Original Article

Individual Differences in the Susceptibility to the Feature-Positive Effect

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Abstract: The feature-positive effect (FPE) is the phenomenon that learning organisms are better at detecting the association between two present stimuli than between the absence of one stimulus and the presence of the other. Although the FPE was first described over 50 years ago, it remains an ill-studied and ill-understood bias. Nonetheless, the FPE can have far-reaching negative consequences in various decision-making contexts. In the present contribution, an attempt was made to document the FPE with a within-subject measurement. Initial psychometric analyses (PCA, Cronbach's α, test–retest reliability, and concurrent validity correlations) suggest that such intraindividual measurement of the FPE is indeed possible. Consequently, individuals can be expected to differ in their susceptibility to the FPE. This individual difference factor can be measured with the described feature-positive effect test (FPET), which opens new research avenues in which FPE-proneness is taken as a starting point.

Keywords: feature-positive effect, individual differences, causal inferences, negative causation

The feature-positive effect (FPE) refers to the finding that learning organisms are better at associating two present stimuli ("if p then q") than at learning an association between a present stimulus and an absent stimulus ("if p then not q" and "if not p then q"). It was first observed by Jenkins and Sainsbury (1969) in pigeons. Imagine that a pigeon is reinforced for pecking at stimulus A + B but not at A alone. In that situation, B is a positive feature that predicts reinforcement. Now, imagine that a pigeon is reinforced when pecking at stimulus A but not at A + B. In this case, the absence of B predicts reinforcement and (–) B is thus a negative feature. Jenkins and Sainsbury discovered that pigeons learn the predictive power of the presence of B faster than that of the absence of B. In essence, the FPE boils down to problems with detecting negative causal relations.

By now, the FPE has been documented several times in pigeons (e.g., Pace & McCoy, 1981), but also in, for example, monkeys (Pace et al., 1980) and even honeybees (Abramson et al., 2013). Although they were not the first (see Sainsbury, 1971), Newman et al. (1980) are considered to be the authors who firmly established that humans also display an FPE. In a typical study, they presented participants with cards with four symbols (e.g., Δ, ▫, O, *, X, #, and/or T). Participants had to "guess as soon as possible the solution which reliably predicts whether a card is *good* or *not good*" (p. 632). After each card, the participant received feedback on his guess. For some participants, the to-be-discovered rule was that the presence of the triangle was the defining feature of goodness (cf. the feature-positive condition). For others (the feature-negative condition), it was the absence of the triangle. Newman et al. found that participants in the positive condition needed on average 17.8 trials to discover the rule. Participants in the negative condition needed 62.9 trials. This finding illustrates that people (like animals) have more difficulty with discovering the predictive power of the absence, compared to the presence, of stimuli.

There are several theoretical explanations for the occurrence of the FPE. First, when looking for associations between stimuli, it is quite logical that a present stimulus is more readily considered a possible candidate than an absent stimulus (Lotz et al., 2012). People are simply more familiar with positive causation than with negative causation (Wolff et al., 2010). Second, the identification of a present stimulus merely calls upon recognition of that stimulus, whereas the identification of an absent stimulus requires the more demanding process of recalling which stimuli were previously present, but are now, at the time of reinforcement, absent. Note that theoretically, the learning organism has to choose from an infinite number of possible stimuli. Third, and related to the previous points, the feature-positive identification corresponds with visual perception of the physical reality, whereas the search for negative predictors does not (Hovland & Weiss, 1953; Wason, 1959).

Although the theoretical explanations mentioned above are of interest, it must be acknowledged that none of them have been tested. In the words of Lotz et al. (2012, p. 229): "The feature-positive effect can be said to be a robust characteristic of human discrimination learning. It is thus particularly frustrating to discover that no single theory of learning can provide a wholly satisfactory explanation for this effect, unless it is assumed that this effect is a consequence of more attention being paid to relevant than to irrelevant stimuli." Indeed, while, since the eminent study of Newman et al. (1980), the FPE has been replicated a number of times in humans (e.g., Cherubini et al., 2013; Richardson & Massel, 1982), strikingly, the research on the FPE in humans is still primarily concerned with documenting the existence of the FPE in the first place (see Lotz et al., 2012). Only rarely, other FPE-related topics are targeted in scientific research, such as possible moderators (see Rusconi et al., 2012) or remedies (Rassin, 2014).

Consequently, to date, no attempt has been made to explore another crucial question, namely, to what extent individuals differ in their susceptibility to the FPE. Research on individual differences may fuel further insight into variables that reduce or inflate the FPE. In what follows, an attempt is described to document the occurrence of the FPE with a within-subject measurement. Note that research so far has mostly relied on between-subjects designs. An exception is the research by Richardson and Massel (1982). These authors found that the FPE can be observed in a within-subject design, but only if the discriminative stimulus in the positive and negative trials is different. If participants initially undergo positive discrimination learning and subsequently negative learning with the same predictor variable, the FPE will disappear. Hence, the authors found an FPE in a within-subjects design wherein participants had to discover a discriminative stimulus (e.g., the letter A in positive trials and the absence of the letter E in negative trials) by analyzing feedback on their guesses. Particularly, participants discovered the positive feature after 39 trials and the negative feature after 59 trials. The authors stress that for the FPE to be of general importance, it must be demonstrated using within-group designs (Richardson & Massel, 1982).

Furthermore, measuring the FPE with a within-subjects design is a first step in developing a measure of the FPE. While it would be of interest to have a measure of individual differences in susceptibility to the FPE, at least for research purposes, it seems unlikely that the FPE can be captured with a self-report measure. For one thing, the FPE is not easily explained to the respondent. Furthermore, the FPE may well occur in different decision-making domains and may thus be a consistent skewness in our decision making. In as far as it would then resemble a bias, it must be acknowledged that people tend to have a blind spot for their own biases (Kukucka et al., 2017; Zappala et al., 2018; see also Schwarz, 1999, for an overview of potential problems with self-reports). With this in mind, the aim was to develop a test in which the participant is placed in a decision-making context that allows for the occurrence of the FPE. An initial version of such a test was described by Rassin (2014). Based on the work of Newman et al. (1980), the idea behind the test is that the participant is presented with various constellations of symbols. In some instances, there is a picture of a cat among the symbols. In other constellations, the cat is absent. The participant is instructed to find out how the presence of the cat can be predicted. Unknown to the participant, in some cases, the presence of one of the symbols predicts the presence of the cat (positive trials), while in other trials, the absence of a pertinent symbol predicts the presence of the cat (negative trials). Hence, the performance on positive and negative trials can be registered. The FPE dictates that people perform better at positive compared to negative trials.

In this contribution, an initial attempt was made to create a test for the intraindividual measurement of the FPE. First, the test is described (Study 1). Second, test–retest reliability is discussed (Study 2). Third, correlations with higher-order traits are described (Study 3). Fourth and finally, meaningful correlation with a relevant behavioral measure is discussed (Study 4).

Study 1: Item Development of the Feature-Positive Effect Test (FPET)

Participants

Eighty-two undergraduates participated in this study. The mean age of the sample was 21.3 years (*SD* = 2.02). Sixty-nine (84%) participants were women. Participants in this, and the other studies reported, were enrolled in an introductory psychology course and received extra course credits in return for their participation.

Measure

To measure the FPE intraindividually, 10 one-page trials were created. In each trial, there are 10 bars with constellations of symbols. In some bars, a cat (Pipa) is present. As mentioned, the participant has to find out how the presence of the cat can be derived from the

Table 1. Descriptives for the 10 FPET trials

FPET trial	Percentage of correct responses (%)	Factor I	Factor II
Positive trials			
Trial 1	65	.65	.12
Trial 3	62	.78	.35
Trial 6	56	.62	.58
Trial 7	51	.69	.10
Trial 10	59	.74	.45
Negative trials			
Trial 2	50	.86	.08
Trial 4	50	.85	.21
Trial 5	52	.84	.19
Trial 8	52	.82	.38
Trial 9	48	.79	.31

constellation of symbols. The instruction was as follows: "In this test, the occurrence of the cat is to be predicted. On each page, there are 10 constellations of symbols. In some instances, the cat is present in the centre of the constellation, in others, it is not. The presence of the cat depends on the constellation of symbols. You must try to find out how the occurrence of the cat is predicted, on each page." Next, participants completed the 10 trials (see the Appendix). All participants completed the trials in the same order, without time constraint. Thus, for everyone, Trials 1, 3, 6, 7, and 10 were positive (the presence of the cat can be predicted from the presence of a symbol), and Trails 2, 4, 5, 8, and 9 were negative (the presence of the cat can be predicted from the absence of a symbol). The number of correctly solved positive trials ranges from zero to five. So does the number of correctly solved negative trials. The main variable borne out from this feature-positive effect test (FPET) is the difference between the number of correct responses on the positive trials (range 0–5) and negative trials (range 0–5). This difference score (positive minus negative) ranges from −5 to 5, with scores above zero indicating an FPE.

Results

Where possible, both inferential null hypothesis significance testing and Bayesian analyses are reported. Crucially, Bayesian analyses yield a Bayes factor (BF_{10}) that represents the likelihood ratio for the fit of the data under the alternative and under the null hypothesis. BF_{10}s smaller than 1 indicate that the data fit better under the null hypothesis than under the alternative hypothesis. BF_{10}s larger than 1 suggest that the alternative hypothesis predicts the data better. BF_{10}s larger than 3 can be interpreted as positive/substantial support for the alternative hypothesis (Jarosz & Wiley, 2014).

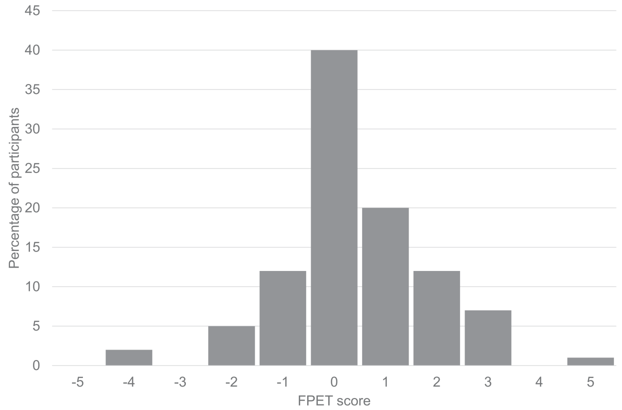

Figure 1. Distribution of FPET difference scores (percentages).

Table 1 presents participants' responses on the 10 trials. These responses were first entered in an unrotated PCA to explore internal cohesion of the trials. This analysis yielded two factors with eigenvalue > 1.0 (namely, 5.88 and 1.01, respectively). As can be seen in Table 1, all items loaded satisfactorily on the first factor, but not on the second factor. Cronbach's α for the 10 trials was .92.

On average, participants solved 2.93 positive trials correctly (*SD* = 1.88) and 2.52 negative trials (*SD* = 2.19), yielding an FPET total score of 0.40 (*SD* = 1.49): one sample $t[81; \neq 0] = 2.45$, $p = .017$; $BF_{10} = 1.5$). The distribution of difference scores is displayed in Figure 1. As can be seen, this distribution was fairly normal (skewness < 1.0, Kurtosis = 1.51). It is also apparent that 40% of participants did not display an FPE while 20% even demonstrated a feature-negative effect. The remaining 40% did display an FPE. The FPET total score was not associated with age ($r = -.03$, $p = .763$; $BF_{10} = 0.09$) or gender ($t[80] = 0.05$, $p = .963$; $BF_{10} = 0.22$).

Discussion

The goal of the current study was to explore whether the FPE can be documented in a within-subject measurement. So far, such an attempt was made only once by Richardson and Massel (1982). In line with previous findings, the current measurement employed different feature stimuli in all trials, and the positive and negative trials were intertwined. The present measurement differed from that used previously in that it can be administered quite easily, without intervention from a psychologist. By contrast, the measurement used in previous studies required the psychologist to register the number of trials needed to discover a causal relation.

The findings suggest that, when measured on an individual level, we generally tend to be better at detecting positive causation compared to negative causation. However, individuals obviously differ in their susceptibility to this skewness, with 40% of participants displaying the FPE to some extent, but others displaying no or even a reversed effect (i.e., a feature-negative effect). Consequently, overall, the observed FPE was significant but small.

The results of the PCA suggest that the FPE is a one-dimensional construct, which was confirmed by a high Cronbach's α. This one-dimensional operationalization of the FPE deserves some further justification. Admittedly, the use of a difference score can be criticized. A disadvantage is that the information inherent in the original variables (i.e., the performance on the positive and negative trials) is lost. However, if desired, these original scores are obvious from the test results. Difference scores have also been criticized because they may be less reliable than the original scores. This may be particularly so if reliability is defined as the correspondence between the test score and the actually measured variable, that is, the true correspondence as a proportion of true correspondence plus error margin. It can be statistically deduced that the smaller the difference between the original variables is, the less reliable the difference score becomes (see Thomas & Zumbo, 2012). The suppressed reliability may reduce the sensitivity of the difference score, leading to false-negative findings in research, but paradoxically possibly also to false-positive ones (Edwards, 2001). Hence, it is advisable to use original scores instead of difference scores when possible. Arguably though, for practical purposes, the FPET score is much more convenient than the original two scores for positive and negative trials, for example, compared to a situation in which a pre- and postmeasure of mental health is considered to be captured in one difference score. While the practical usefulness of the FPET total score arguably outweighs the potential statistical limitations, it has been argued that much of the critique on difference scores is unjustified and can actually be construed as myths (Edwards, 2001).

Study 2: Test–Retest Reliability

To explore temporal stability, 66 undergraduates (82% women) with a mean age of 21.73 years (*SD* = 3.01) completed the FPET (see the description under Study 1) twice, with a 5-week interval. Participants were recruited from an introductory psychology course and received extra course credits in return for their contribution.

The mean FPET score at T1 was 0.61 (*SD* = 1.33; one sample $t[65; \neq 0] = 3.69$, $p < .001$; $BF_{10} = 43.48$; $\alpha = .92$). The mean score at T2 (5 weeks later) was 0.39 (*SD* = 1.37; one sample $t[65; \neq 0] = 2.51$, $p < .028$; $BF_{10} = 1.07$; $\alpha = .93$). The correlation between the two measurements was .34 ($p < .006$, $BF_{10} = 4.26$; *ICC* = .50).

These findings suggest that, as in Study 1, the FPET has good internal reliability in terms of Cronbach's α. Also as in Study 1, the present sample displayed a significant but small FPE. While the mean score at T2 was lower than that at T1, the difference was not significant: $t(65) = 1.19$, $p = .240$; $BF_{10} = 0.19$.

The test–retest correlation and the *ICC* (which is more robust against the nonsignificant difference in FPET scores between T1 and T2) suggest that the FPE is somewhat, although not strongly temporally stable.

Study 3: Correlation With Higher-Order Personality Traits

The purpose of the current study was to explore correlations between FPE-proneness and general personality characteristics. Arguably, if susceptibility to the FPE is to be construed as a personality trait, correlations with higher-order traits can be expected. Particularly, because the FPE has been associated with anxiety (Rassin et al., 2008), it can be expected to be associated with neuroticism.

Method

Participants

Seventy undergraduates (58 women, 83%) with a M_{age} of 21.42 years (*SD* = 3.75) participated in this study in return for course credits. Participants completed the measures online without time constraint. Participants were recruited from an introductory psychology course and received extra course credits in return for their contribution.

Measures

Participants completed the FPET, as described in the previous studies, and the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975).

The EPQ consists of 48 *no/yes* items tapping three high-order personality traits, namely, extraversion, neuroticism, and psychoticism. Each trait is measured with 12 items, and thus, total scores range from 0 to 12, with higher scores indicating a stronger presence of the pertinent trait.

Table 2. Descriptives and correlations between the FPET and the EPQ

Test	*M* (*SD*)	Cronbach's α	2	3	4
1. FPET	0.93 (1.74)	.87	−.30*	−.17	−.14
2. EPQ-extraversion	8.58 (3.22)	.87		−.20	.16
3. EPQ-neuroticism	6.30 (2.99)	.77			−.01
4. EPQ-psychoticism	2.20 (1.62)	.37			

Note. * $p < .050$.

Results

Descriptives and correlations are presented in Table 2. As can be seen, FPET scores correlated negatively with extraversion, but not with neuroticism or psychoticism.

Discussion

The current findings are somewhat surprising. In the first place, we anticipated an association between the FPET and neuroticism, but failed to observe that. Given that we did find a significant (negative) correlation between the FPET and extraversion, this null result is not likely to be caused by a lack of power. Second, the negative association with extraversion was not anticipated and remains unexplained because there is no theory dictating or prohibiting that such association occurs. Finally, it is remarkable that the EPQ-psychoticism scale had low reliability, which makes this scale's noncorrelation with the others difficult to interpret. Meanwhile, these findings are not very supportive of the idea that FPE-proneness is a stable personality characteristic.

Study 4: FPE-Proneness and a Behavioral Measure of Confirmatory Decision Making

In this study, support was sought for the validity of the FPET. Unfortunately, in the literature, there is hardly any reference to concepts with which the FPE is associated. However, there is a good reason to argue that it may at least underlie confirmatory decision making or preference for positive test strategies. In the words of McKenzie (2005, p. 208), there seems to be a "combination of positive testing – in this case, asking about features expected to be present if the working hypothesis is true – and the fact that participants are more affected by the presence of features than by their absence." In addition, the FPE may fuel confirmation bias as hypothesized by Skov and Sherman (1986): "…there may be very good theoretical reason for expecting confirmation strategies in information seeking. Both humans and animals show difficulty in processing negative information (disconfirmations as proof of a hypothesis) and in using non-occurrences as cues for making judgements and decisions" (p. 98). In this study, the association between the FPE and confirmatory decision making, tapped by a small thought experiment, was explored. Based on the limited theory available (McKenzie, 2005; Skov & Sherman, 1986), a positive association was anticipated.

Method

Participants

Seventy-eight undergraduates (63 women, 81%) with a M_{age} of 21.63 years ($SD = 2.39$) participated in this study in return for course credits. Participants completed the measures without time constraint. Participants were recruited from an introductory psychology course and received course credits in return for participation.

Measures

Participants completed the FPET as described in the previous studies. Then, they received the following instruction: "Imagine that you play a game in which you need to locate an object. Beware that this object is not the price. It is 100% certain that the object is hidden behind one of two doors: A black and a white door. You are allowed to open one of the doors to find out whether the object is there or not. You have a hunch that the object is hidden behind the black door. Which door will you open?" Participants then circled their response (*black door/white door*).

Results

Forty-nine participants (63%) chose the black door (i.e., the confirmatory strategy). Twenty-nine chose the white door. The former participants scored higher on the FPET ($M = 1.06$, $SD = 1.61$) than the latter ($M = 0.21$, $SD = 1.24$; $t[76] = 2.46$, $p = .016$, $BF_{10} = 2.64$).

Discussion

As hypothesized, the FPE was positively associated with confirmatory decision making. Hence, the current findings are the first to deliver empirical support for the considerations brought forward by McKenzie (2005) and Skov and Sherman (1986). It is important to note that in the thought experiment used to measure confirmatory decision making, both alternative strategies (i.e., the black door and the white door) are in fact equally diagnostic. Therefore, a preference for confirmatory testing does in this instance not imply a confirmation bias. This limitation may have suppressed the association between the FPET and the confirmatory decisions in the thought experiment, in as far as participants who understood the diagnosticity of both options may have refrained from their usual confirmatory strategy. Also, the study was limited by the fact that we imposed the hypothesis (the item being behind the black door) on participants, rather than having them test (i.e., confirm or disconfirm) their own hypothesis.

General Discussion

The purpose of the current contribution was to develop and describe a measurement of the FPE that can be employed intraindividually and can thus be construed as a psychological test. Given that the FPE is arguably immune to introspection, the measurement cannot rely on self-report. An additional challenge was that, one exception excluded (Richardson & Massel, 1982), the FPE is always demonstrated in between-subject designs (i.e., one group of participants receiving positive instruction and another group receiving negative instruction). Eventually, an easily administered 10-trial test was developed. Preliminary scrutinization suggests that this test is coherent (Study 1) and somewhat temporally stable (Study 2). Furthermore, we found an unexplained negative correlation with extraversion (Study 3). The FPET scores displayed a theoretically sound association with confirmatory decision making (Study 4).

Limitations

The current research and data have various peculiarities and limitations that deserve attention. First, as to the nature of the FPET, it was already mentioned that the total score is in fact a difference score, which is practically convenient but statistically limited. It is also important to acknowledge that the FPET defines the FPE as a superior detection of positive compared to negative causation. That is not the only possible operationalization of the FPE. By comparison, Newman et al. (1980) employed the number of trials needed to detect one positive or one negative association anyway. Hence, the definition of the FPE underlying the FPET is quite specific. Furthermore, the FPET aims to be an easily administered, old-fashioned, pen-and-paper test. However, in this digital era, online tests might also look at other potentially relevant variables, such as decision time and confidence (see Rassin, 2014).

Second, it should be noted that throughout the studies, the FPE was significant but small. The mean FPET scores ranged from 0.21 to 1.06, with a potential range from −5 to 5. Third, and possibly related to the second limitation, all studies relied on (different) student samples, which makes the extrapolation to the general community unwarranted.

Fourth and foremost, while the FPET seems to be a reliable and valid measure of the FPE in terms of structure and cohesion (Study 1), and in its association with confirmatory decision making (Study 4), it remains to be seen to what extent the FPE is a trait and/or state phenomenon. While we like to argue that the FPE possesses trait-like qualities, our data cast doubt on that claim. For one thing, the test–retest correlation was small to modest, suggesting that the trait is not very stable (Study 2). Also, we did not obtain the expected association with neuroticism but got an unexplained correlation with introversion instead (Study 3). Finally, the FPE seems to be not only small but also fragile. For example, the effect may be inflated or suppressed by instruction. Note that the instruction in the FPET is quite neutral in that it evades hinting that the solution of the trials lies in the presence or absence of any symbols. In a study by Rassin (2014), the FPE was suppressed by alerting participants that the solution to some of the trials lies in the absence of symbols. In fact, a study done in our laboratory suggests that the FPE can be manipulated by giving participants either a positive example and then five positive trials or giving them a negative example followed by five negative trials. Not only did the performance on the congruent trials increase by this manipulation, but the positive manipulation, as compared to the negative one, also fueled confirmatory decision making (selective exposure) in a subsequent allegedly unrelated task. This experiment is accessible as a supplementary material to this contribution on OSF. Obviously, the possibility of manipulating the FPE supports the state quality of the phenomenon, but not the trait characteristic.

The described FPET will primarily benefit research. That is, the study of the associations between the FPE and numerous other cognitive phenomena becomes easier with this test because it allows for designs in which FPE-proneness is taken as a starting point. For example, a phenomenon that seems akin to the FPE, but has not been associated, is the omission bias which dictates that people react more emotionally to the same outcome if it is the result of one's action compared to one's inaction (Spranca et al., 1991). To illustrate, we tend to feel worse if we are involved in a traffic accident after we have decided to take an alternative route, compared to when we have considered an alternative, but ultimately decided to stick with the original route. While the omission bias pertains to a skewed emotional evaluation of situations, the existence bias reflects a skewed moral evaluation (Eidelman et al., 2009). Particularly, we tend to assume that any given situation must be somehow right, merely because it occurs. Counterfactual alternatives are, by contrast, considered not right because if they were right, they would exist. Obviously, associations between the FPE, omission bias, and existence bias are an interesting topic for future research. In the longer run, a measure of individual differences in the susceptibility to the FPE may also become useful in selection contexts. Imagine a situation in which the prevention of false-negative conclusions is of essence (e.g., a disease screening context; see also Wolfe et al., 2005), or the context of evidence evaluation in which sensitivity to negative evidence is crucial (see Liebman et al., 2012), or a context wherein observers evaluate (positive and negative) contributions in collaborations (Savitsky et al., 2012). For example, when coauthoring a manuscript, additions made by collaborators are oftentimes considered more valuable than deletions. Generally, work that leaves little physical evidence and thus merely maintains or restores status quo (think of an artist restoring a painting, a SWAT team preventing a crime, or a group of economists preventing financial crisis) tends to be detected and valued little. In such contexts, it would be helpful to have a tool that selects individuals who are at low risk of falling prey to the FPE.

Conclusion

In conclusion, the present findings suggest that the FPE can be measured with an easy-to-administer within-subject test. This will open avenues for future research of the FPE, which remains to date, half a century after it was first described by Jenkins and Sainsbury (1969), a meagerly studied, ill-understood, and somewhat enigmatic phenomenon.

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Appendix

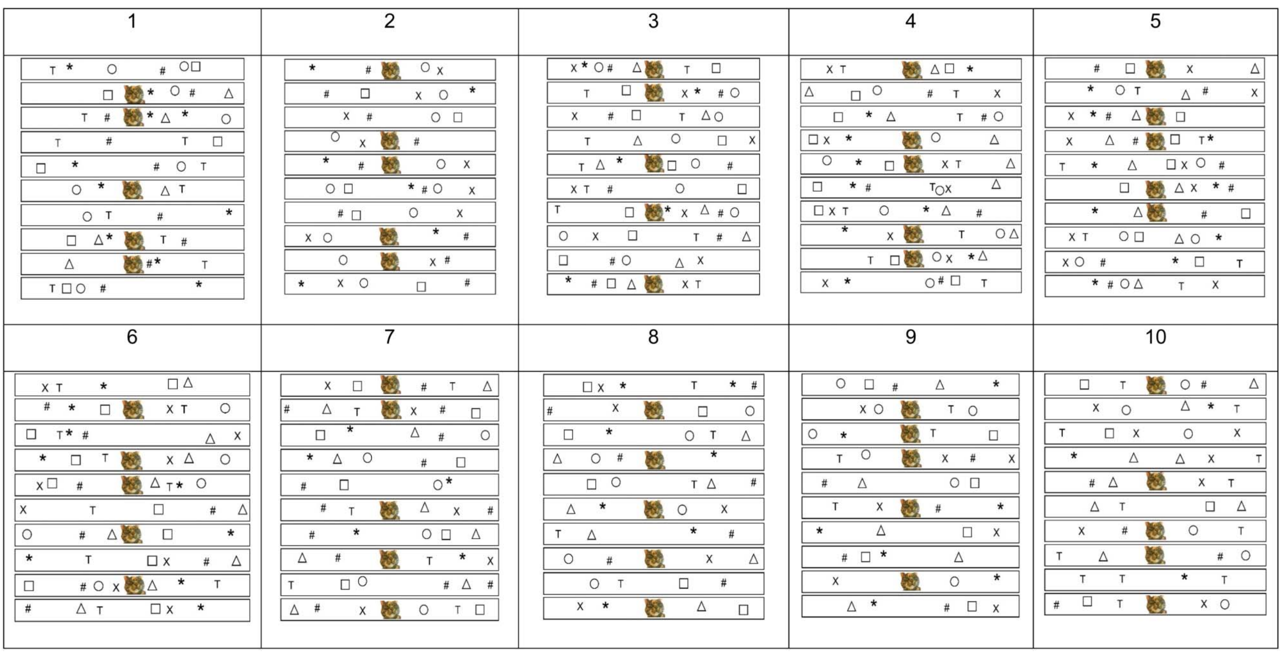

Figure A1. Ten trials of the FPET. *Note. Solutions.* 1 presence of a triangle; 2 absence of a square; 3 presence of a star; 4 absence of a hashtag; 5 absence of a circle; 6 presence of a circle; 7 presence of X; 8 absence of T; 9 absence of a triangle; 10 presence of a hashtag.