности: соответствующие усвоенной грамматике и находящиеся в условиях низкой перцептивной зашумленности строки чаще оценивались как грамматические. Однако на суждения о субъективной легкости прочтения обнаружено влияние лишь перцептивного фактора: менее зашумленные строки чаще оценивались как легкие для прочтения. Полученные результаты согласуются с представлением о том, что беглость обработки может делать вклад в эффекты имплицитного научения. Предполагается, что эвристика беглости обработки играет роль дополнительного источника суждений в случае нехватки эксплицитных знаний. Возможно, перцептивная зашумленность несла достаточно эксплицитной информации для вынесения суждения о легкости чтения и применение дополнительных эвристик не потребовалось. Другое возможное объяснение результатов связано с идеей стадиальности когнитивных процессов, где перцептивная обработка характеризуется обязательностью исполнения, в отличие от концептуальной. В целом результаты исследования в большей степени соотносятся с гипотезой о невозможности различения источников беглости обработки на субъективном уровне.

Ключевые слова: имплицитное научение, беглость обработки информации, метакогнитивные переживания, научение искусственным грамматикам.

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Introduction

There are two primary sources of judgement used by people in daily life. One is the accessible mental content (cf. Schwarz, 1998). Another source of judgement that reflects the dynamics of cognitive processing and plays an essential role in judgement is *processing fluency* — the common experience of processing ease or speed by which information is processed by the cognitive system (Winkielman et al., 2003; Alter & Oppenheimer, 2009).

Processing fluency can be used as a heuristic (Whittlesea & Leboe, 2000). Originally in implicit memory studies it was shown that fluency heuristic is used by participants in cases of lack or unavailability of episodic content (Jacoby & Dallas, 1981; Jacoby et al., 1988; Johnston et al., 1991). Further, it was shown that fluency heuristic could be a beneficial basis of judgments in a wide range of tasks. For example, people may use fluency originated from the previous perceiving of a stimulus to decide whether they have seen it before (Whittlesea, 2002), to estimate the popularity of an opinion (Weaver et al., 2007) or material's coherence (cf. Schwarz, 2015).

People may or may not rely on fluency heuristic depending on adopted types of processing or strategies. The *analytic* strategy is based on scrutinizing each item and its details in their own right; it prevents people from experiencing processing fluency. Hence, they use recollection/generation, resemblance, and other content-related heuristics instead of fluency heuristic. Otherwise, it is possible to encourage a *nonanalytic* or *intuitive strategy* through the absence of explicit knowledge, restriction of instructions, or short time to respond (cf. Higham & Vokey, 2000; Johansson, 2009). An item is processed as a complete entity, and people may use a fluency heuristic if the nonanalytic strategy is adopted (Whittlesea & Leboe, 2000; Whittlesea & Price, 2001; Kinder et al., 2003).

Many different factors can affect processing fluency (henceforth, fluency factors will be called fluency sources). Depending on sources of fluency, researchers usually dissociate between different instantiations of fluency, commonly perceptual fluency and conceptual fluency. For example, a variety of perceptual characteristics of stimuli, such as high figure-background contrast, long exposure time, and simple repetition, form priming, facilitate low-level processing and increase *perceptual fluency*, or the ease of identifying the physical identity of stimuli (e.g., Jacoby & Dallas, 1981; Roediger, 1990). Facilitating high-level processing through, for example, exposure to semantically related concepts, context congruity and rhythm, is accompanied by *conceptual fluency* or the ease of mental operations related to meaning and semantics (Whittlesea, 1993; Winkielman et al., 2003). To the present time it is not clear whether experiences promoted by different fluency sources are uniform or differ in a subjective experience level.

There was much evidence of *misattribution effects* when fluency-based affective experience could be misattributed to an irrelevant source in a wide range of judgments, notwithstanding whether it applies to the content of judgements. For example, it has been shown that changes in perceptual characteristics of stimulation impact affective judgments (Reber et al., 1998), truth judgments (Parks & Toth, 2006; Unkelbach, 2007;

Topolinski & Reber, 2010; Hansen et al., 2008) and familiarity judgments (Whittlesea, 1993). The opposite effects were registered much less often: it was shown that conceptual fluency impacts noise judgments (Jacoby et al., 1988), and judgments of clarifying (Whittlesea et al., 1990: Experiment 4); there is also an effect of semantic priming on liking judgments when exposure to the target item was limited to precognitive level (Labroo et al., 2008).

Here appear two critical factors of using fluency heuristic. First is the above-mentioned adopted strategy: fluency heuristics may serve as a nonanalytic basis for judgments. Nonanalytic processing increases participants' reliance on fluency (Johansson, 2009), and the fluency effect on classification judgments disappeared when participants were forced to analytical processing (Kinder et al., 2003). Second is the relevance of fluency sources: even adopted to apply, fluency may be unhelpful and lead to misattribution of nonspecific fluency to a salient judgement dimension.

Thus, there is considerable evidence of nonspecific fluency effects, but still, we do not know if a person could distinguish between relevant or irrelevant fluency instantiations when making judgments. Lanska and colleagues observed reliance on relevant fluency sources in recognition memory depending on instruction dimension (verbatim recognition vs meaning-based), and that diagnostic values of different fluency instantiations depend on the encoding-retrieval match in the emphasized attributes of stimuli (Lanska et al., 2014; Lanska & Westerman, 2018). However, they did not manipulate fluency sources within the same context when participants needed to differentiate between fluency instantiations. Notably, most of the misattribution effects were obtained in the one-sided influence of perceptual fluency on conceptual judgments, whilst the opposite influence of conceptual fluency on perceptual judgments was poorly observed.

In the present research, we aimed to investigate whether people can distinguish different fluency sources according to their relevance to judgments dimensions. People must distinguish between relevant and irrelevant fluency sources if fluency-based experience contains information about its source, i.e., information about specific cognitive processes (for example, to distinguish between the fluency of lower-level perceptual processing and higher-level semantic or conceptual processing). However, people cannot discriminate between different sources if the fluency-based experience is a cumulative form of different fluency instantiations. In contrast to previous studies (Lanska et al., 2014; Lanska & Westerman, 2018), different fluency instantiations were manipulated in the same stimulus context and were exposed simultaneously within the stimulus. Also, participants were forced to make two types of judgement depending on a more diagnostic type of fluency. To release the fluency heuristic as much more robust, we had to construct conditions that encourage nonanalytic processing. Thus, we chose an implicit learning paradigm because people are more likely to use fluency as an essential source of judgment in the lack of explicit knowledge.

Implicit learning is a process of unintentional and unconscious acquisition of complex knowledge, in which an individual cannot verbally express the content of the obtained knowledge, but they can use it to perform new tasks (cf. Perruchet, 2008; Moroshkina et al., 2017). Various experimental methods have studied implicit learning; one of the most frequently used is the *artificial grammar learning* paradigm (AGL; Reber, 1967, 1989). Generally, in the AGL task, participants memorize a set of letter strings generated by a complex set of rules, typically a finite state artificial grammar. In a subsequent test phase, participants are informed of a complex set of rules, i.e., artificial grammar, and are asked to categorize whether novel strings follow the rule. Most participants can classify the new strings at above-chance accuracy (see review in Pothos, 2007). According to the earlier Reber's view, people can abstract general structures across grammatical exemplars and apply them in the test phase (Reber, 1969; Reber & Lewis, 1977). However, several researchers suggested an alternative explanation of classification performance by which it processed similar to implicit memory: participants categorize items as grammatical or ungrammatical based on their similarity to specific training items (Shanks & St. John, 1994; Perruchet & Pacteau, 1990) or on specific fragments of them (Vokey & Brooks, 1992). This similarity-based approach fits more with fluency effects. Several implicit learning studies have shown that fluency heuristic plays a vital role as a default strategy in grammaticality judgement if people engage the nonanalytical processing and that irrelevant sources of perceptual fluency influence grammaticality judgment (Kinder et al., 2003; Topolinski & Strack, 2009: Experiment 11). However, we still do not know whether conceptual fluency may affect perceptual judgment. Previously Buchner (1994) showed only an effect of conceptual fluency source (grammaticality) on response time, which was operationalized as fluency measure: "grammatical" or "regular" stimuli are easier to process than "ungrammatical" or "irregular" (but Scott and Dienes (2010) showed that Buchner did bot balance fluency sources well). It was also shown that grammatical strings were liked more than ungrammatical ones (Gordon & Holyoak, 1983; Manza et al., 1998). Here we tried to find and compare the effect of an irrelevant source of perceptual fluency on the judgment of the compliance of a stimulus to implicit rules and the effect of implicitly acquired knowledge (a source of conceptual fluency) on the classification by perceptual characteristics of stimuli in the same stimulus context.

In our study, conceptual fluency was operationalized by the grammaticality of strings in the AGL paradigm. To operationalize perceptual fluency, we used the intensity of noise masks to cover test strings. To avoid side effects on judgments (like emphasizing specific features of stimuli during encoding; Lanska et al., 2014; Lanska & Westerman, 2018), fluency instantiations were manipulated only in the test phase. There were two dimensions of judgments based on their relevance to specific fluency manipulations: judgment of grammaticality for conceptual fluency and judgment of subjective ease of reading for perceptual fluency. We assumed that changes in the perceptual fluency of processing these stimuli would affect the judgment of accordance with the implicitly acquired knowledge (besides the effect of relevant sources of conceptual fluency and others). Changes in the conceptual fluency associated with implicitly acquired regularities would affect the judgment about the ease of perceptual processing (besides the effect of relevant sources of perceptual fluency and others).

Method

Participants

Forty-five students (39 female) from St. Petersburg universities took part in the study. They were from 18 to 35 years old (M_{age} = 21.64 years, SD_{age} = 4.62) and had normal or corrected-to-normal eye vision and colour acuity. All participants provided a verbal informed consent to participate. The protocol was approved by the Ethics Committee of Saint Petersburg Psychological Society.

Participants were tested individually at a computer. They were randomly assigned to one of the three between-participants conditions, depending on the instruction and type of stimuli: EGgram (15 persons), EGread (16) and Control groups (14). The differences between the terms are presented in the design and procedure section below.

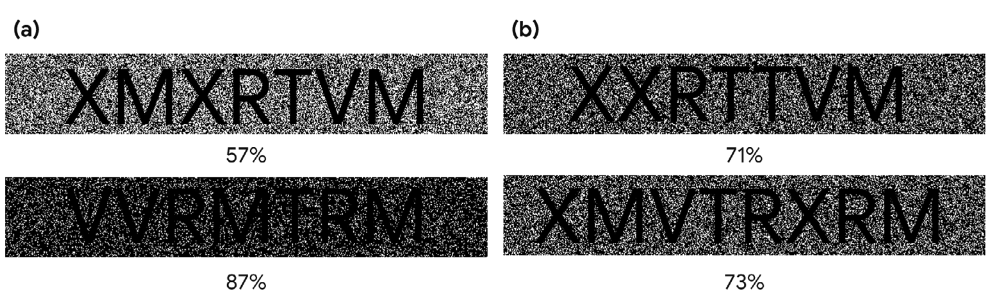
Apparatus and stimuli

Conceptual fluency varied by the grammaticality of strings. The set of training and test strings was generated from two grammars used by Scott and Dienes (2010). The string length was between seven and nine characters, balanced between two grammars. The training lists comprised 16 training strings from each grammar. The test list comprised 32 novel strings (16 from one grammar and 16 from another grammar). All strings were presented in the center of the screen in black text (Google Sans font) on a white background. Stimuli can be found in Appendix A.

We varied the perceptual fluency by the intensity of noise masks covering a rectangular area above the strings. The noise was created by randomly generating 2-per cent lack pixels at random locations within the rectangle. Sixteen noise masks were varying between 57% and 87% occlusion with 2-per cent increments (Figure 1); each mask was used the same number of times within strings composed of different grammars. The perceptual noise and grammaticality of strings varied

Figure 1

Examples of Stimuli with Overlapping Masks: (a) extreme intensity of noise and (b) minimum increments of 2 per cent (the minimum noise difference)



within participants in EGgram and EGread groups. To control the effect of noise masks, we included a control condition with a common AGL task.

Stimuli were presented in PsychoPy software (v. 3.2.3) on the personal laptop (15.6 inches, 1080Ч1920 graphics display resolution) with a screen refresh rate of 60 Hz, 32-bit colour depth ("true color").

Design and Procedure

We used mixed factorial design: Instruction in the test phase as between-participants factor × [Perceptual Noise above test strings × Grammaticality of test strings] as within-participants factors.

The experiment comprised a learning phase and a test phase. At the learning phase, all participants memorized training strings composed of artificial grammars. Half of the participants were presented with strings composed of grammar A and the other half with strings composed of grammar B. Training lists were repeated three times, strings were randomized separately within participants, resulting in 48 presentations in total.

At the test phase, participants from the first and third conditions (EGgram and Control groups) were informed that previous strings obeyed a complex set of rules at the test phase. Participants from the second condition (EGread) were not informed about the rules. We did not focus their attention on the irrelevant properties of the stimuli (grammar is irrelevant for EGread and intensity of noise is irrelevant for EGgram) because we were interested in whether people can distinguish fluency sources based on the specific cognitive processes and tried to reduce the impact of explicit knowledge. Therefore, we used a between-participants design here.

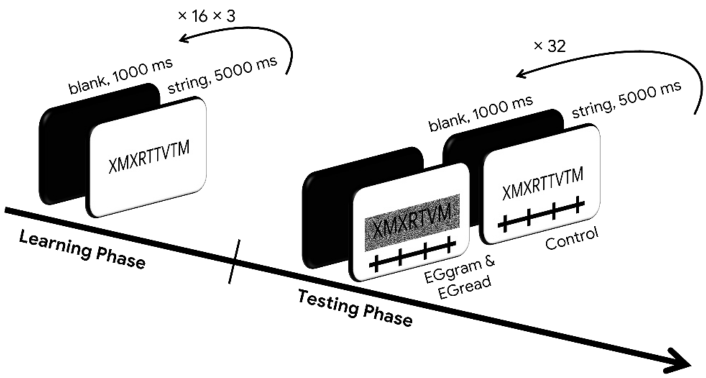
After the presentation of instructions, all participants were presented with novel strings from the test list (half of them were composed of learned grammar and another grammar comprised the other half). In EGgram and EGread groups, strings were presented with overlapping masks of the various intensity of noise. In the Control group, testing strings were presented without a mask. In both phases, strings appeared for 5000 ms and then disappeared; the response-stimulus interval was 1000 ms until the subsequent trial.

Participants from EGgram and Control groups were asked to rate strings according to grammaticality on a 4-rank scale from 1 ("not grammatical") to 4 ("grammatical"). Participants from the EGread group were asked to evaluate strings by the subjective ease of reading them on a 4-rank scale from 1 ("hard to read") to 4 ("easy to read"). Also, we asked participants from the EGread group not to evaluate masks but rely on subjective feelings instead of evaluating objective stimuli parameters (Figure 2). Instructions (Russian originals and English translations) can be found in Appendix B.

We expected that the grammaticality judgments in EGgram would be affected by the perceptual source of stimuli processing fluency besides conceptual source (grammaticality). In contrast, the judgments of subjective ease of reading in EGread will be affected by the grammaticality of strings besides the perceptual

Figure 2

The Procedure of the Experiment



source of fluency (intensity of noise). The control condition was added to test the effect of the presence of noise itself on judgment.

Data Analysis

To indicate grammar learning within EGgram and Control groups, we used a one-sample Student's *t*-test. The first Linear regressions with mixed effects were used to analyze the effect of perceptual noise on response time in grammaticality judgment a) between EGgram and Control group and b) between experimental groups. The first model included the Group as a predictor, the response time was used as an outcome, and a random intercept for every participant and stimulus was added. The Control group was used as a reference level. The second model was built for between experimental groups analysis. The regression model for each group included Noise as a predictor; an outcome and random intercept were the same as in the first model.

To analyze predictors of classification decisions, we used logistic regressions with mixed effects to account for between-participant and between-stimulus variability. Grammaticality and perceptual noise were used as predictors, classification decision as a binary outcome (scales with four responses were collapsed to create 2-point scales: "grammatical"/"not grammatical" or "easy to read"/"hard to read"), and a random intercept for every participant and stimulus was added.

Analysis of predictors of classification decisions for each group included four steps. First, we compared maximal models to restricted models with the interaction term removed to evaluate the interaction effect. Second, we compared restricted models with Grammaticality removed to restricted models with interaction removed to evaluate the contribution of the main effect of Grammaticality to the overall fit. Third, to evaluate the main effect of Noise, we compared restricted models without interaction to restricted models without Noise. Finally, we compared restricted models with only one predictor (Perceptual Noise or Grammaticality) to evaluate each predictor's relative importance.

The data analysis was carried out using statistical functions of R programming language (v. 3.6.3) and R package lme4 for mixed effects (Bates et al., 2015).

Results

Outliers

Three participants in the EGread group were excluded from the data analysis because of a strong response bias. They did not differentiate the strings by readability, i.e. they classified more than 90% of stimuli as easy to read. We assume it indicates a misunderstanding of the instructions or low motivation (similar approach: Ivanchei & Moroshkina, 2018).

Three per cent of the shortest and longest RTs for every participant were deleted from the analysis.

Learning

The probability of classification of test stimuli in both groups showed significant differences from the chance level (50%): 61.3% for EGgram, $t(14) = 4.69$, $p < .001$, Cohen's $d = 1.21$, and 61.4% for Control group, $t(13) = 3.59$, $p = .001$, Cohen's $d = 0.99$.

Response Time

EGgram did not significantly differ from the Control group, $B = -0.03$, $t(26.9) = -0.199$, $p = .84$. There were no significant differences between EGread and EGgram, $B = 0.01$, $t(43.5) = 0.05$, $p = .96$ in response time. The main effect of Noise was also not significant, $B = 0.005$, $t(95.2) = 0.581$, $p = .560$, as the interaction between Group and Noise, $B = -0.01$, $t(900.2) = -1.385$, $p = .17$.

Predictors of Cclassification Decisions

The interaction between Grammaticality and Noise was found not significant in EGgram ($\chi^2(1) = 0.39$, $p = .53$) and EGread ($\chi^2(1) = 0.79$, $p = .37$). The main effect of Grammaticality was obtained only in EGgram, grammatical strings were positively classified more often than ungrammatical ones ($\chi^2(1) = 26.4$, $p < .001$), but it was not significant in EGread ($\chi^2(1) = 0.003$, $p = .99$). We observed the main effect of Perceptual Noise in both groups (EGgram: $\chi^2(1) = 5.4$, $p = .02$; EGread: $\chi^2(1) = 41.27$, $p < .001$). The fit of the model with Grammaticality was slightly better (AIC = 625.27; BIC = 641.86; Log-likelihood = −308.64) than the fit of the model with Noise (AIC = 646.28; BIC = 662.87; Log-likelihood = −319.14) in EGgram. Thus, the model with Grammaticality has higher explanatory and predictive power in grammaticality judgments compared to the model with Noise. Reverse results were found in EGread: the fit of the restricted model with Noise was slightly better (AIC = 511.03; BIC = 527.85; Log-likelihood = −251.51) than the fit of the model with Grammaticality (AIC = 552.3; BIC = 569.13; Log-likelihood = −272.15). The model with Noise has higher explanatory and predictive power in judgments of subjective ease of reading compared to the model with Grammaticality.

The regression coefficients of the maximal models are displayed in Table 1 and Table 2. In addition, probability curves of log-odds ratios of maximal models are shown in Figure 3.

The obtained results showed an effect of perceptual noise on grammaticality judgments. However, there was no significant effect of grammaticality on judgments of subjective ease of reading.

Figure 3

Probability Curves of Log-Odds of the Maximal Model in (a) EGgram and (b) EGread Groups with 95% CI. Odds are p/p−1, where p is the probability of classification as grammatical (EGgram) or easy to read (EGread)

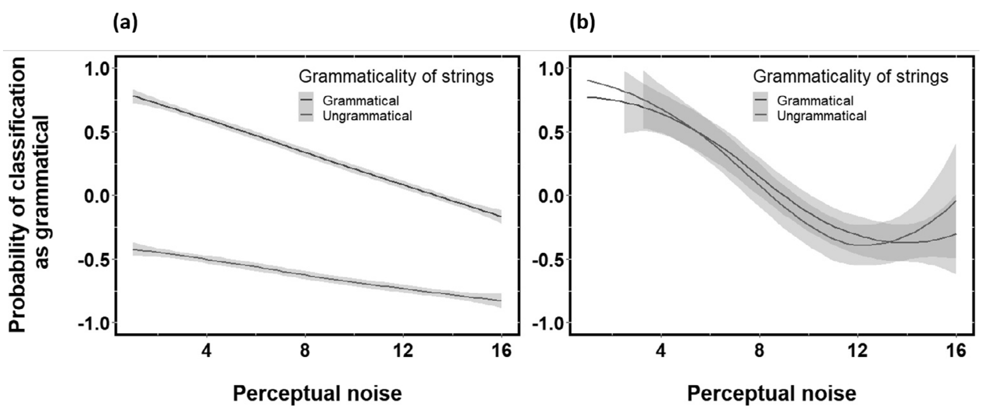


Table 1

Regression Coefficients (Betas) of the Maximal Model in the EGgram

Variable	Coefficient	Std. error	z value
(Intercept)	0.84	0.29	2.95**
Grammaticality	1.20	0.40	2.99**
Perceptual Noise	−0.06	0.03	−2.11*
Perceptual Noise × Grammaticality	0.026	0.04	0.63

Table 2

Regression Coefficients (Betas) of the Maximal Model in the EGread

Variable	Coefficient	Std. error	z value
(Intercept)	2.71	0.55	4.954***
Grammaticality	0.43	0.54	0.802
Perceptual Noise	−0.2	0.04	−5.248***
Perceptual Noise × Grammaticality	−0.05	0.05	−0.894

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Discussion

Our study aimed to investigate whether people can disentangle different fluency sources according to their relevance to judgment dimensions. We predicted that two types of judgement would be affected by irrelevant fluency instantiation in addition to relevant sources of judgements.

The effect of grammar learning was demonstrated in the EGgram and the Control groups. Based on these results, we may assume that participants in the EGread group also implicitly acquired relevant grammar because the training phase in all groups was the same. Although participants from EGread were not notified about the rules after the learning phase, we guess that conceptual fluency was changed between trials through the factors of repetition and structural accordance with an artificial finite state grammar (see Newell & Bright, 2001).

The experiment showed the effect of perceptual fluency (produced by changing the intensity of noise) on the application of implicit knowledge in addition to the effect of relevant factors. The less noisy strings were evaluated more often as grammatical in EGgram. Since we did not find significant differences in learning in EGgram and Control groups, noise masks did not make the classification task more difficult. It can be assumed that people rely on conceptual fluency in the application of implicit knowledge, which is produced by the stimuli' structural match between learning and test phases, and perceptual fluency (in addition to analytic heuristics).

These results provided evidence of the non-specific influence of perceptual fluency on grammaticality judgement, which corresponds to previous studies (Kinder et al., 2003; Topolinski & Strack, 2009). Our results expand the boundaries of the effect of perceptual fluency. In contrast to previous work, we used a static noise mask to manipulate perceptual fluency, while others used the speed of clarification (Kinder et al., 2003) or the figure-background contrast. Our experiment showed the effect of perceptual fluency precisely on judgment but not on response time. The perceptual factor has lower predictive power than the conceptual one (see Section *Predictors of Classification Decisions* in Results) because the grammaticality effect includes both the contribution of fluency heuristic and the contribution of relevant explicit knowledge (rules, exemplars, etc., Dienes & Scott, 2005). Presumably, this result may indicate that people tend to switch to the processing fluency heuristic if there was insufficient information from explicit knowledge (Higham & Vokey, 2000; Johansson, 2009; Scott & Dienes, 2010).

However, the hypothesis about the nonspecific effect of conceptual fluency on the judgement of ease of reading has not been confirmed. Following the interpretation above, different fluency sources may only affect the lack of explicit knowledge about the task and when the nonanalytic strategy is adopted. Perhaps, participants in the EGread group might firmly base their judgments of string readability on explicit characteristics without using the fluency heuristic. A second explanation for such an effect is that the participants could just confuse different tasks and evaluate the intensity of the noise but did not read the strings because this strategy was more straightforward than others. Earlier Jacoby and colleagues showed an effect of familiarity on judgments of the loudness of noise and the opposite effect (1988). However, there are some differences between their study and ours. They presented stimuli in the auditory modality, so their participants could not evaluate noise without word processing. Another difference between the studies is that the familiarity of the words in Jacoby and colleagues' study was significantly higher than the familiarity of the strings in our experiment. Hence, conceptual fluency was also significantly higher than in our study. It is possible that familiarity also determines the influence of conceptual fluency on perceptual judgments.

The third possibility to explain the results obtained in EGread may be provided by the fluency-specificity hypothesis that consists in the fact that "the processing experiences promoted by different fluency instantiations are not uniform and all alike and that people are able to dissociate between those different experiences" (Vogel et al., 2020, p. 1588). In their recent study, researchers used a similar design and showed that aesthetic judgments were affected more by visual contrast than content repetition and vice versa for judgments of truth. Based on this finding, the authors concluded that people could dissociate between conceptual and perceptual fluency experiences within the same context. It is possible that the relevant source of processing fluency had a much more significant effect on perceptual judgments. In grammaticality judgments, the influence of both sources of fluency was observed; nonetheless, conceptual fluency played a decisive role. However, some difficulties arise when comparing their results and ours. Suppose fluency heuristic has a powerful effect on judgments in the absence of alternative sources of judgement. In that case, the AGL tasks gain relevance to the question of specificity/non-specificity of fluency because of the lack of explicit knowledge and semantic processing in classification performance (unlike Vogel and colleagues' stimuli characteristics). Also, it raises doubts that aesthetic judgment sources lie in the perceptual dimension because there were shown effects of conceptual fluency sources (semantic priming, prototypically) on these judgments (cf. Reber et al., 2004). Finally, the fluency-specificity hypothesis does not explain the perceptual fluency effect on grammaticality judgment obtained in our study.

To sum up, our results are more consistent with the non-specific fluency hypothesis. It seems that different fluency sources affect judgments if it is based on a fluency heuristic and if the primary task is performing different levels of information processing. However, the effects of perceptual fluency misattribution are easier to find because the perceptual processing is activated in almost any cognitive task. In contrast, conceptual processing is activated only when it is necessary to recognize or classify objects. Additional research is required in order to find out which of the options indicated above is more plausible.

Limitations of the Study

The first limitation of our study is related to perceptual fluency manipulation. As mentioned earlier, our manipulation could be too easy to make a perceptual judgment, so participants from the perceptual judgement condition relied on explicit knowledge but not on fluency heuristic.

The second limitation of the study is the instruction that encouraged the participants to rely only on perceptual characteristics of stimuli in the perceptual judgement condition.

Conclusion

In this study, we developed a new experimental design that directly compares the effect of the irrelevant perceptual fluency source on the application of implicit knowledge and the effect of the irrelevant conceptual fluency source on perceptual judgment.

Taken together, our findings confirmed predictions of the non-specific fluency hypothesis in one direction only. Conceptual judgments may be affected by relevant and irrelevant fluency sources. However, we failed to create the opposite effect for perceptual judgment that can be explained by different factors of activation of high-level and low-level processing. Further, it is necessary to develop a perceptual task similar to the application of implicit knowledge in complexity. Next, studies should more precisely test our assumptions to perceptual judgments.

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Appendix A

Stimuli

Learning lists		**Test list**	
Grammar A	*Grammar B*	*Grammar A*	*Grammar B*
XMXRTVM	VVTRMTM	XMMXRVM	VTRRRRM
VVTRVTM	VVTTRXM	XXRTVTM	VVRXRRM
VTVTRVM	VVRMTRM	XXRTTVM	XMVRXRM
VTTTTVM	XMTRRRM	XMMMMXM	XXRRRRM
VTTVTRVM	XMVTTRXM	VVTRTTVM	XMVTRXRM
VVTRTVTM	VVTTRXRM	XMMXRTVM	VVTTRMTM
VTTTTVTM	VVTRXRRM	VTTTTTVM	VVRMTRRM
XXRVTRVM	VVRMVRXM	XMXRTVTM	XMVTRMTM
VTVTRTVM	XMVRXRRM	XMXRTTVM	XMVRMTRM
XMMMMMXM	VTRRRRRM	XXRTTTVM	VVTTTRXM
XXRTVTRVM	XMVRXRRRM	XXRVTRVTM	VVRMTRRRM
VTVTRTTVM	VVRMVTRXM	XMXRTTTVM	VVRMVRMTM
XMMMXRVTM	VVTTTRMTM	VVTRTTVTM	XMVRMVRXM
XMMMMXRVM	XMVTRXRRM	VTTVTRTVM	VVTTRXRRM
XXRVTRTVM	XXRRRRRRM	XMXRVTRVM	VVTTTRXRM
XMMMXRTVM	VVTTRMTRM	VVTRTTTVM	XMVTTRXRM

Appendix B

Instructions for the Experiment

1. Instruction for Learning Phase.

English translation:

Welcome to our experiment!

You are taking part in memory research.

Strings composed of Latin letters will appear on the screen in front of you. Your task is to read each string from left to right carefully and try to remember it. There will be 48 strings in total. Each string will be presented for 5 seconds.

Press the “spacebar” to start.

Russian original:

Приветствуем вас в нашем эксперименте!

Вы принимаете участие в исследовании памяти.

Перед вами на экране будут появляться строки, составленные из латинских букв. Ваша задача — внимательно читать про себя каждую строку слева направо и стараться запомнить ее. Всего будет 48 строк. Каждая будет предъявляться на 5 секунд.

Чтобы начать, нажмите клавишу «пробел».

2. Instructions for Testing Phase for EGgram and Control (without the example with noise).

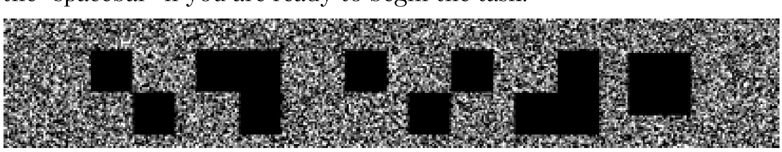
English translation:

The second phase of the experiment will begin now.

In the previous phase, you were presented with strings that obeyed a complex set of rules. Now you will be presented with similar new strings. A noisy rectangle will cover each string (see the example below). Your task is to read the string without paying attention to the noise and rate it on a 4-point scale to the extent that this string corresponds to the same set of rules as the strings from the previous stage (i.e., how grammatical it is). You need to press one of the keys from 1 to 4, where 1 is “non-grammatical”, 2, “rather non-grammatical”, 3, “rather grammatical” and 4, “grammatical”. Try to use all four grades.

Each string will be presented for 5 seconds, during which you should respond as quickly as possible. Concentrate your attention.

Press the “spacebar” if you are ready to begin the task.



Russian original:

Сейчас начнется 2-й этап эксперимента.

На предыдущем этапе вам были предъявлены строки, составленные в соответствии со сложным набором правил. Сейчас вам будут предъявляться аналогичные новые строки, поверх которых будет наложен зашумленный прямоугольник (как на примере ниже). Ваша задача — несмотря на шум, сначала прочитать строку, а потом оценить по

4-балльной шкале, настолько эта строка соответствует тому же набору правил, что и строки из предыдущего этапа (т.е. насколько она является грамматической). Для этого вам необходимо нажать на одну из клавиш от 1 до 4, где 1 — «неграмматическая», 2 — «скорее неграмматическая», 3 — «скорее грамматическая» и 4 — «грамматическая». Старайтесь использовать все четыре градации оценки.

Каждая строка будет предъявляться на 5 секунд, в течение которых вы должны как можно быстрее ответить. Сосредоточьтесь.

Если готовы приступить к заданию, нажмите «Пробел».

3. Instructions for Testing Phase for EGread.

English translation:

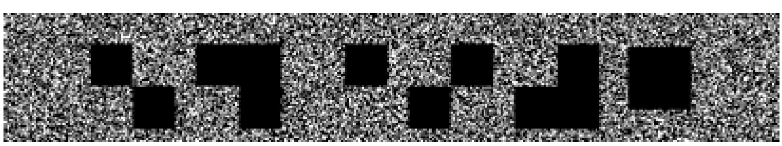
The second phase of the experiment will begin now.

Now you will be presented with similar new strings. A noisy rectangle will cover each string (see the example below). Your task is to read the string without paying attention to the noise and to rate it on a 4-point scale to the extent that this string is subjectively easy to read. You need to press one of the keys from 1 to 4, where 1 is «difficult to read», 2, «rather difficult to read», 3, «rather easy to read», and 4, «easy to read». The «readability'of strings depends on several factors (for example, length, lettering, noise, etc.), so try to evaluate the ease of reading the string and not the density of the mask or other. Try to use all four grades.

Each string will be presented for 5 seconds, during which you should respond as quickly as possible. Concentrate your attention.

Press the «spacebar» if you are ready to begin the task.

Russian original:



Сейчас начнется 2-й этап эксперимента.

Вам будут предъявляться новые строки, аналогичные тем, что Вы видели на первом этапе, поверх которых будет наложен зашумленный прямоугольник (как на примере ниже). Ваша задача — несмотря на шум сначала прочитать строку, а потом оценить по 4-балльной шкале настолько субъективно легкой для прочтения является строка. Для этого Вам необходимо нажать на одну из клавиш от 1 до 4, где 1 — «трудная», 2 — «скорее трудная», 3 — «скорее легкая», 4 — «легкая». Поскольку «читабельность» строки зависит от целого ряда факторов (длина, буквенный состав, шум и т.д.), важно, чтобы Вы старались оценить именно легкость прочтения строки, а не плотность маски как таковой. Старайтесь использовать все 4 градации оценки. Старайтесь отвечать, опираясь на собственные ощущения и интуицию.

Каждая строка будет предъявляться на 5 секунд, в течение которых вы должны как можно быстрее ответить. Сосредоточьтесь.

Если готовы приступить к заданию, нажмите «Пробел».