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Inevitable Magic – Reason, Magic and Manipulation.

A thesis submitted to Middlesex University in fulfillment of the requirements for the degree of Master of Philosophy by Research (MSc)

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Abstract

Magical thinking occurs when supernatural causes, as opposed to rational ones, are assumed in events that defy reasonable probability. To investigate magical thinking, 64 adults were tested in a novel experiment where they were told they were playing an online game with opposing players. However, neither the "Game" nor the opposing players were real. It was a presentation designed to provide an illusion of game play. The "game" consisted of two sessions, each showing three opposing players (six rounds each). Half the opposing players were "seen" (pre-recorded videos with confederates posing as players) and the other half were "unseen". To play the "game", participants were asked to choose a card (from a set of five) and then observe the opposing player attempt to guess that card without being able to see it. Participants were then shown that one-third of opposing players displayed "good luck" (many correct guesses, defined by a by an above average score), one-third "neutral luck" (some correct, defined by an average score), and one-third "bad luck" (almost none correct, defined by a below average score). After the game, participants were asked to score each player on how likely they are to choose that player for a second stage of the game (in reality, there was no second stage). In the results, there was a significant effect of "luck" (with higher preferences for higher luck). There was also a significant effect of visibility (seen players preferred over unseen). Participants also completed two questionnaires to assess their disposition for magical thinking. There was a weak effect of questionnaire scores on the preference for luck. Results are considered in the context of research in anthropology and psychology.

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Table of Contents

Chapter 1

Reasoning and Magical Thinking

1.1 Inductive vs. Deductive Reasoning and the Problem with Probability

"Man, facing the unknown, must, in order to reduce cognitive discomfort, generate a formula which yields a satisfying sense of understanding." – (Wallace, 2013, p.19)

The above quote highlights the hugely important need of human beings to explain the unexplainable, often using methods that are in themselves irrational but none the less have an internal logic. Superstition and superstitious behaviours are ways of generating the understanding of the unknown, acting or deliberately refraining to act in specific ways to ensure a positive outcome, when there is no causal relationship between those actions and the outcomes (Skinner, 1948, p.168-172). Where rational means fail to explain an event, we are unlikely to believe those means (Hood, 2010), and seek pathways to explain them in kind. This is the creation of a supernatural superstition through magical thinking, and while this may appear to be an inadequate way of processing a situation, cognitively they could be a fundamental way of reducing the risk of failing to exploit an existing causal relationship, or of trying to exploit a non-existent causal relationship (Abbot & Sherratt, 2011, p.85-92), thus having a critical bearing on risk management and perception.

From an evolutionary standpoint superstitions might be considered an anomaly, a set of behaviours that cost more than benefit and therefore would be presumed to fade as more beneficial behaviours bear more reliable success. To make up a shortfall in information about the causal relationship between ones own behaviour and an event, superstitious behaviour tries to modify the unknown through apparent observed success, aided by instinct, (Foster &

Kokko, 2009) personal experiences or cultural transmission (McNamara et al. 2006; Beck & Forstmeier 2007; Abbot and Sherratt, 2011, p.85).

Here, I propose an experiment and questionnaires to test for the susceptibility of a participant to create irrational properties and associate them with a person that has been shown to be lucky or unlucky in an experimental setting; then test for any preferences that may result from this. In addition, participants will be questioned as to the nature of this reaction, with questions that explore likely schemas that would account for the results generated within the experiment. A questionnaire measuring the participant's perception of paranormal events will be taken, to see if there is a correlation between a person's general perception of unlikely or unexplainable phenomena, and the susceptibility to the associate these phenomena to others.

Humans reason in two generally accepted ways; through *deduction*, the inference of an outcome by reference to a principle or generally accepted law, or *induction* by which acceptable principles are formed from those outcomes (Reisberg, 1997). Both are used to not only as a strategy to learn new concepts, but also as a path to build connections between learning schemas, an aid to create pathways for decision-making. Traditionally, the two have been viewed as rival methods of thought, with deduction achieving accurate and logically robust conceptions of reality and induction producing somewhat ineffable conclusions as they are based on corroboration (Hammond 1996). Crucially, inductive reasoning as an inferential method for deriving knowledge relies on corroborating, rather than proving, a claim about knowledge to aid decision-making. As such, it utilises metaconceptualisation to not only form but also inform these corroborations. Whereas conceptualisation is the ability to maintain a concept about a physical object or event, metaconceptualisation is the ability to maintain concepts of mental states (Sperber 1996, p. 71). Metaconceptualisation is therefore critical in the formation of abstractions about events; one could not disbelieve or express

doubt in a concept or event without the opposing metaconceptualisation of the event being true. Both abstractions in this instance are created through inductive generalisation about the event, when faced with an event that cannot be proved. Inductive generalisations rely on a small number of phenomena to extrapolate a knowledge claim for a larger amount of phenomena; and can easily result in flaws, as the small sample may not be representational of the larger group.

Inductive generalist reasoning involves several strategies including analogical reasoning; where previous experiences are labelled *source domain* and used to inform inferences for situations that are inconsistent, incomplete or contain elements that are not understood or fragmentary, called a *target domain* (Gentner et al. 1997, p. 5). Analogical reasoning is a process formed of three sequential steps that work to understand a target domain.

1) The first creates a surface domain, a set of conceptualisations and relations from long-term semantic memory that can best match the target domain, based on surface similarities. While what the target domain is and how it triggers the subject remains specific to the subject based on their understanding (and therefore creation) of the target domain, the first step of the analogical reasoning process is seen to be universal (Gentner 1989, p. 231 -232). I would argue that it is this universal core process where misconceptions in the perception of causality are copied from long-term memory and applied to the target domain. A combination of the structural cognitive pathways that lead to magical thinking and the reinforcement of these pathways lead to the creation of surface domains that misrepresent causality.
2) The second step in the analogical reasoning process maps the retrieved analogues to the target domain and is comprised of two universal conditions that provide linkage between the source domain and the target domain. The first is one-to-one mapping,

where each concept in the target domain must correspond to a concept in the source domain (Gentner 1989). In terms of an event where the outcome defies what one may consider to be an average probability, a subject would necessarily draw upon instances in their long-term memory that correspond to similar events where the outcome was unexpected. A distinction need to be made here however, between events that are merely surprising, and those which defy a subjects perception of what they would classify as within the normal limits of probability. The second condition is that of parallel connectivity, where the relations between the concepts much match. If both conditions are met, then the implication is that the entire structure of relationships that have been recalled in the source domain can be used to inform the entire structure of the relationships in the target domain, and a new analogy is created. So in addition to the surface similarities of the first step, the second stage establishes a structural similarity. This requires a subject to draw upon a large amount of memory that involves not just the concepts themselves, but the relationships between them. That in turn means that the subject and target domains cannot just be linked by category, but thematically.

3) The third step in the analogical reasoning process applies to equally to the surface and the target domains and the new analogy by judging how robust it is. This judgement depends on how successful the analogy is in improving understanding of the target domain, the relevance of the analogy. If the analogy is deemed to be untenable, the entire process is repeated until an analogy is formed that stands up to the subject's judgement (see Fig 1.1).

While the first two steps have been argued to be unaffected by culture (Gentner 1989, p. 230), the third step is the most susceptible to cultural factors. What is relevant to a subject depends largely on the culture they have been exposed to throughout their lives. In the

framework of magical thinking, how a culture perceives events that defy causality or explanation will irrevocably alter a subject's judgement to future events that bear similarities. If a culture has traditions of magic, a framework that exists parallel to the physical world for example, and this tradition is held to be as real as the physical world, then the third step in the analogical reasoning process would be judged against concepts that from a rational point of view would be impossible.

Deduction on the other hand, is the creation of conclusions that do not require external validations via internal judgements, as they must be true given that the premises they are based on are true. Piaget argued that formal reasoning (i.e. methods used in mathematics and logic) in the form of deduction is arrived at in early adolescence with children spontaneously reiterating the rules employed (Beth & Piaget 1966). Humans are universally gifted with a mental logic. In essence, in order to form conclusions, the reasoning mechanism applies a number of deductive rules to the abstract logical form that an encoding device has extracted from a set of premises. Therefore performance (measured by the difficulty of the problem face and the accuracy by which the problem is solved) can theoretically be predicted by the likelihood that a heuristic is available for use based on the context of the problem and the number of heuristics required to make the deduction.

Figure 1.1

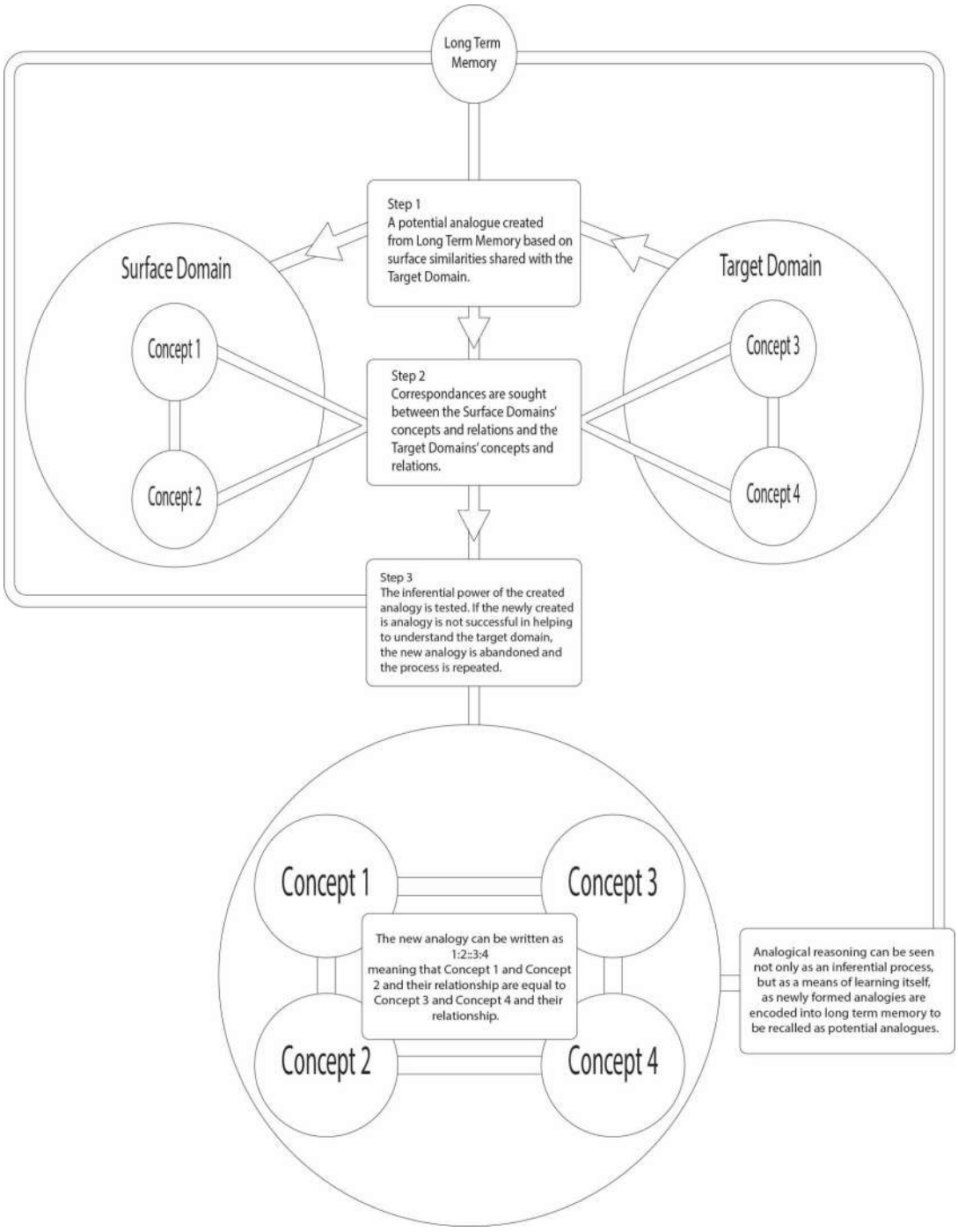


Fig. 1.1

Displaying a simplified version of Gentners model of analogical reasoning. The steps describe the process by which a new analogy is formed, and how the concepts and

relationships in the surface domain correspond between to the concepts and relationships in the target domain. An original production by the author.

The paradox created by these two rationales for reasoning is clear. Where deduction can be flawed in the availability and rationality of the heuristics applied, induction is by its nature flawed by its corroborative nature. However, people in everyday life still manage to make accurate judgements using both systems. Wason and Johnson-Laird in 1972 conducted experiments that suggested that while subjects regularly commit logical errors, when the content of the problem was changed to an everyday problem, many people made the correct selections. The experiment ran thusly:

Four cards were laid out in front of subjects labelled as A, B, 2, 3. Subjects were informed that if a card had the number 2 on one side, it must have the letter A on its reverse, and vice versa. They were then asked to select the cards that must be turned over to find out if the stated rule was true or false. Most of the subjects selected the cards A and 2, or A alone. The problem lay in the fact that subjects rarely selected the card labelled 3, for if that card had an A on its reverse the rule is false. When the choices however were changed to an everyday generalisation however, subjects made the more logical selection.

It seems therefore from the example above that the even insofar as the task in front of the subject is deductive, the assumed mental logic is confused by the effect of the content of the stated rules which have no effect on the logic of the choice.

Logic can be viewed as providing critical boundaries for human thought (Davidson 1984; Quine 1953). Logic contains the proof of a thought not only with its conclusions but also within its structure. A simple example of such would be All A are B, All B are C, therefore All A are C. Regardless of what the categories of A B and C are, this proof remains valid as there is no reliance on any other facts. If the first statement is true, and the second

statement is true, then the third must be true. That logic is undeniable not through the content of its constituent parts but the relationships that exist between them, that the conclusion is in fact just another means of stating the premise. To refute the structure of logic is not then a mistake, but is incoherent. No new facts are required for this conclusion to be reached. This property is called monotonicity, in that while structure of the above model cannot be changed with external knowledge, new facts can alter the premise and a new conclusion will therefore be formed but *within the same structure*.

In contrast, reasoning in humans is overwhelmingly *nonmonotonic*, in that all conclusions can be overturned with new information. The inference of, for example, *Its cold outside and I am about to leave my house* to *I will be cold,* contains within it many indefinite premises that can in turn overturn the conclusion, for instance that it might be warmer soon, that temperature itself is relative, that the subject will wear a warm coat, etc. The Frame Problem posited by McCarthy and Hayes in 1969 eloquently described this problem in the developmental stages of the science of artificial intelligence. It runs thusly:

A subject has a base of knowledge, K, and proceeds to make action A. What other information in the base of K needs to be updated in order for this action to be accurately accounted? The problem is that while nearly all previous information in K would be unaffected, the consequences of A are radically altered based on the circumstances of A itself and therefore any conclusions based on K can be logically overturned.

In addition, adding a new piece of information, F, that does not necessarily concern A, can render conclusions of K in extremely idiosyncratic ways; it is impossible to restrict the inferential consequence of F in advance. Nonmonotonicity can therefore apply to items contained in K, and of course any inference resulting from K that can be overturned by the addition of new premises and are therefore logically invalid in themselves (Fodor 1983; Pylyshyn 1987). To combat nonmonotonicity, and therefore the problem of everyday

applications of logic, Bayesian probability posits that while humans are typically unable to apply the large amount of calculation required by probability computation, they are sensitive to patterns of qualitative probabilistic reasoning. Simply put, Bayesian probability is interpreted as the quantification of a personal belief in an event or argument. It is represented mathematically in Figure 1.2.

Figure 1.2

$$P(A/B) = \frac{P(B/A)P(A)}{P(B)}$$

Where A and B are events and P (B) ≠ 0

P (A/B) is a conditional probability: the likelihood of A occurring given that B is true.

P (B/A) is also a conditional probability: the likelihood of B occurring given that A is true.

P (A) and P (B) re the probabilities of observing A and B independently of each other, known as the marginal probability (Ord, 1994).

The mental models view that assumes that subjects create mental models of what is causal that are governed by internal formulae that are regarded as true (Johnson-Laird 1983). The Mental Model posits that subjects that are unfamiliar with the above calculus infer the probabilities of events by creating an array of mental models that have an equal probability of what is true (Johnson- Laird, 1983; Johnson-Laird & Byrne, 1991). These mental models are a representation of a scenario that has a similar structure and content to that of an imagined possibility. However it would be a mistake to assume that probability calculus is not a factor

in the creation of mental models, that subject's beliefs are the determining factor in assigning probability to these models as well as an events probability being dictated on the amount of models in which it occurs (Johnson-Laird 1999).

The Conjunction Fallacy

Tversky and Kahneman (1983) proposed a fallacy in the calculation of probability by naïve subjects. As shown in Fig 1.2 (page 9) the probability of the conjunction P(A&B) cannot exceed the probabilities of its constituent parts, P(A) and P(B). Tversky and Kahneman found that subjects frequently used intuitive heuristics that are not bound this by this rule, that a conjunction can have a higher representativeness than a constituents and that "instances of a specific category can be easier to imagine or to retrieve than instances of a more inclusive category. The representativeness and availability heuristics therefore can make a conjunction appear more probable than one of its constituents."

In effect, this papers experimentation is a continuation of Tversky and Kahnemans research and manipulate this effect to discover if, when participants are faced with a probability event that falls outside the statistical average for the Negative and the Positive Confederates, any difference in judgement is apparent, and then with the questionnaire that follows link this behaviour (if it exists) to specific schemas of magical thought according to the Rational Thinking and Magical Thought scale detailed in Appendix 3.

Neuroimaging studies have discovered evidence that humans indeed have more than one method for evaluating events (Goel, Gold, Kapur, & Houle, 1997; Osherson et al., 1998). When viewing a series of arguments, subjects were asked to decide in a first condition whether the arguments premise contained the conclusion and in the second condition if the premises made the conclusions more or less probable. The studies found that different areas of the brain were activated dependent on whether the task was deductive (as in the first condition), or inductive (as in the second condition).

As discussed above, there are multiple ways of viewing how humans perceive the events that occur around them and how they react to them in turn. In the following subchapters, these various methods and more will be viewed through the lens of magical thought and how the following experiment was constructed.

1.2 Magical Thinking from an Anthropological Perspective

Magical thought has been a topic of interest and frustration for anthropologists for over a century and has many perspectives. There are several viewpoints have stood out in anthropological theory, and in my experience as an anthropologist each contain a percentage of the truth that inform and add complexity to the other, two of the most relevant to this paper I have highlighted here.

Firstly, that magic is an irrational procedure built from symbolism and existing in phantasy, as an attempt to control the uncontrollable (Malinowski 1935, 1945). Malinowski found that Triobriand Islanders in the Western Pacific used ritual magic more when sailing and fishing than in agriculture. When planting crops, Triobrianders could rely on relatively simple reasoning to insure a satisfactory crop, mainly that if they planted sufficiently, and the soil and weather was in their favour, they would succeed. However on the sea, during fishing expeditions or trading missions with other islands, the risks were far higher, meaning the outcomes where far less predictable. There was even a difference in the use of magic ritual between the fisherman that worked in the lagoon, verses those that worked on the open sea. Weather had a much higher impact on lives out at sea, fish were harder to find and catch, the sheer number of variables in any given voyage outside local waters were impossible to numerate let alone calculate. In addition to the number and scale of possible outcomes, the pace by which various outcomes occurred was increased immeasurably. Where weather events or soil quality would have effects over a long period of a season or a year, faulty equipment maybe identified and fixed within a day with no harm done, sailing is a different matter entirely. Faulty equipment could cost a life; repairs are difficult to carry out at sea. Weather events turn deadly very quickly, or indeed could becalm a boat for weeks to the

same effect. Shoals of fish behave in ways infinitely more complicated than root vegetables and therefore require a lot more knowledge to predict, and even then there are no guarantees. There are certainly no guarantees when dealing with other islands. Malinowski posited that there was a direct link between risk and magical thought, that the higher or more inscrutable the risk, the more likely that magical thought is used as a method of understanding and affecting this risk. There has been a large amount of experimental research that has lent weight to this theory, for example Rudski & Edwards, 2007 where the aim of the study was to investigate the relationship the use of superstitious stragies in conditions of uncertainty. Subjects were presented with a task where they could use either their own selection of a card or use a card selected by a 'psychic'. It was found that when there was a perceived likelihood of failure, a subject's chance of selecting a superstitious tactic, namely the use of the psychic's selection over their own, increased, regardless of the subject's actual belief in psychics. This study presents several interesting ideas, apart from providing a clear linkage between risk and magical thought, namely that subjects are likely to use supernatural means to aid them in tasks where probability is the main factor. This in itself presents an interesting dichotomy, even when the subject does not themselves have any faith in the supposed ability of psychics, they will still utilize the psychic for their benefit. Magical thought is not only a passive reaction to a risk situation; it is a flexible mechanic that provides logic for behaviour.

Secondly, proposed by Evans-Pritchard, that magic is a form of the scientific principle, a comparative set of heuristics that provide a framework for explanation and implementing will over events. In his ethnographic research with the Azande of the South Sudan, Evans-Pritchard in 1937 found that they held both the natural and the supernatural in equal partnership in terms of misfortunate events. An example of this was an event where a granary collapsed after the supports had given way, killing everyone inside. The Azande

knew that the supports had been eaten away by termites, and that it could have fallen at any point. There use of reasonable logic was not flawed; however they still insisted, as with most unfortunate events, that the reason why the granary had fallen at the particular point when there were people inside was due to witchcraft. The two principles, that of rational logic and irrational magic, both follow their own laws and have a systemic approach to events, and both are equally true, equally believed. There is no difference between magical thought and rational reasoning, they are both valid pathways to understanding situations in specific ways. Why did the granary fall at that specific time, killing those people, and not at midnight when the granary was empty? The termites were the cause, termites acted as termites do, but the shock of the loss of life required an explanation beyond the physical, which magical thought in this case about witchcraft, provided the answer. An emotional event required an answer that served its question.

In a more industrialised western setting, magical thought and superstitious thinking is prevalent in nearly every part of society, with professional athletics being especially pronounced. I would posit that the reason behind the overwhelming acceptance of magical thought as a factor in sports (as opposed to magical thought in say, religion, where the suggestion that magical thought has an influence is met with resistance) is because of the symbiotic relationship between the fans and the sports people and teams. Fans are invested in teams on an emotional level that is renewed and reenergised every time they watch the sport being played. Sports are kinetic, melding tactics and movement (or at least the tactic). Within each match or event there is a built in narrative, of overcoming odds, opponents, records, success and failure; but paired with an overarching metanarrative of how teams or individuals are performing over a season, a career, a lifetime. With sports, the risks are separated from the observers but felt as keenly as if they were participating themselves.

This example displays both of the aspects of anthropological perspective discussed earlier, principally that magical thought is a reaction to situations that have a structural aspect of risk, and that magical thought is a mirror image of the scientific principle in terms of logical structure if not causal reality.

Reasoning and Magical Thinking

1.3 Magical Thinking in Psychology

Magical thinking has been defined as a category mistake with in the construct of metal domains; a belief that one can exert some kind of control or that control is being exerted externally by supernatural agents or forces, that defy the laws of cause and effect (Lindeman & Aarnio 2007). There are examples in all human cultures and there is anthropological evidence that magical thinking, represented by practise, have their origin at the inception of human culture (Campbell, 1959; Guthrie, 1993). The concept has been variously looked at as having a pragmatic purpose (Nemeroff & Rozin, 2000; Vyse 1997) or as a cognitive error (Piaget, 1928). Piaget posited that the foundations of magical thinking develop from the conflict of phenomenalism (where chronological and physical proximity suggest one event caused another) and efficacy (where emotional reactions or wishes are causal) when infants first establish a connection between their physical reality and their mental intentions at the third developmental stage between the ages of 3 to 7 months (Piaget, 1954, 1927; Subbotsky, 1992). When children use these pre-causal modes of thinking there is a confabulation between casual relationships and correlational relationships. As they grow older this confabulation lessens as ontological beliefs alter with increased exposure to information and transition to primarily causal relationships from correlational between ages 4 through 9 (Carey, 1985; Subbotsky 2004). So as well as being an affect of cognitive development, superstitious behaviours, rituals (either personal or societal), religious practices, are manifest innumerably in modern society (Vyse 1997; Zusne & Jones 1989). These behaviours are causally obscured, their causes not logically apparent but nevertheless engaged in with the same vigour as less obscured behaviours.

Overimitation, or the copying of causally opaque behaviour, is not unique to our species, but is far more important in our development than compared to other primates

(Horner & Whiten, 2005). A useful example of overimitation and the perspectives employed is that of Sylvia's Recipe (Gergely & Csibra, 2006), described below.

Sylvia is a scientist that employs a specific way of cooking a ham, learned from her mother at an early age, and never questioned it for the remainder of her life; she cuts off both ends of the joint before placing it into the oven. When Sylvia then cooks a ham in this manner for her elderly mother in adulthood, her mother expresses surprise, while Sylvia herself had never questioned it. The reason why Sylvia's mother had cut the ends of the ham was that the roasting dish she owned was not large enough to fit an average joint of ham so she was forced to cut off both ends. There are a number of possibilities as to the assumption that the young Sylvia made when she watched her mother prepare the ham. Sylvia may have assumed that the practise had a physical-causal relationship, for example that this preparation led to the improvement of the flavour of the meat, even if this instrumental purpose was only known to her mother, a more experienced cook. However it is equally possible that a more normative, noninstrumental understanding of the technique was deployed. It could be that this was an affect of social class, that displayed her mother's sophistication in comparison to others, or an ethnic tradition passed down from previous generations. It is possible that the Sylvia's recipe had a supernatural function, one that allowed the spirit of the deceased animal to escape via the cuts her mother made. Or perhaps the most confusing reason, that the meat should just be prepared like this, without a reason.

Developmental psychologists have historically viewed children as using basically explicit hypothesis to explore and test their environment (Gopnik, 2000; Piaget, 1928). When children copy actions that have demonstrated purpose but the actions that produce this are seemingly needless or extraneous, the inference is that they have overattributed causal worth to the extraneous elements as they do not know the purposes behind them (Lyons, Young, & Keil, 2007). That children do so would imply a level of implicit trust with the person that

they are imitating, that they must have a valid reason for behaving in this way and that every action has a meaning, regardless of how inscrutable it is to the child observing (Tomasello 2009). However a purely psychological viewpoint may not be the best to uncover the mechanism that drives this behaviour. In social anthropology, the view is that humans are universally predisposed to imitate behaviours that are incomprehensible in principle via teleological reasoning in the anticipation that the behaviour serves a *social* rather than a technical purpose (Legare & Whitehouse, 2015). Magical thought is certainly not limited to the lack of cognitive maturity or level of education, (Rozin, Millman, & Nemeroff, 1986; Subotsky & Quinteros, 2002). As cognitive maturity progresses there is a higher dependency on logical principles in concert with a greater accuracy in information gathering, which can compound faults in logic the older a person gets (Markovits & Vachon 1990). Adults clearly engage in magical thought in many areas of their lives on a daily basis, without internally ever describing it as "magical". In the absence of overt contingency humans often perceive a causal relationship (Ward and Jenkins 1965). In addition, there is evidence that people treat events that are based on probability alone as controllable. Henslin in 1967 studied the players of craps at casinos and observed that they clearly exhibited behaviour that suggested they thought they had a measure of control in their outcomes, in that they threw softly for a low numbers and harder for high numbers. This suggests not only that they engaged in magical thinking when trying to influence the result, but that even the type of action was defined by the want of a specific result. Players had decided, due to rules that are casually opaque, that throwing harder would induce higher numbers, and vice versa. This suggests linkage between physical strength and higher numbers, which in turn suggests a magical logic, a mode of thinking about causality that while defying the rational, nevertheless makes its own sense by its own logic. Langer in 1975 defined the illusion of control as "an expectancy of a personal success probability inappropriately higher that the objective probability would warrant." In

experiments designed to induce inappropriate confidence Langer introduced factors apart from skill including competition, choice, familiarity, involvement, and found that experimentation supported the prediction that subjects did indeed act more confidently in situations where the above factors have been introduced.

It follows therefore that there is a cultural dimension to the acquisition of knowledge during the course of socialisation that is causally obscured. For instance, we can operate in a complex world of technology without having to know every aspect of its function or design. We create a analogical space where the reason we do not have to know every aspect of a target domain is two fold, firstly the event is reliable, secondly that the knowledge of how a target domain occurs is available to learn should we wish to, or that there are others that have this knowledge and their application of it is a reliable as the target domain itself. When the event falls out of this criteria and is therefore causally obscured in a much stronger sense, it cannot be reasoned using a logical causal rationale (Whitehouse, 1992, 1995, 2000, 2004; Humphrey & Laidlaw, 1994; Sorensen, 2007). Rosengren and Hickling (2000) stated that magical thinking could be a part of an independent domain of knowledge based upon a concept of "magic" which follows alternative rules of causality compared with foundational forms of causal logic. Religion in particular has a large amount of magical thinking built into its structure and has been suggested to be an advantage in individual and group fitness (Wilson, 2002). One could argue that the majority of culture universally falls into this category, that from the outside aspects like religion, fashions, social mores and manners, do not have a clear causal relationship with reality.

Magical thought is widespread in all major sports (Buhrmann, Brown, & Zaugg, 1981), including but not limited to behaviours related to post game activity, pregame activity, clothing, food; but more broadly defined as any behaviour that is separate from technical performance or ability, exist in a formal or sequential structure, or are repetitive, indeed all

behaviour that involves actions to manipulate the outcome but do not have a rational causal foundation (Womack, 1992). These behaviours can be seen to be highly ritualised due to their repetitive, sequential and symbolic natures. While there is no rational causal link (touching a rabbits foot for luck does not have any effect on probability, certainly not for the rabbit) but an effect has been shown for the athlete or team by the lowering of anxiety levels; Becker, 1975; Buhrmann et al 1982). Magical thought in the form of ritualised behaviours has been thought to be separate and distinguishable from behaviours that maybe occur with the same frequency or at the same time like preperformance routines, which are used specifically to enhance physical performance (Cohn, 1990). I would argue that there are large number of similarities between the two not in the specific practise but the results. For example, the use of cognitive preperformance routines that includes relaxation techniques, strategies for focusing the mind and coping with the stress of performance, imagery that may help in these strategies; they are prepared and delivered by an individual or group that holds the status of expert (like a coach or a sports therapist or psychologist) a prerequisite of which would be the analyses of team performance (Ravizza & Osborne; 1991 Eklund, Gould & Jackson, 1993). To my mind, the similarities are clear although as always in the realms of magical thought, somewhat muddled. Personal rituals can, in opposition to preperformance routines, be created entirely by the individual. However they are formed in the same manner, namely an assessment of performance. While this assessment is by definition subjective as it is carried out by the individual, it still follows the same logic of success and failure, the difference being that what has been identified as causal is in error. It is extremely difficult to identify even from a professional objective perspective, what makes a player more skilful than the next when they are operating within the same scenario with the same training and experience. Skill always has a somewhat nebulous factor at least in its assessment. From a subjective analysis, it is unsurprising that an emotional assessment would include a causal flaw. In

addition, while personal rituals are indeed created by the individual, this is denying the other factors in its creation. While preperformance routines are constructed and bestowed by experts in a position of authority, rituals can be created and passed on in a similar manner. A new player may be instructed in a team-wide ritual, the experienced players taking the role of experts in authority. The mere fact that other players have their own rituals may inspire rituals in other players out of a need for group compliance. As to the rituals themselves, they occupy the same functional space as preperformance routines. Images that encourage relaxation and other relaxation techniques, strategies to focus the mind and cope with stress, could easily be factors in ritualised behaviour, and if have been created by the individual are necessarily more personalised. The main difference to my mind in the practise and results of ritual and preperformance routines is that preperformance rituals have an effect on player performance regardless of whether the player believes they have an effect or not, in opposition to ritual where belief is a necessary factor (although given the evidence of studies like Rudski & Edwards, 2007, belief may not be as critical to the process of magical thought and its effects on subject mind-set than may have been previously thought).

Order of hits and misses and the Belief on Small Numbers

In their study entitled 'Belief in Small Numbers' 1971 Tversky and Kahneman posited "People have erroneous intuitions about the laws of chance. In particular they regard a sample randomly drawn from a population as highly representative, that is, similar to the population in all essential characteristics".

This conclusion is a demonstration of magical thought on a relatively basic level, the assumption that success now is indicative of success later without any supporting evidence to create further premises other than the previous results. Tune in 1964 found evidence that supported this, significantly for this papers experiment in that when Tune's subjects were asked to create a random sequence of tosses of a "fair" coin (fair here meaning untampered

with and thrown the same conditions every time); they produced a pattern that in any short segment assigned the result of 'heads' that stayed far closer to 50% than the laws of chance would predict. As Tversky and Kahneman point out in their 1971 study, this creates "A conception of chance based on representativeness, therefore, produces two related biases. First, it induces a belief that the probability of heads is greater after a long sequence of tails than after a long sequence of heads-this is the notorious gambler's fallacy (see, e.g., Tversky & Kahneman, 1974). Second, it leads people to reject the randomness of sequences that contain the expected number of runs because even the occurrence of, say, four heads in a row-which is quite likely in a sequence of 20 tosses-makes the sequence appear nonrepresentative (Falk, 1981; Wagenaar, 1972)."

The Contagion Effect

In order to avoid a participant being affected by the previous results of a confederate in either the observed or unobserved condition, all of the results in a round are displayed at the same time when the participants are asked to make the judgement about future performance.

In magical thought theory, the law of contagion involves the transfer of behavioural properties from one object or person to the next (Nemeroff & Rozin, 1992, 2000; Rozin, Millman, & Nemeroff, 1986). Where the previous research here focuses on the transference of a concept like disgust from for example a piece of clothing owned by someone who has recently died, here the mechanic is that a previous confederates performance may effect the next confederates performance.

The hypothesis is that superstitious perceptions can be created and reinforced with the manipulation of a participant's perception of observed luck; that there is a predisposition for participants that employ higher levels of magical thought to be more susceptible to this bias;

and that the nature of this superstition can be broken down into specific types of reactions to various schema.

In addition, a Rationality and Magical Thought Scale has been produced and tested, in order to bridge the gap between a general belief in the paranormal and the specific event created in the experiment. The research here endeavours to shed light on the relationship between the general beliefs in the paranormal which is argued to be more influenced by culture and society and the specific behaviours and reasoning strategies used when confronted with a paranormal event (in this case a belief that a person that has an ability to accurately guess a card with greater accuracy than the statistical average and that this ability can be replicated).

Chapter 2

Method

2.1 Design

A computer program was created in Microsoft PowerPoint that the participants are playing a game against opposing players. The results are displayed and participants are asked to express a preference to their opposing players based on these results. The opposing players are in fact pre-recorded confederates and the results are manipulated so that the confederates have had positive luck, negative luck and neutral. In addition, two separate, within-participant conditions of play are included, in that the participant can observe the confederate they are playing against, or not. Participants are separated into two groups, the only difference being the order in which they play with an observed/non-observed confederate.

The computer program (hereafter known as the Game) has been designed specifically to limit the amount of explanations available for the results created in game. A complete page-by-page break down of the game is included in Appendix 1. Participants are informed that they are playing with other participants involved in the same experiment being conducted around the world. The game displays five Zener Cards, the opposing player (observed or not observed), and the results generated (Fig. 2.1). Zener Cards have been used in parapsychology since its inception, see materials for details).

Figure 2.1

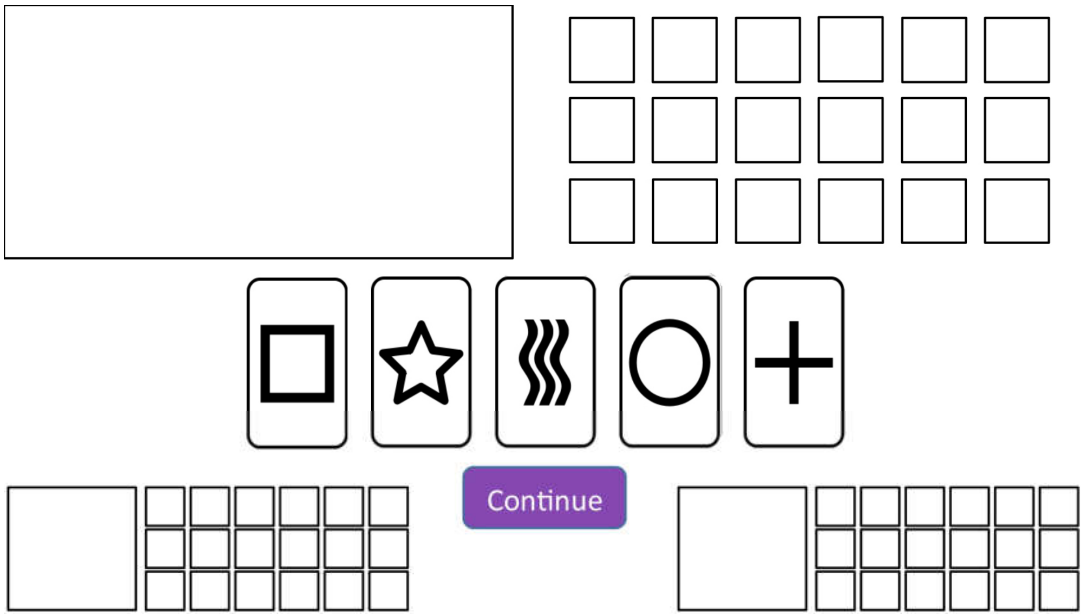


Fig 2.1

Displaying the layout of the program that the participants interact with, the Zener cards are interactive and can be selected.

Participants are required to select one of the cards, the pair of which is then ‘guessed’ by the opposing player, i.e. it appears as if the confederate is a live participant and is actively playing. The results of this selection are displayed next to the opposing player (Fig 2.2).

Figure 2.2

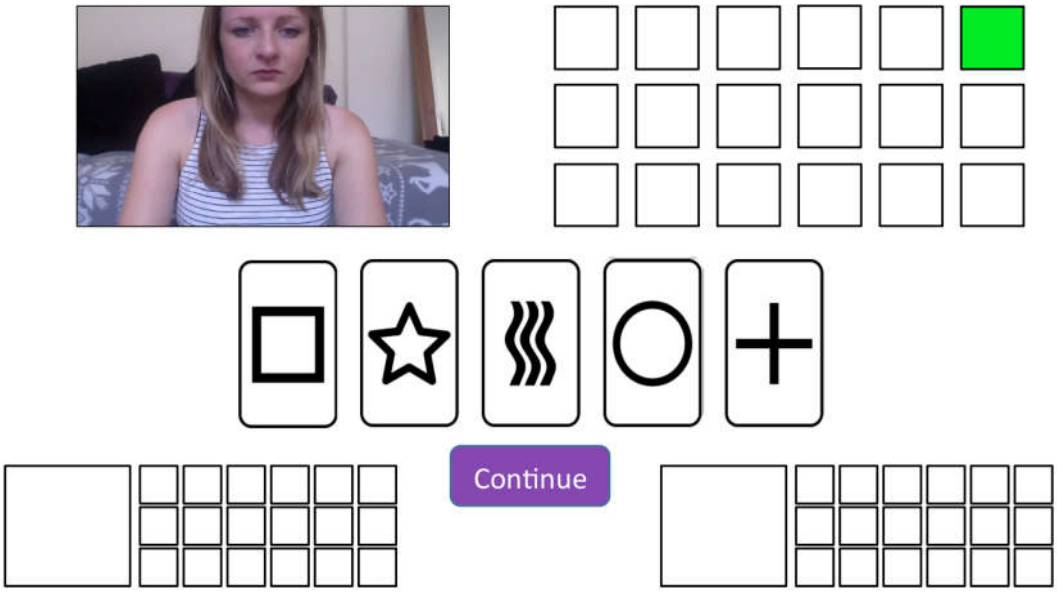


Fig 2.2 Displaying the layout of the program and the position of the results and confederate 'live' video.

The purpose of this is to place the onus of responsibility for the result upon the opposing player. Thus, it is their performance that is the operative element. The results are pre-programmed so that the confederates either 1) perform well 2) perform badly 3) score averagely. After each round of three, the results of the confederates are displayed (Fig 2.3) participants are asked to complete a questionnaire with the following question: Which player would you like to play with again? Options range from Strongly Disagree, Moderately Disagree, Slightly Disagree, Uncertain, Slightly Agree, Moderately Agree, and Strongly Agree (Appendix p153). Two rounds of three are completed, where participants have completed the above questionnaire twice. When the participants are asked to complete the questionnaires, the confederate's results for that round are displayed. This means that possible reinforcement bias created by the order of the positive, negative and control

conditions are negated and that participants are exposed to; and asked to express a result for, every condition of confederate, positive, negative and control and observed and non-observed for each.

The game creates a pattern of results for each confederate. As the participant does not know that the confederates are pre-recorded or that their results are fabricated, it limits the possible explanations as to why they have the scores they have achieved. As with any explanation for any performance that deviates from the average result expected given the probabilities available, the explanations available are either rational or superstitious. The questionnaire requires that the participant express an affinity based on performance. If the participants were following a rational explanation (i.e. the game was rigged, the other participants were cheating, or indeed any explanation that does not involve luck or any other supernatural explanation) as to the in-game results, one would expect the results of the questionnaire to be a lower score per confederate with no deviation between them based on performance or on whether they were visible to the participant.

Figure 2.3

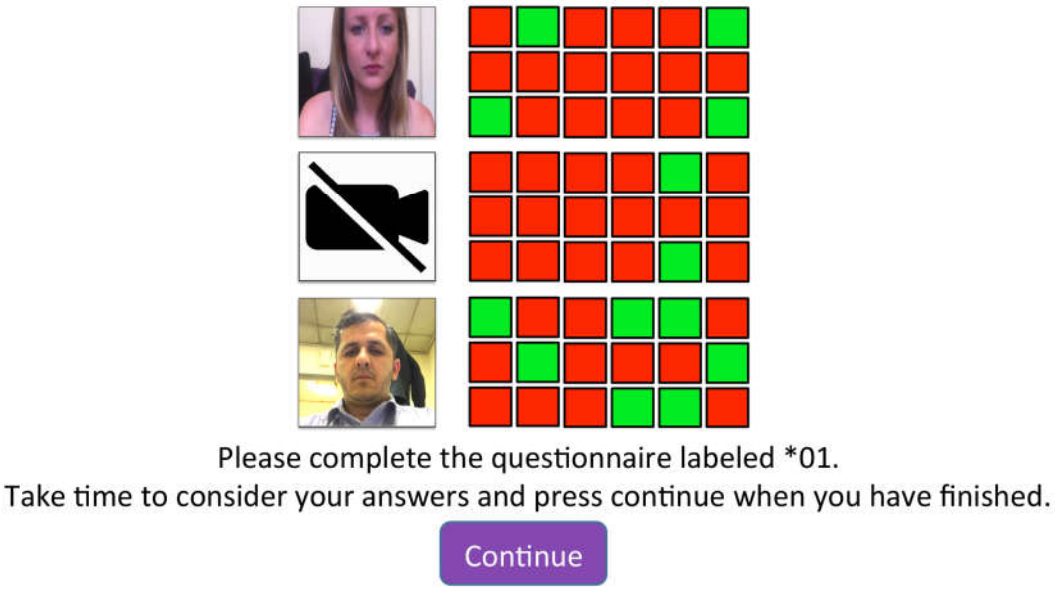


Fig. 2.3

Displaying the results for a round of guesses with three confederates.

A key component in the experiment is that the participants are not aware of the true testing that is being carried out. This is critical in the formation of the participants conclusions, they cannot be aware that the goal is to measure perceptions of unlikely events. While the true intent of the experiment is initially withheld from each participant, they will be fully debriefed as to its true goal at the end. The selection of a card by the participant for the opposing player to guess, as opposed to the participants guessing themselves, is key for three reasons. Firstly it allows the investigator to manipulate the results to a simple success or failure. From a design perspective, this enables the experiment to be streamlined in terms of results that the participants receive and the form that these results take. Secondly it eliminates the 'skill' factor, which a participant may be, for whatever reason, skilful at predicting the results of the game directly; crucially creating a scenario that allows the possibility of an irrational causal link between participants and players that has no outward explanation, as opposed to a link created between the participant and the game itself. Thirdly, it goes someway to establishing the idea that the results are not, or at least less likely to be, manipulated by and outside source (for example the Investigator). A simpler method that involved the simulated flip of a coin for example, would generate a similar set of results that could be manipulated by the investigator to create bias in the same way, and could eliminate the "skill" factor. However the very simplicity of this generation lends itself to a simpler set of conclusions to be drawn from the results. Upon witnessing a set of results that have a specific outcome, say the more heads than tails, there are only a few conclusions that can be drawn from this result. The baseline rational assumption is that in general, ten flips of a coin will generate a fairly even pattern of results, 50/50 maybe within tolerance of plus or minus 10%. If a set of results start skewing more than that, there can only be a certain number of conclusions that can be drawn from that result. It is either that the game is defective, leading

to a set of results that are not within bounds of credibility; the game is rigged, the results being manipulated by a rational outside influence (i.e. the investigator).

Two questionnaires are included in the experiment. The first is of my own construction, designed specifically to investigate the nature of the participants perception of the experiment, and their perception of the results generated by it. The Rational Thinking and Magical Thought questionnaire as seen by the participants is included in Appendix p155-157. The second questionnaire, the Revised Paranormal Belief Scale (Appendix p158-161) provides a separate score on each of seven factorially derived sub-scales, with each sub-scale reflecting a major dimension of paranormal belief. The RPBS sub-scales are: Traditional Religious Belief, Psi, Witchcraft, Superstition, Spiritualism, Extraordinary Life Forms, and Precognition. Respondents indicate degree of belief for each of 26 items by using a seven-point rating scale (Tobacyk 2004). Its use in this experiment is to provide an independent rating for participants as to the strength and nature of belief in the paranormal. An analysis of the factorial structure and dimensionality of the Revised Paranormal Belief Scale carried out in 2017 by Kenneth Drinkwater, Andrew Denovan, Neil Dagnall and Andrew Parker at Manchester Metropolitan University, is included in the Appendix (p162).

Logical Premises

As the Game portion of the experiment is the mechanism by which participants are reasoning it is important to be clear as to the logical premises that the Game creates.

A. That the confederates cannot see the participants.
B. That results are only generated by the confederates.
C. That the confederates have no prior knowledge of the participant's selections.

The participants take the first premise on trust, as they have been informed that they are not being observed in any circumstance. This fiction was relayed by the investigator at the beginning of the experiment, by explaining that the condition that the participants were currently operating in did not require their image to be transmitted. No evidence to the contrary is given or implied.

The second premise is created by the Game only displaying a single confederate onscreen (or a blank box with a symbol indicating that the confederates while not seen are still playing); and that the results are generated procedurally by the confederate and the participant. As each result is generated individually and requires the participant's selection of a card, the inference is that only the two players are generating results.

The Game mechanic itself creates the third premise, in that participants are required to select the card for the confederate to guess.

A deductive rational based on the above premises would lead to conclusion D;

D. The results are random.

A B and C are true, conclusion D must be true.

If the results are random, when asked the question "Which of the players would you prefer to play with again" would lead to an answer that reflects this, that all players would be judged the same. Therefore, any difference in the score assigned to a confederate by a participant indicates an inductive reasoning process. It is important to note that this process does not require any specific score for each player, only that the scores are equal to each other.

The design of the experiment endeavours to restrict participants to the above premises and restrict the effect of various cognitive errors that may occur in testing of this kind to explore if magical thought can still be measured when the experiment has been specifically designed with those in errors in mind.

The Creation of Performance

Confederates are scored in the following manner, with a correct selection designated 'hit' and an incorrect selection designated 'miss' in accordance with paranormal investigative parlance.

Control Confederate: 4 hits out of a possible 18

Negative Confederate: 2 hits out of a possible 18

Positive Confederate: 6 hits out of a possible 18

As each selection is made from a selection of 5 cards, the average score over a round of 18 guesses is 3.6, rounded to the nearest whole number of 4. The Control Confederate therefore has been scored at the average that one would expect with a random selection of cards. The Negative Confederate has subsequently been scored half this rate, and the Positive Confederate at twice this rate, with a variance of plus or minus 1 over the two rounds.
The scores were selected in this manner to fulfil a clear difference between the confederates, but not so much that the difference would be deemed as unbelievable. While more drastic scores may well have driven the manipulation more effectively, I would argue that beyond a certain point, (assumed by the Controller to be more than 50% more or less than the average score), an average participant would start to rely on less magical thought and more upon more basic inductions that required only the extreme scores as evidence. Further study could

indicate the levels at which comparative scoring extremes begin to alter believability of said score.

In relation to the experiment conducted in this paper, in order to effectively maintain the fiction that the confederates results are indeed generated by them and not by any other source, the sequence of hits and misses was programmed to reflect the above heuristic, as displayed in the figures below.

Figure 2.4

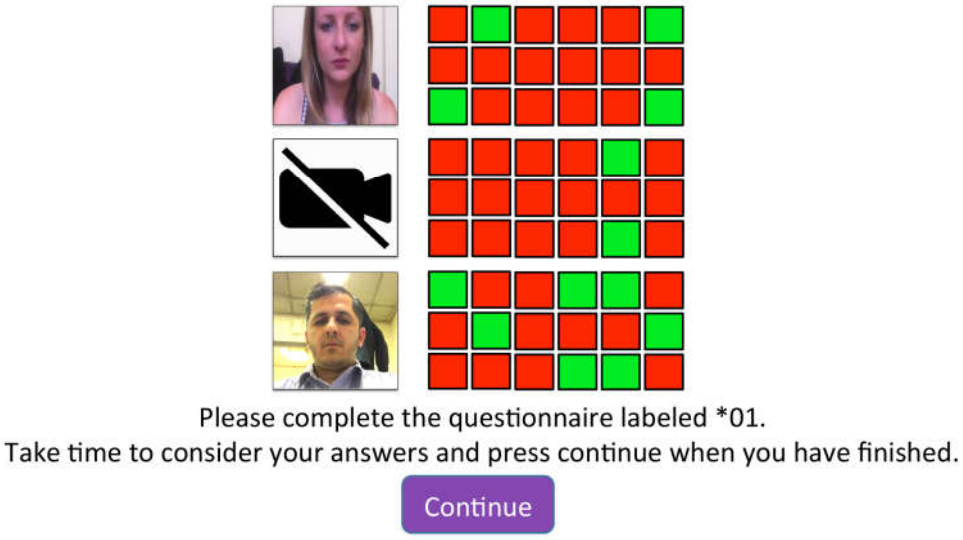


Fig 2.4 Displays the layout for confederate's results, procedurally generated by the participants, preprogramed by the investigator.

Figure 2.5

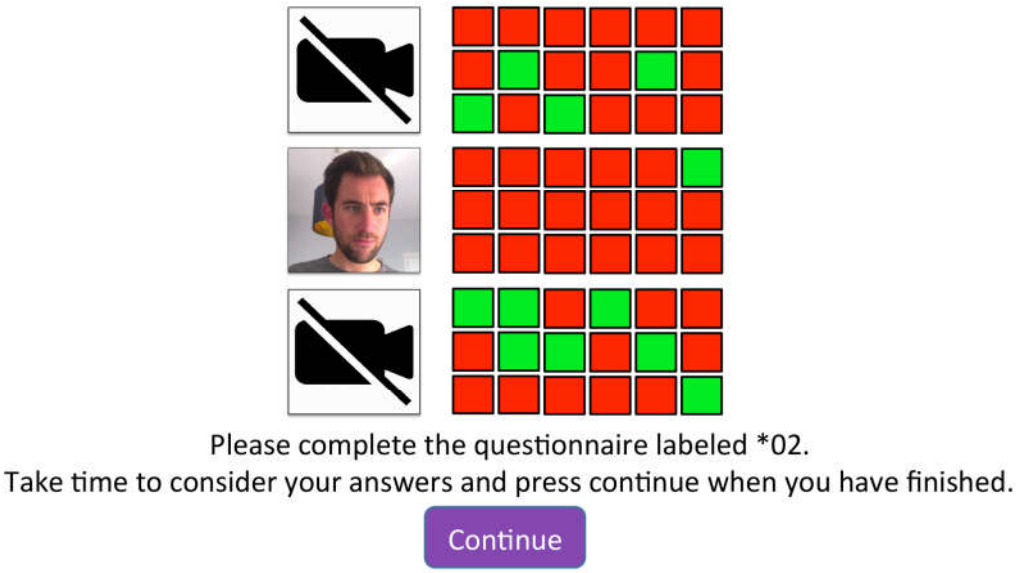


Fig 2.5

Displays the layout for confederate's results, procedurally generated by the participants, preprogramed by the investigator.

As is displayed above, the hits are spread relatively evenly across the 18 guesses. The Positive Confederate has a single instance of sequential hits, however the graphical layout of the results endeavours to spread the hits out and create an impression of positivity and negativity.

Observed vs. Unobserved

The Observed and Unobserved Conditions explore a possible difference in a participant's reaction to lucky and unlucky events when the perpetrators can be seen or not. Previous experiments have highlighted that both observers and participants in an event that is affected by probability (in this case the 'hot hand' phenomenon in basket ball) are affected by previous results (see Gilovich, Vallone, and Tversky 1985). Gilovich et al found that both

players and fans made the error that previous streaks of scoring were indicative of future scores. A detailed analysis found that there was no evidence for a positive correlation between the outcomes of successive shots, but that it did alter the perception of the players and the fans as to the probability of the success of successive shots.

Here, the experiment explores a similar mechanic in that participants are asked to judge the future performance of confederates, as opposed to their own performance, but critically investigates if actually observing confederates perform (as opposed to not observing them) changes this judgement. To create the same circumstance through the condition, confederates have exactly the same scores in the control, negative and positive outcomes, and are displayed in the following order for half (32) of the participants.

Luck Condition of the Confederate	Observational Status of the Confederate
Control Confederate	Observed
Negative Confederate	Unobserved
Positive Confederate	Observed
Control Confederate	Unobserved
Negative Confederate	Observed
Positive Confederate	Unobserved

The second group of participants has the reverse order.

Luck Condition of the Confederate	Observational Status of the Confederate
Control Confederate	Unobserved
Negative Confederate	Observed
Positive Confederate	Unobserved
Control Confederate	Observed
Negative Confederate	Unobserved
Positive Confederate	Observed

This ensures that the observation protocol is evenly distributed across the participants. In addition, any bias that the participants may have toward any visible confederates is eliminated.

The Rational Thinking and Magical Thought Questionnaire

The Rational Thinking and Magical Thought Questionnaire breaks down the participants reactions into five sub-scales; Super-Rational, Sceptical, Weird Science, Luck, Religious, as a template for possible schemas to the results generated by the experiment, with the questions marked R being reverse scored. They are arranged according to a scale of rationality that judges the subscales on their reliance on evidence, as well as the level of magical thought required for this evidence to make sense within the schema created around it.

Super-Rational

- I think the best players results were random.
- I think the game did not allow players to get better or worse.
- I think that all of the results were arbitrary
- I think the worst players could not improve their results regardless of what they did.

The Super-Rational questions dismiss any possibility of any luck or unexplained activity, and focus solely on the results within the experimental framework. In addition, this section should identify participants that may hold specific beliefs, but can separate these beliefs from minimally counter-intuitive events like the one created and tested in the experiment. The questions do not require an explanation of or make any predictions as to the results. These explanations are purely deductive in nature and correspondingly require no external facts or magical thought to justify.

A high score indicates that the participant accepted the premise of the game, and using this premise made the conclusion that the results were random, that the structure of the game precluded an ability to achieve better results, that the results were indeed an arbitrary

expression of probability across the three confederates. This is an accurate deductive summation that requires no external knowledge to acquire.

A low score indicates that the participant has used external knowledge to make this conclusion, and would be indicative of inductive reasoning.

Sceptical

- I think that if there had been more guesses, players would have improved. R
- I think skill played a part in the player's results. R
- I think that the best player was cheating. R
- I think that the game was rigged.

The Sceptical questions address the results as generated from within a rational framework of analysis, exploring why the results occurred as they did but requiring a minimum of magical thought in the inductive reasoning process. It differs from the Super-Rational in that the questions make predictions about possible explanations for the results that indicate an inductive framework of analysis. However, the questions relate to known factors in events that involve probability only, so while the reasoning process is inductive, it requires only minimal magical thought processes to conclude. Effects such as frequency of guesses, skill (regardless of the games premise that skill is not a factor), cheating or rigging require supplemental evidence to confirm, but as these factors are affects in similar games involving cards, can be included in the induction process without any further magical thought being applied.

Middlesex University

Weird Science

- I think that observing the players affected the results. R
- I think that observing the pattern of player's results effected the results. R
- I think that if players could have seen me, it could have affected the results. R
- I think that body language affected the results. R

The Weird Science questions test the participants belief in the results that are a further step removed from the Sceptics questions, in that while they are inductive, they require further magical thought schemas in order to justify. These magical thought schemas however are still based on scientific evidence that is misunderstood as opposed to schemas that rely entirely on belief.

To score highly in these questions indicates a belief that confederates results were in some way affected by the act of observing them; which in turn requires a belief that the act of observation has an effect over probability in this instance. This belief may well be affected by misunderstood science involving the observation of particles and the resultant affect on their behaviour, or by pseudoscientific theories surrounding 'morphic resonance'.

It is expected that participants that score highly in this section will also score highly in the Psi and Extra Ordinary Life Form subsections with some overlap with the Precognition sub-section of the RPBS, as they share similar assumptions and flawed interpretation of science or an acceptance of certain pseudoscience.

Luck

- I think that if the worst player had a lucky charm, that would have helped them perform better. R
- I think that the best player had good luck. R
- I think that players that didn't perform well or poorly don't believe in luck. R
- I think that luck affected the results. R

The Luck questions centre on the participants disposition to ascribe the results to luck, and that this effect had an impact either positively or negatively. They also address the existence of lucky charms as talismans, a key aspect of the transference of luck. While belief in luck is by definition driven by magical thinking, it is also a widely held societal belief. As it is so widespread, the societal cost of participating in the belief is extremely low. There are no risks to this belief, it does not single out or expose the believer to a cost. However, it also requires a higher level of rational suspension in order for the mechanics of the schema to work. Luck in terms of a charm or talisman requires the believer (whether consciously or not), to ascribe to the belief that luck is a concept that has the aspects of a physical force; that it can be lost, gained, transferred. There are no physical mechanisms or measurable instances of this outside of the schema in which it is considered; yet these mechanisms are highly ritualised and principled. This is a higher order of magical thought than necessary than the previous subscales as the only evidence required is the result of the event.

Religion

- I think that if the worst player had prayed before the game, they would have performed better. R
- I think the best player was blessed somehow. R
- I think that players who neither did well or did badly probably don't believe in god. R
- I think that the best player believed in god. R

The Religion questions address the participant's disposition to ascribe the results to a traditional religious framework, which involves having faith, exercising this faith through prayer, and being given boons through piety. Religion requires a deity or deities as the final arbiter of positive or negative events, and the believer's actions and/or level of faith as the heuristic by which this is judged. It therefore requires a high level of magical thought as the stages and the relationship that these stages have to each other are based on multiple overlapping irrational concepts.

The Revised Paranormal Belief Scale

The Revised Paranormal Belief Scale is included below broken down into the subscales as prescribed. A factorial analysis is included on page 162 of the Appendix, conducted by Kenneth Drinkwater, Andrew Denovan, Neil Dagnall and Andrew Parker at Manchester Metropolitan University, Manchester, United Kingdom, published in September 2017 in Quantitative Psychology and Measurement, a section of the journal Frontiers in Psychology.

Traditional Religious Belief

- The soul continues to exist though the body may die.
- There is a devil.
- I believe in God.
- There is a heaven and a hell.

Psi

- Some individuals are able to levitate (lift) objects through mental forces.
- Psychokinesis, the movement of objects through psychic powers, does exist.
- A person's thoughts can influence the movement of a physical object.
- Mind reading is not possible.

Witchcraft

- Black magic really exists.
- Witches do exist.
- Through the use of formulas and incantations, it is possible to cast spells on persons.
- There are actual cases of witchcraft.

Superstition

- Black cats can bring bad luck.
- If you break a mirror, you will have bad luck.
- The number "13" is unlucky.

Spiritualism

- Your mind or soul can leave your body and travel (astral projection).
- During altered states, such as sleep or trances, the spirit can leave the body.
- Reincarnation does occur.
- It is possible to communicate with the dead.

Extraordinary Life Forms

- The abominable snowman of Tibet exists.
- The Loch Ness monster of Scotland exists.
- There is life on other planets.

Precognition

- Astrology is a way to accurately predict the future.
- The horoscope accurately tells a person's future.
- Some psychics can accurately predict the future.
- Some people have an unexplained ability to predict the future.

Method

2.2 Participants

A minimum of 64 participants was required to generate a usable body of data to demonstrate the effectiveness of the experiment and generate any useful conclusions. The mean age of the participants is 21.00 with a mix of male and female, 17 male, 47 female. The participants were recruited through advertisements at the Middlesex University campus and through personal contacts of the investigator. They are not screened by age, gender or any other factor. The reward for participation is a set amount of course credits for first year undergraduate students in psychology, and entry into a draw where the first prize is £50 worth of Amazon vouchers, with second and third prize being £25 each. For participants that are not first year psychology students they are entered into the draw. This reward is not in anyway tied to success or failure; the only proviso is the completion of all of the stages of the experiment. The participants are informed of this prior to the beginning of the experiment. The participants are required to provide the following information; their name, age, specified gender if provided, and the highest level of education up to the current level. They are provided with a 'Participants Pack' that consists of a file designating their group and participant number, the Information Sheet (p56) the Consent Form (p57), the questionnaires and the Debrief Sheet (p58).

The Confederates

Three confederates are used to implement the fiction that the participants are playing against live opponents. They were each asked to sit in front of a computer in a quiet room with a blank background with the experiment loaded and recorded using it. The investigator was present the entire time of recording, which went on for 10 minutes per person. This

footage was then edited into 15 second sections, with edits made for continuity. No sound was recorded.

They are not in any way involved in the testing other than having their image used in the video recording. Their video will be destroyed after the testing has been completed and no details of their participation other than their acceptance to appear in the videos will be held.

Confederates are used to negate any ethical problems with deliberately focusing negative opinion on them using the experiment. The confederates are briefed thoroughly before the assignment, so that they were aware of their role within the experiment and how to achieve it.

Method

2.3 Materials

The game was created using Microsoft Power Point, with graphics and video created with Adobe Illustrator, Adobe Photoshop, Final Cut Pro, Handbrake and text edited in Microsoft Word and Adobe Acrobat. The following are the program versions for each, PowerPoint: mac 2011, Version 14.0, Adobe Illustrator CC, Version 22.0.1, Adobe Photoshop CC, Version 22.0.1, Final Cut Pro X, Version 10.3.4, HandBrake, Version 0.10.5 x86_64, Word: mac 2011, Version 14.0.0, Adobe Acrobat Pro DC, Version 2019.010.20069

The Participants were recruited from Middlesex University using flyers distributed during lectures, and posters around the university.

The data has been compiled and analysed using Microsoft Excel and SPSS, with the following versions, Excel: mac 2011, Version 14.0, IBM SPSS Statistics, Version 24.

The experiment was conducted onsite at Middlesex University in designated cubicles specifically booked for the task in the Hatchcroft Building, H121 and H122, and are designated for use by the Psychology Department. These rooms are small cubicles with a desk and chair provided.

The Investigators personal laptop was used to conduct the experiment, a 13 inch Macbook Pro. The participants were given a Participants Pack that included an Information Sheet, Consent Form, four questionnaires, and the Debrief Sheet. (see p56, 57, 58). A brief introduction was given thanking the participants for their participation, and giving a brief verbal walk through of the contents of the Participant Pack.

The video was presented in Powerpoint in high definition gif format. Participants were provided with ballpoint pens to enter the information in the participant pack.

Zener Cards

Zener cards have been historically used in experiments that test for extrasensory perception. Psychologist Karl Zener designed them for use in experiments he conducted with parapsychologist J. B. Rhine. They consist of five cards marked with a five-pointed star, a square, a circle, three parallel wavy lines, and a Greek cross. J. B. Rhine used the cards extensively in his experiments in the early 1930s in various methods including enclosing the cards in opaque envelopes or solid boxes (Rhine 1938). These experiments have been widely criticized as having serious flaws in both execution and analysis (Hansel. 1985) and with Rhine failing to accurately describing his methods it was extremely difficult to replicate any of the results gained (Gulliksen. 1938) The use of Zener cards in this experiment was due to the need for a number of unique symbols to choose and because the cards have a historical importance in paranormal research. The research itself has nothing to do with the paranormal, only the expression of superstition and the place of superstition within our cognitive processes.

Method

2.4 Procedure

The participants were greeted in and asked to sit in one of the rooms used for the test. They were thanked for their attendance and provided with the Participant Pack and two pens. They are asked to fill out all of the information required in the Information Sheet and the Consent Form. The Investigator leaves the room while the participant fills out the forms.

When the participant has entered the information the investigator re-enters the room to give a short brief as to the upcoming experiment. They are informed of the details of the following experiment using the information contained in the Information Sheet. In addition, the participants are informed that they will be playing with others linked via webcam, and this webcam is live but one way, in that the person observed on the webcam cannot see the participant. They are also informed that the webcam footage is susceptible to typical frame loss that may interrupt live stream momentarily but that this is not a concern. This was to provide an explanation to participants if there was any unavoidable frame rate loss when moving between pages of the game. A verbal conformation is requested from the participant to indicate they have understood the briefing. They are then asked to enter the room where the testing will be carried out.

The test has been loaded onto the Macbook Pro described in the Materials Section. The participant is guided through the stages of the test by commands on screen. A complete run through lasted around 20-25 minutes, with the time taken to complete varying.

The participants are led through the test, with an opportunity to practise before playing properly in order to familiarise themselves with the format.

Participants are informed that they will be playing with a group of three other players, completing three rounds of eighteen guesses in pairs, until each player has played against one another. They are informed that they are completing the first condition, where they are

observing the player assigned to them but not being observed themselves. A window in the test displays the participants opposite player, in an apparent live connection.

Participants are presented with a choice of five Zener cards to select for the confederate to 'guess'. When the selection has been made, the result of the participants opposite player, either correct or incorrect, is displayed on the table adjacent to the cards. Eighteen guesses are completed, and then the next player in the group is displayed for the participant. The selection process starts again, and repeats until all three players have generated results in the tables.

In the second stage of the experiment, the participants are asked to score each player as to how likely they are to play with them in the next stage of the experiment. The participants are then asked to complete the Rationality and Magical Thought Questionnaire and the RPBS, labelled as Questionnaires 3 and 4.

The investigator is not present in the room during testing. When the participant has finished the experiment and completed all parts, including the Debrief Sheet provided at the end of the questionnaires, they indicate this to the investigator.

The Investigator then proceeds to verbally debrief the participants by talking them through the information contained on the debrief sheet. They are asked if they understood the nature of the deception involved, the reasons it was necessary and the final goal of the experiment. In addition to the signatory on Debrief Sheet a verbal confirmation was sought that they were comfortable with the experiment and were giving consent to their results being used.

Chapter 3

Results and Analysis

3.1 Reliability Analysis

The Rationality and Magical Thought Questionnaire – Reliability Analysis.

A reliability analysis was carried out on the RMT with the results as displayed below.

A reliability analysis was conducted on both scales. Starting with our bespoke (designed especially for the current study) scale of Rationality and Magic Thought (RMT), these reliability results was analysed both on a question level and a subscale level. The RMT had five subscales (five items each): Super-rational, Sceptical, Weird Science, Luck, and Religion. Cronbach's alpha was low for all questions on a subscale level (Super-rational α = .417; Sceptical α = .291; Weird Science α = .613; Luck α = .442; Religion α = .679). When all of the questions were considered together, the alpha was still low, α = .409). The weakest subscale was the "Sceptical" scale. When this subscale is removed, then the alpha rose, α = .665. When nine items were removed (p301, p302, p304, p306-p309, p311, p315), the alpha rose to an acceptable level, α = .721. We will call this RMT-NEW. Figure 3.1 is a histogram of the RMT-NEW results. The mean score was 57.27 (SD = 9.423), range 29-74. Overall participant score was derived from summing all of the responses along a 7-point Likert scale. This meant that the ceiling score was 77 and the floor was 11.

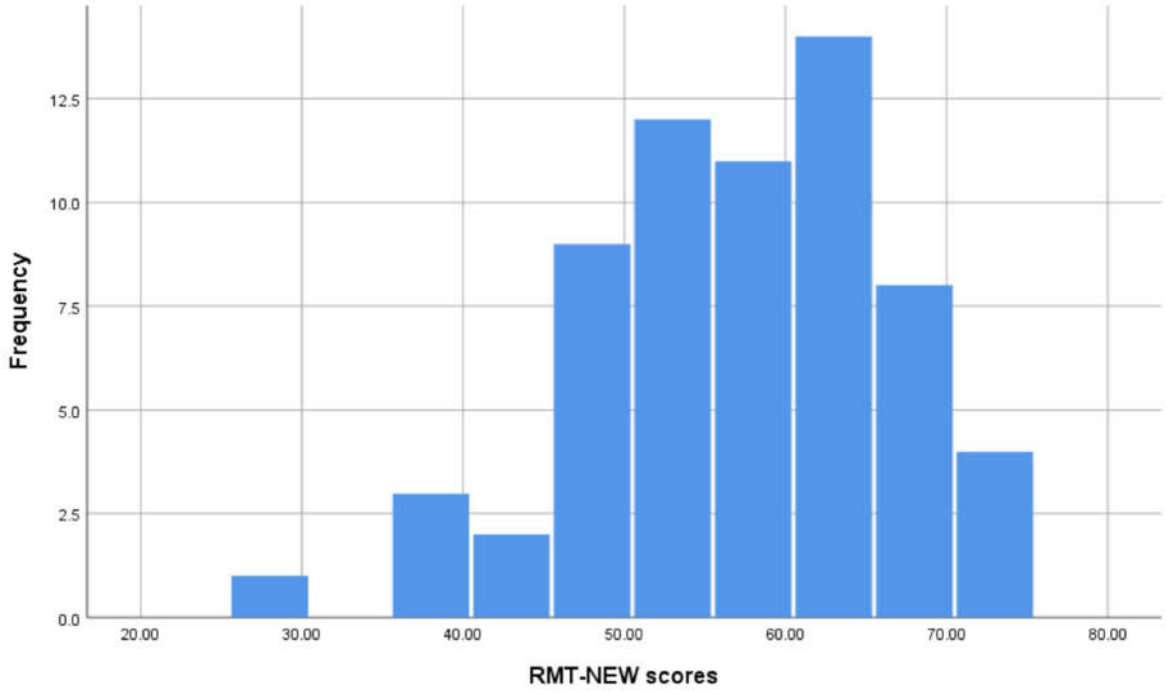


Fig 3.1

Displaying a Histogram of the RMT-NEW results.

Table 3.2

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

(Dennick 2011)

Table 3.2

Displaying the reliability of scores according to Dennick, 2011.

The revised paranormal belief scale (PBS-R) had been published before and is known to have a high reliability level. Nonetheless, a new reliability analysis was conducted here. When all of the questions were considered together, the alpha was very high, alpha = .862). Figure 3.3 is a histogram showing the results of the PBS-R scores. The mean score was 186.67 (SD = 28.974), range 102-254.

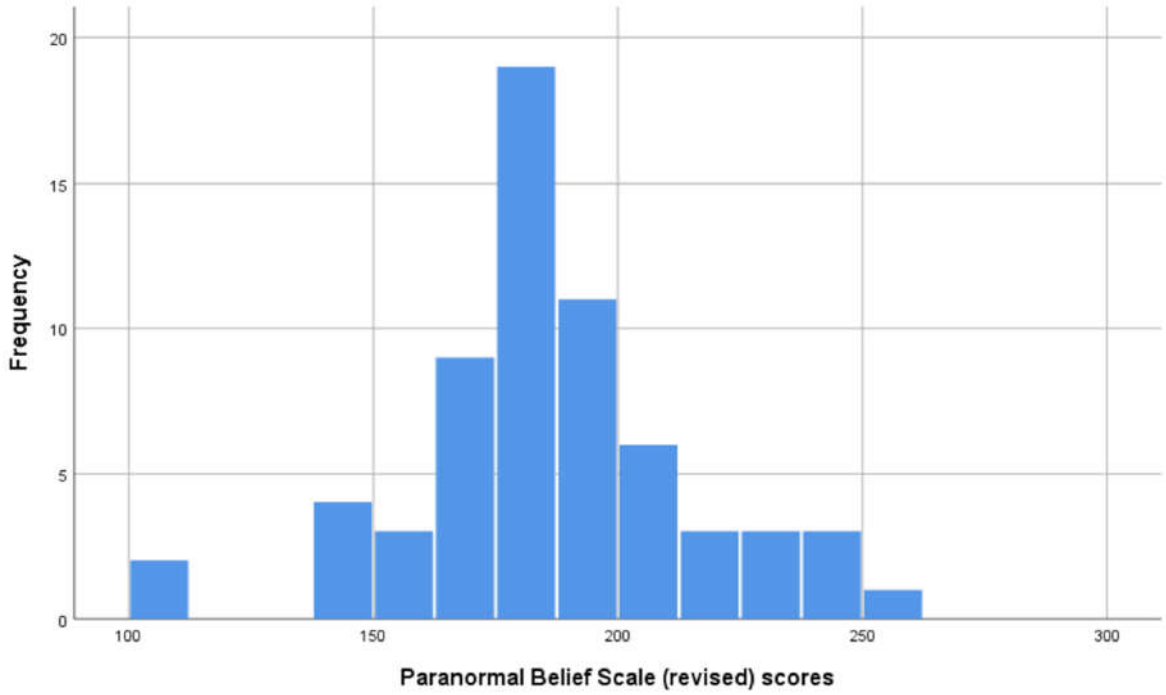


Fig. 3.3 Displaying a Histogram showing the results of the PBS-R scores.

The PBS-R and RMT-NEW scores were correlated with each other, $r = .503$, $p < .001$. However, when I analysed the PBS-R and RMT-NEW scales against the game results (as reported in the next section), there were no significant results at all.

3.2 Results

To analyse the game results, a 2 x 3 repeated measures ANOVA was conducted on the preferences. Here, observational state had two levels (observed, not observed) and "luck" condition had three levels (Positive/good, Control/medium, and Negative/bad). Table 3.4 displays the descriptive statistics across all levels. There was a significant main effect of the Observational State, $F(1, 63) = 6.653$, $p < .012$, partial eta 0.096. There was a significant main effect of the Conditions (Positive, Negative, and Control), $F(2, 1.57) = 65.185$, $p < .000$, partial eta 0.509. There was no significant interaction, $F(2,62) = 1.033$, $p = .262$, partial eta = .032. Post hoc tests using a Bonferroni correction revealed that good luck was preferred over medium luck ($p < .001$) and bad luck ($p < .001$), and medium luck was preferred over bad luck ($p < .001$).

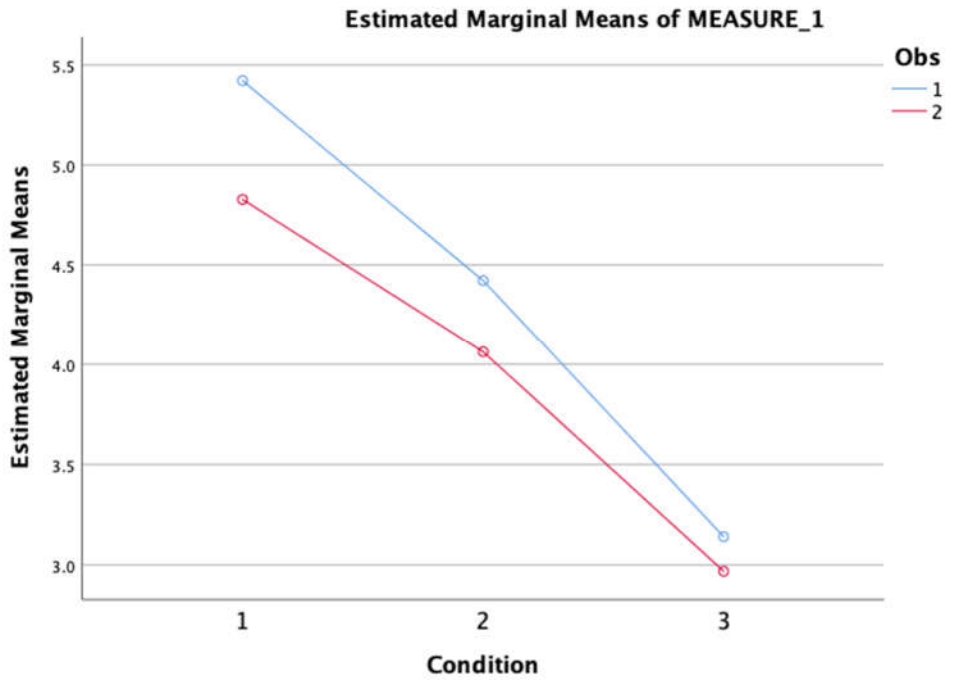
Mauchly's Test of Sphericity

Mauchly's test indicated that the assumption of sphericity had been violated, ($\chi^2(5) = 22.1$, $p < .05$, and $\chi^2(5) = 9.23$, $p < .05$), therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .785$, $\varepsilon = 0.902$).

Descriptive Statistics

Mean (SD) for observational state (rows) and "luck" conditions (columns)				
	Good luck	Neutral luck (control)	Bad luck	All observed / all not observed
Observed	5.15 (1.642)	4.38 (1.444)	3.19 (1.327)	4.24 (1.06)
Not observed	4.42 (1.677)	3.81 (1.201)	2.77 (1.423)	3.67 (1.108)
All luck	4.79 (1.394)	4.10 (1.058)	2.98 (1.204)	

Table 3.4 Descriptive statistics for game conditions



Plot 3.5 Estimated Marginal Means Generated by the 2 x 3 repeated measures ANOVA. Where Obs 1 is the Observed State, and Obs 2 is the Non-Observed State, and Condition 1 is Positive Luck, Condition 2 is Control (i.e. of neither positive or negative luck) and Condition 3 is Negative Luck.

3.3 Conclusions

The results as stated suggest that the participants were indeed affected by the manipulation of the experiment, and that within the parameters of the experiment the first part of the hypothesis was accurate, that perceptions of luck can be created and reinforced. In addition, that the observational status of the demonstrators of this luck, the confederates, has a measurable effect on this bias.

Unfortunately the subsequent questionnaires had no bearing on the results. This could be in part due to the novel creation of the RMT scale, and its wording. The subjective nature of the experience of luck is however one that warrants further investigation.

In regards to the experimental results, participants displayed the irrational belief that previous performance did indeed affect future performance, and critically, that actually observing a partner displaying this ability is in fact a function of this belief. The model displays that positive luck was more effective at driving this effect over the control and the negative. To my mind this suggests that the association of a luck status to an individual has not only the demonstration of the phenomena, but that the performance, viewed as it occurred, is an integral part of the process. This is a literal demonstration of the adage ‘seeing is believing’.

The aim of this experiment was to effectively deny the participants of any of the previously discussed psychological or cultural triggers of a magical thought cognition process other than the most basic phenomena, the positive, negative and control display of abnormal ability, and the visibility of the demonstrator of that luck. In these parameters, the experiment was successful. As a tool to establish the credulity of individuals, it must be paired with an effective questionnaire as to why the participants behaved the way they did, which I would posit requires further study and refinement.

The study of how magical thought is processed, and its role in how behaviour is effected when faced with phenomena that defies reasonable explanation I believe is critical in not only understanding this behaviour, but in how we perceive all phenomena that relies on previous experience of such events. Our credulity of these events effects our credulity of the events associated with them, and how we behave when our beliefs are tested. As has become ever clearer in the modern world where even the most basic of belief systems are routinely tested in the crucible of social media, these belief systems are critical not just for their content, but for their weaknesses for being manipulated.

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Middlesex University

Information sheet for participants.

Psychology Department

Middlesex University

The Burroughs

London NW4 4BT

Supervisor: Dr Yvan Russell

Researcher: Ben Goodwin Self

MSc by Research - Evolutionary Behavioural Science

Observation and Reaction Times – A global study

Dear participant,

Thank you for agreeing to take part in a psychological research study carried out by Middlesex University London. It is important that you understand what this research will involve. Please read the following information carefully. This research is being conducted around the world by participants simultaneously, with participants being tested online, in groups. You will be taking part in a study about reaction times and how they are affected by observing the opposing player, conducted online. The experiment will be played in groups of three participants drawn from a global online pool.

You will be asked to choose a card for your opposing player to select. Depending on which group you are randomly sorted into, you will be able to observe your opposing player or not. There will be a short questionnaire after each test.

While a live video image of participants will be shared between them, no images will be recorded or stored and nothing other than your personal information given below, responses to the questionnaires and your reaction times will be recorded.

Please provide the following information.

Name:

_____

Middlesex University

Age:

_____

I identify my gender as…(leave blank if you decline to answer):

_____

Highest Level of Education (including current):

_____

I hereby confirm that all of the above information is accurate; that I have read and understood the requirements of the experiments, and give explicit consent for my live video image to be transmitted electronically.

All the data is strictly confidential and will not be shared with third parties. It will not be made public. If the study is published, then results will only be published in aggregate form, (e.g. the average results for groups of people). If you somehow feel disturbed by any aspect of the study, then you are able to withdraw anytime you want. Furthermore, you will be able to withdraw your data after the experiment has been concluded by contacting one of the researchers on or before December 1st, 2018. All proposals for research using human participants are reviewed by Ethics committee before they can proceed. The Middlesex Psychology Ethics committee have reviewed this proposal.

Thank you for taking your time to read the information page, and filling it out. If you have any questions or concerns, please contact: Ben Goodwin Self (BG386@live.mdx.ac.uk), or supervisor Dr Yvan Russell (Y.Russell@mdx.ac.uk).

Middlesex University

Participant Identification Number:

CONSENT FORM

Title of Project:

Name of Researcher: Ben Goodwin Self

Please initial box

1. I confirm that I have read and understand the information sheet the above study and have had the opportunity to ask questions. 1

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. 2

3. I agree that this form that bears my name and signature may be seen by a designated auditor. 3

4. I agree that my non-identifiable research data may be stored in National Archives and be used anonymously by others for future research. I am assured that the confidentiality of my data will be upheld through the removal of any personal identifiers. 4

5. I agree to take part in the above study. 5

Middlesex University

Name of participant	Date	Signature

Name of person taking consent (if different from researcher)	Date	Signature

Researcher	Date	Signature

Inevitable Magic – Reason, Magic and Manipulation Debrief

Thank you for taking part in this study.

Debrief Sheet

The aim of this study is to investigate the link between a participants perception of the paranormal and the susceptibility to being influenced in a game scenario where an irrational or superstitious assumption is a possible reason for someone's success; and if observing the opposing player affects these reactions.

The experiment and questionnaires you have just participated in and completed were to test for the susceptibility of a participant to create irrational properties and associate them with a person that has been shown to be lucky or unlucky in an experimental setting; then test for any bias that may result from this. The questionnaire was measuring the participant's perception of paranormal events, principally to investigate any correlation between a person's general perception of unlikely or unexplainable phenomena, and the susceptibility to the associate these phenomena to others.

The hypothesis is that superstitious perceptions can be created and reinforced with the manipulation of a participant's perception in the form of observed luck; that there is a predisposition for superstitious individuals to be more susceptible to this bias, and that the act of observing your opposing player will influence this effect.

The nature of the area being investigated required a level of deception embedded in the design of the experiment. There were no other subjects participating in the experiment, and the time in which it took to make your choices is not relevant. In reality, the experiment is testing a participants susceptibility to being influenced by the results generated from the other 'participants'. The people displayed while you were playing were prerecorded, and their results as to their ability to correctly choose the card you had chosen were fictitious, designed to influence your decision. The need to mask the true intention is unavoidable, as knowledge that the results were fictitious would have affected a participant's judgement. Displaying another 'participant' had two roles, firstly to play into the fiction that the

experiment was investigating participant's reaction times while under observation, and secondly to create a link between participants that could suggest a connection between them that may have an affect on the results. Overall, the goal was to create a scenario that allowed participants to express a preference as to which participants they thought were better at a game that required no skill. This data will then be contrasted with the results from the questionnaires, the primary focus of which are to measure the level of belief in paranormal or superstitious phenomena.

The questionnaires set after the experiment are the Revised Paranormal Belief Scale, the Belief in Good Luck Scale, 20 questions centred around your perception of the experiment. These questions are only to gauge the strength of beliefs, not to define them. Superstition and superstitious behaviours are ways of generating the understanding of the unknown, acting or deliberately refraining to act in specific ways to ensure a positive outcome, when there is no causal relationship between those actions and the outcomes (Skinner, 1948, p168-172). Where rational means fail to explain an event, we are unlikely to believe those and seek pathways to explain them in kind. This is the creation of a 'supernatural superstition', and while this may appear to be inadequate way of processing a situation, cognitively they could be a fundamental way of reducing the risk of failing to exploit an existing causal relationship, or of trying to exploit a non-existent causal relationship (Abbot and Sherratt, 2011, p85-92), thus having a critical bearing on risk management and perception.

All information gathered during this study will not be paired with any personal information. The responses recorded will not be attributed to you, and your name is only taken to confirm your participation and consent to the study.

If you feel negatively affected by any aspect of the study, then you are able to withdraw anytime you want. Your participation can be withdrawn completely without giving a reason and without penalty. Furthermore, you will be able to withdraw your data after the experiment has been concluded by contacting one of the researchers on or before December 1st, 2018.

If you have any further questions or comments regarding this investigation, please contact me by email or phone.

Regards

Ben Goodwin Self

(Investigator)

Name:

Signature:

Date:

By signing you are confirming that you have read and understood this information

Thank you for taking part in this study.

The following test has been designed to measure reaction times between two participants when they are in different states of observation.

Participants will be asked to select
different cards for the opposing player to guess.

Opposing players are selected from an online pool.

Continue

You will be randomly assigned one of the following conditions:

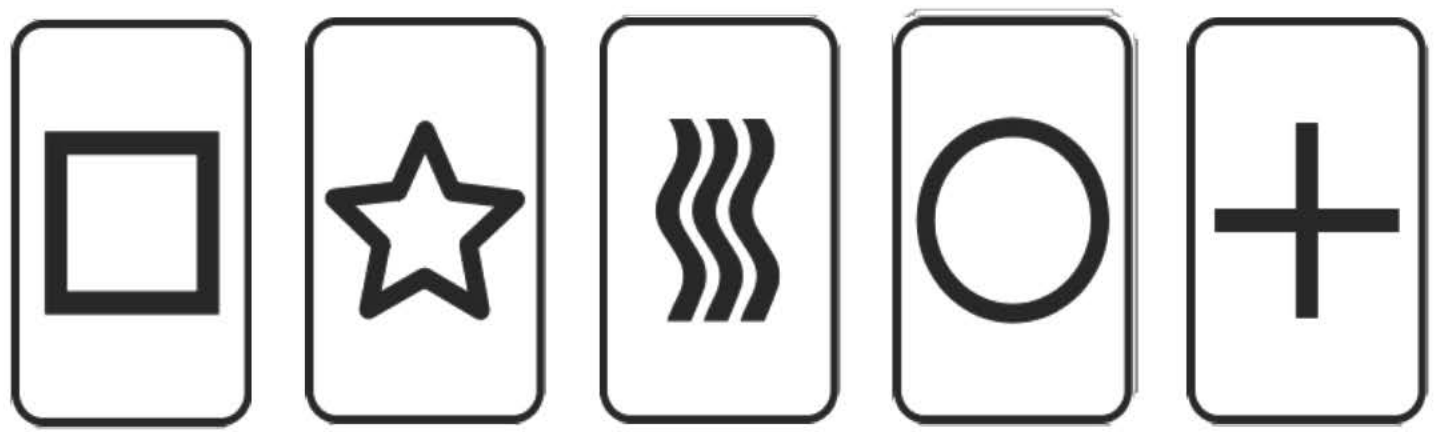
You will observe your opposing player as they try to guess the card you have selected. Their results will be displayed as you play.

No-one will be observed as they try to guess the card you have selected.

Continue

The next screen will run you through the test.

Continue



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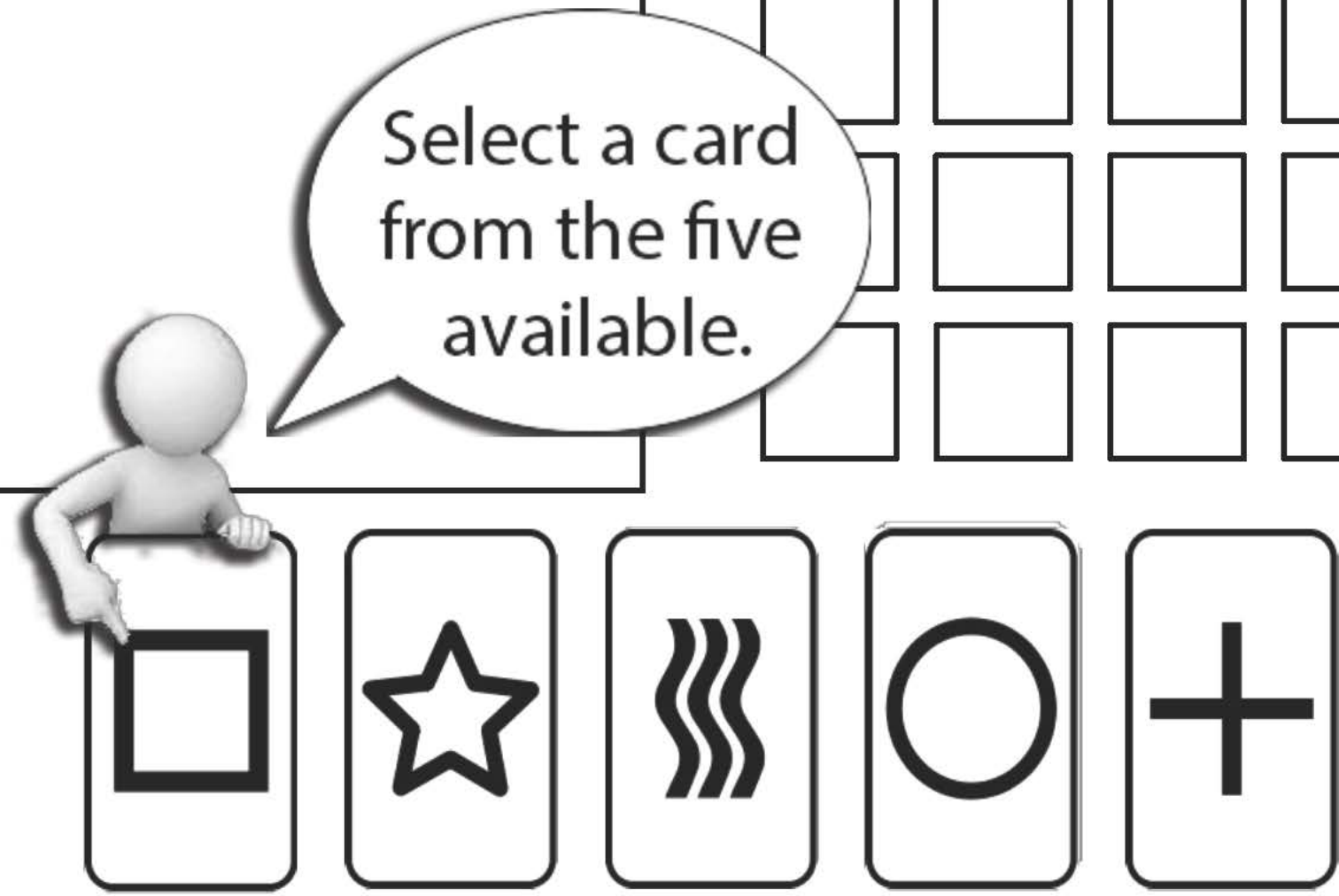

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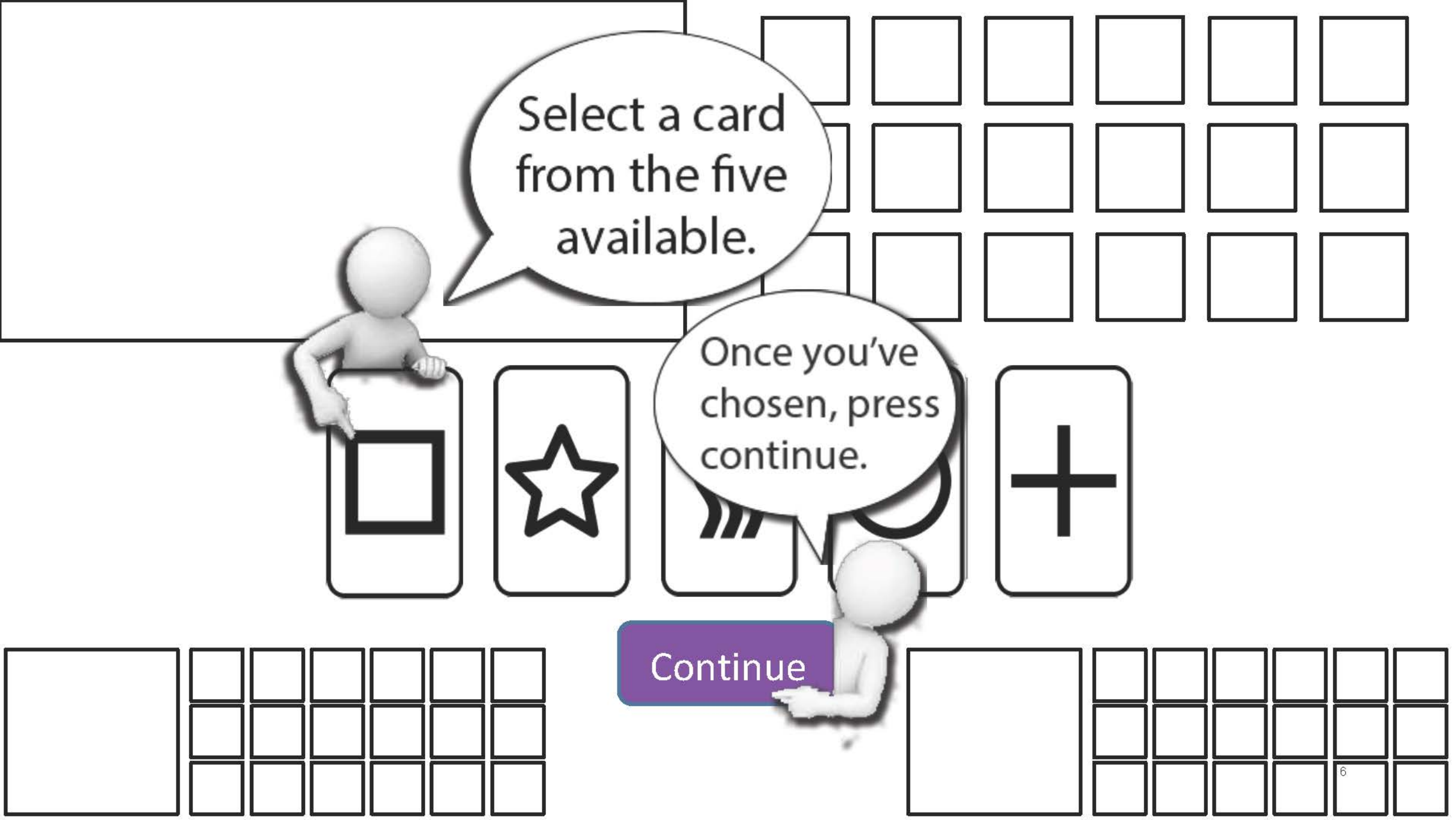
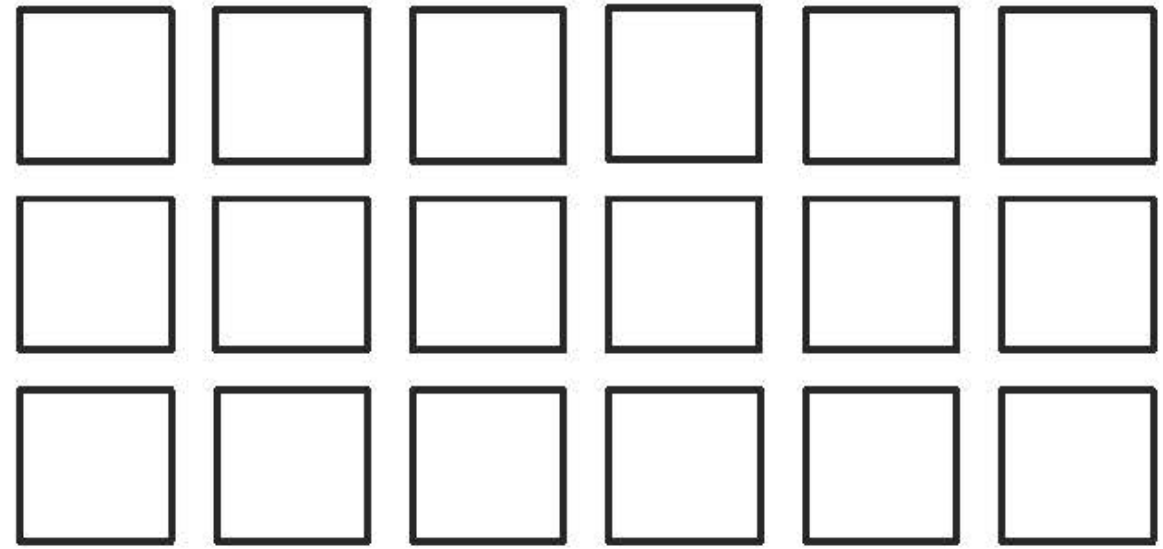
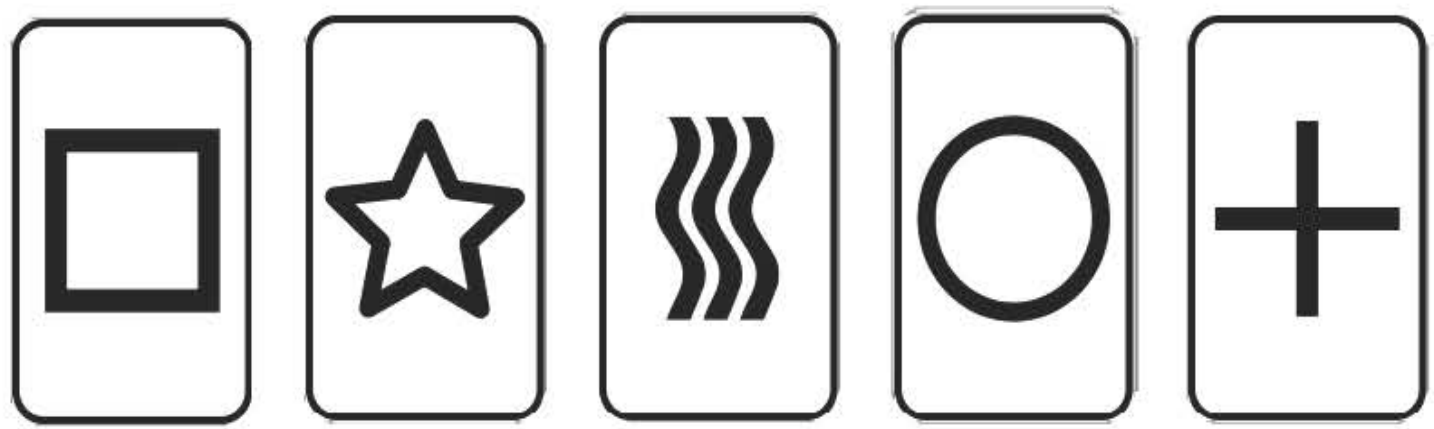

Select a card from the five available.
Once you've chosen, press continue.
Continue





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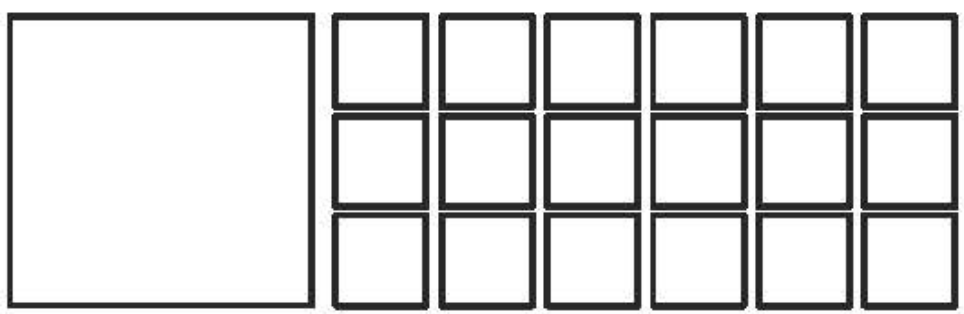

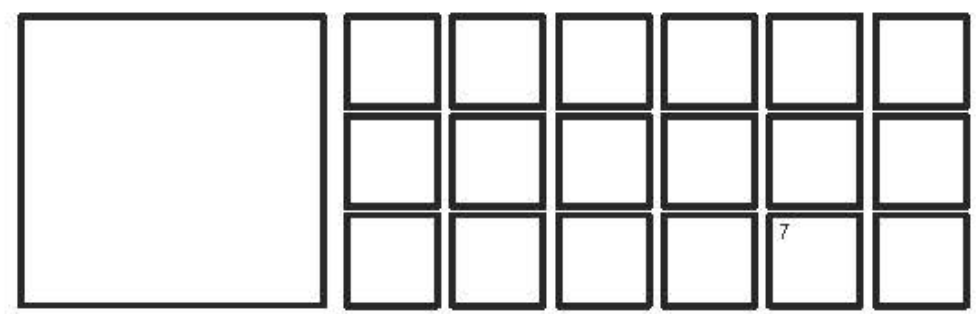

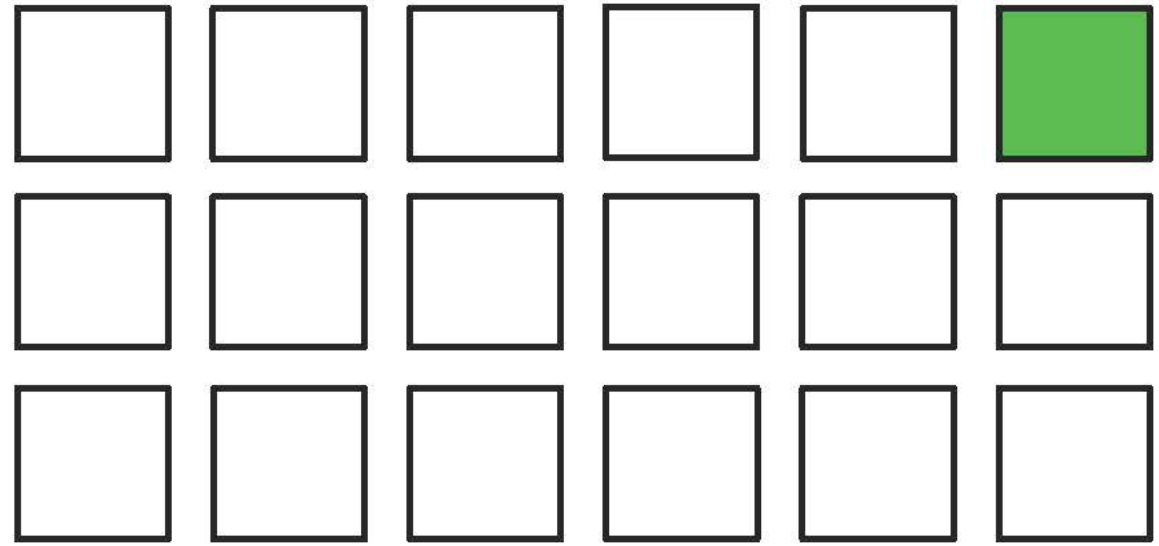

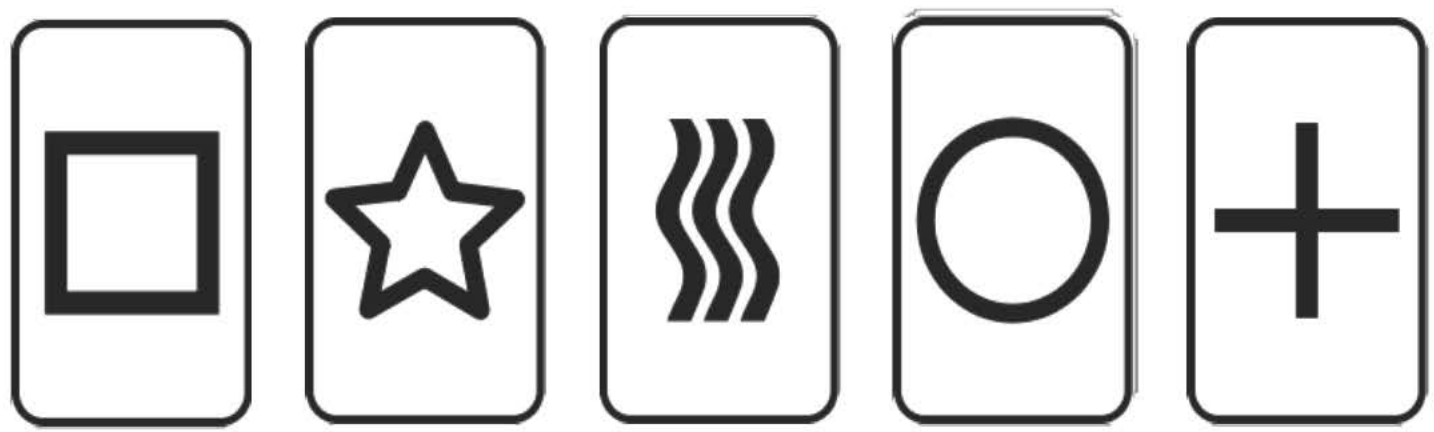

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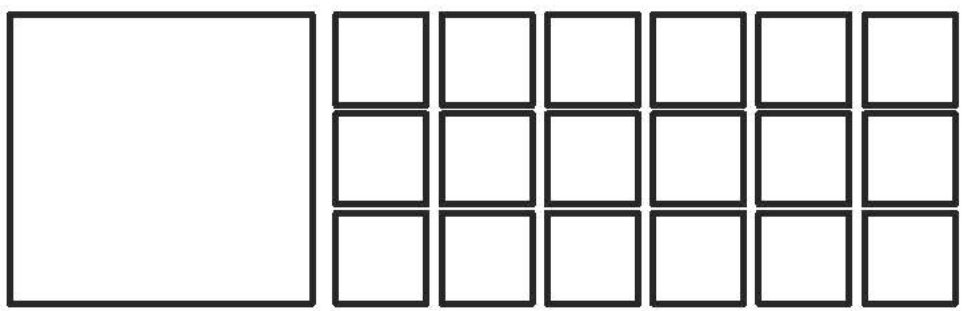
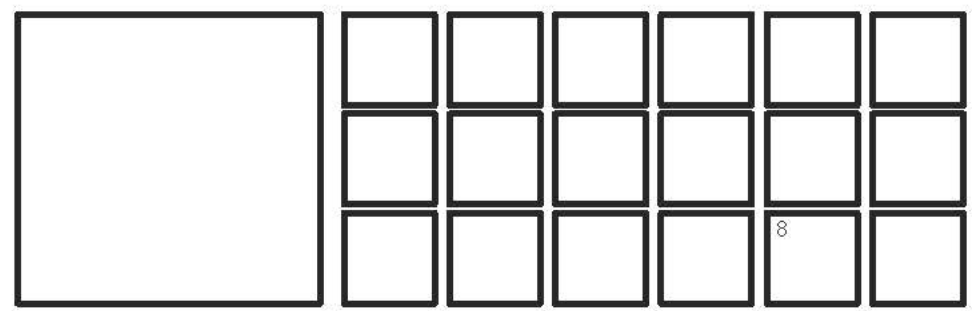




Well done!

This means that your opposing player has correctly guessed the card you selected.

Continue

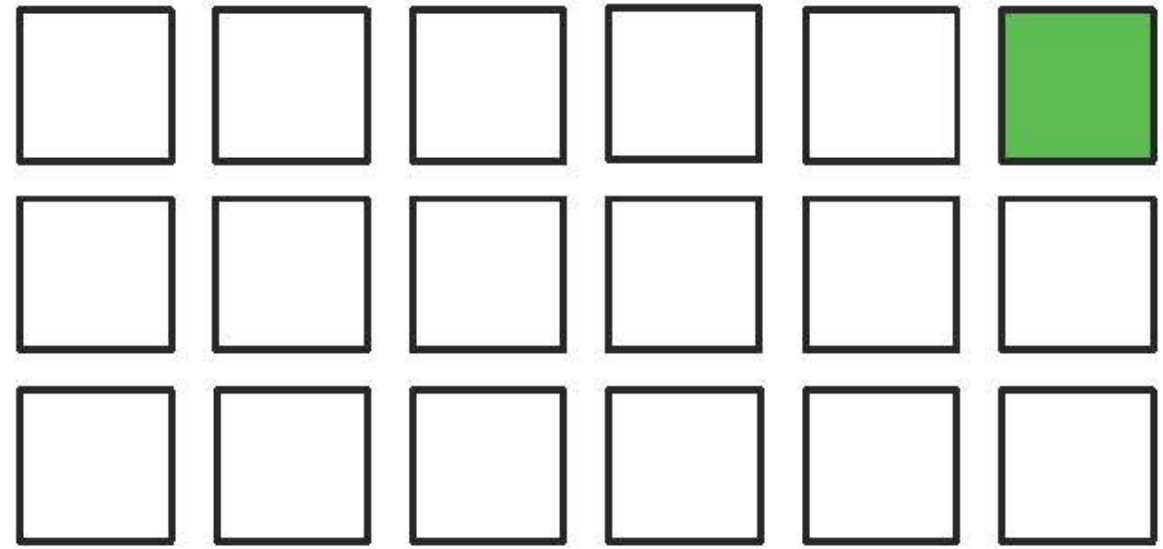
Make sure that you only select one card and press continue.

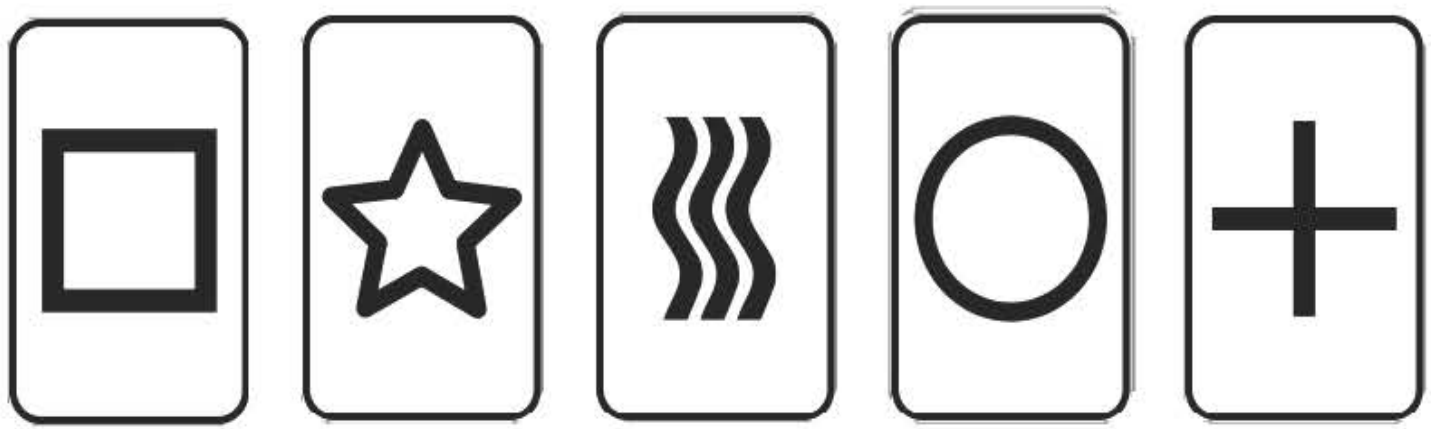
If you select more than one or don’t select one and press continue, a card will randomly be chosen for you.

This will negatively affect the results as we can’t use your reaction times!

Please select another card and continue.

Continue





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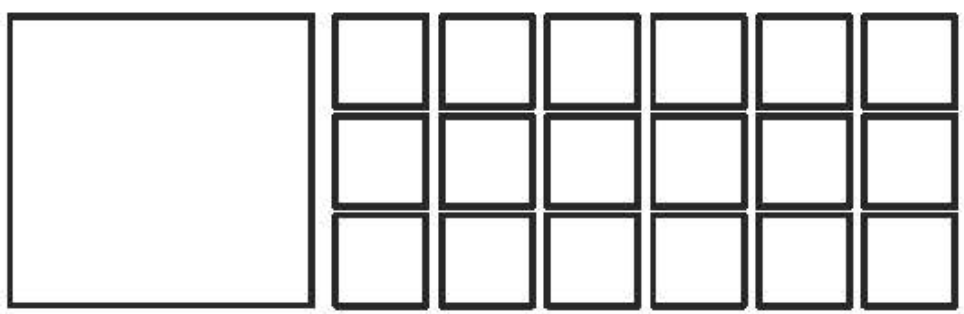

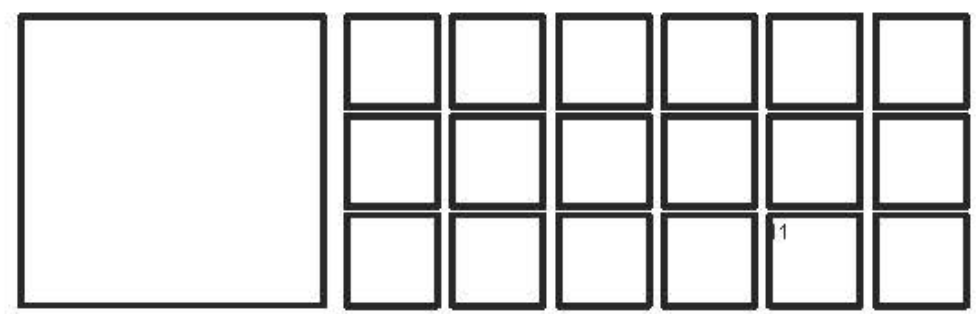

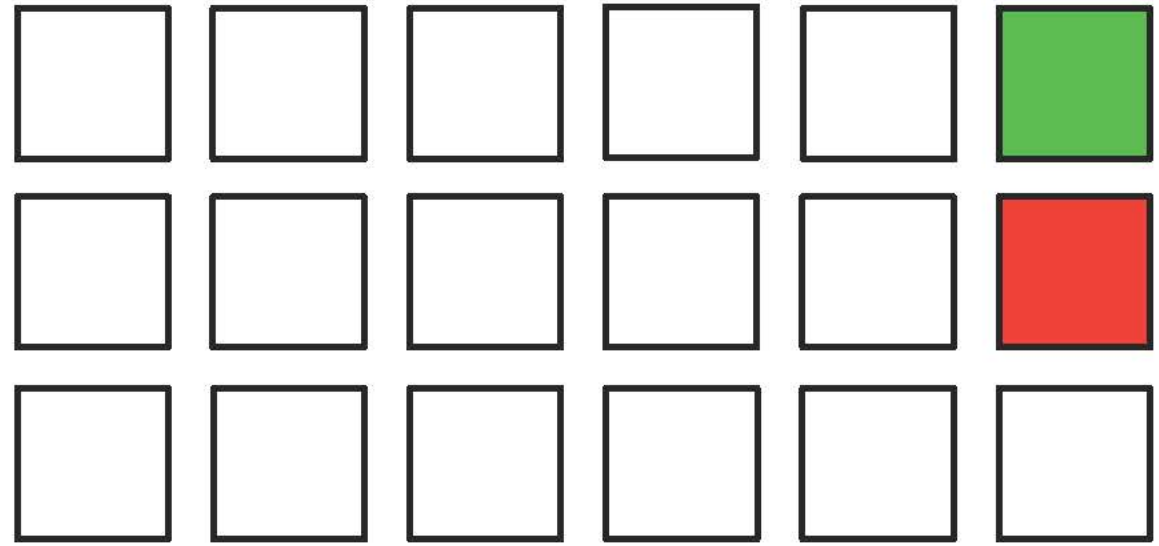

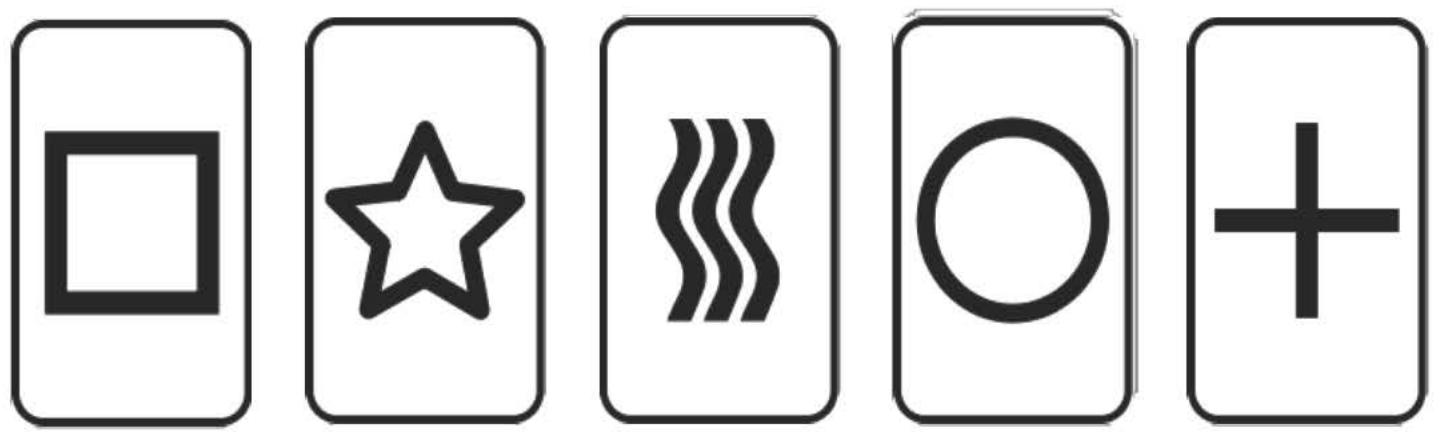

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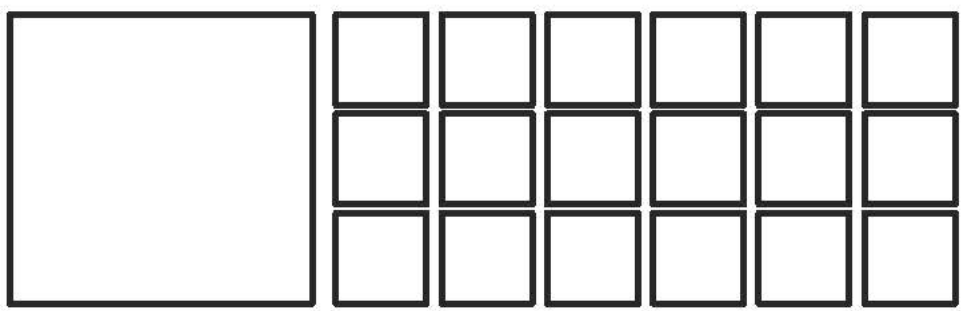
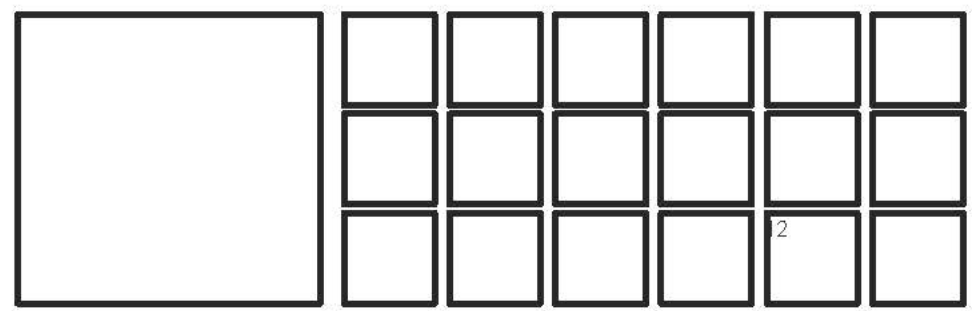




Oh no!

This means that your opposing player has incorrectly guessed the card you selected.

Continue

The next screen will assign you to your group.

You will either see you opposing player immediately via webcam or this symbol

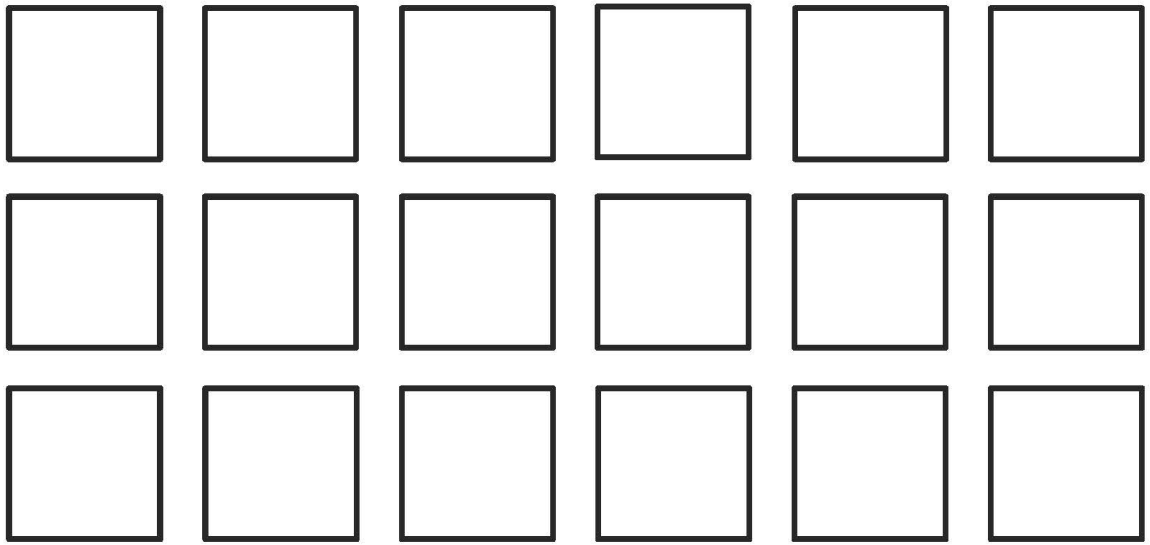
which indicates that your opposing player is unobserved.

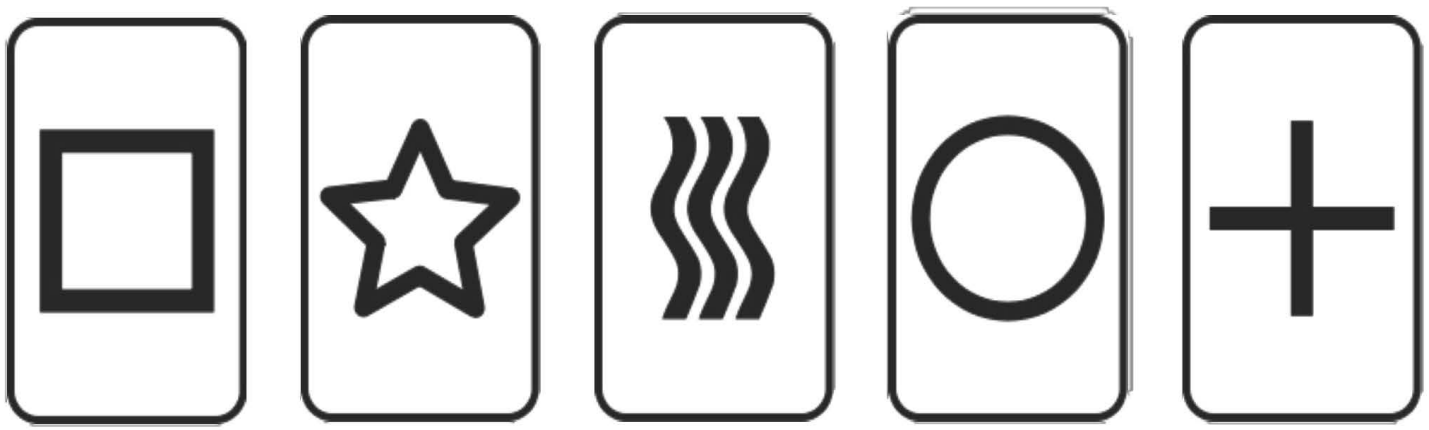
Thank you again for your participation.

Continue

The first participant is being located.

After a short countdown the test will begin.





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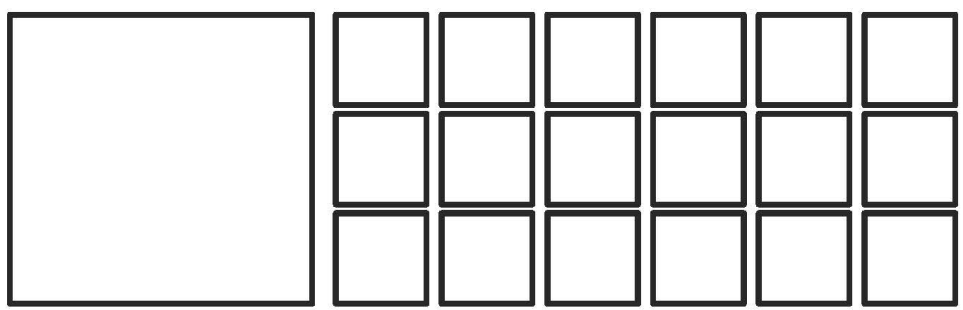
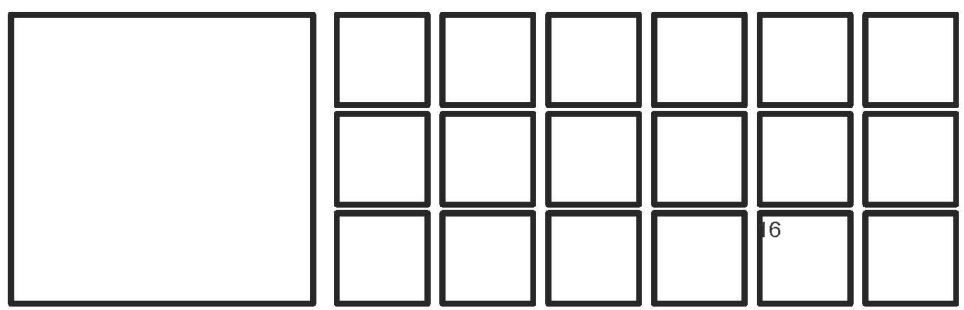
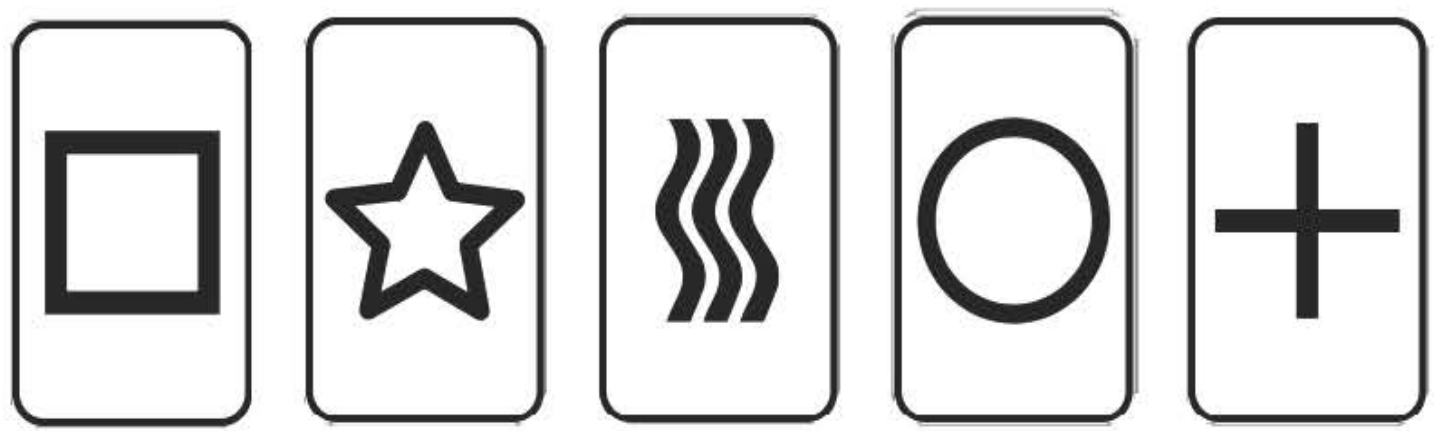




GO!



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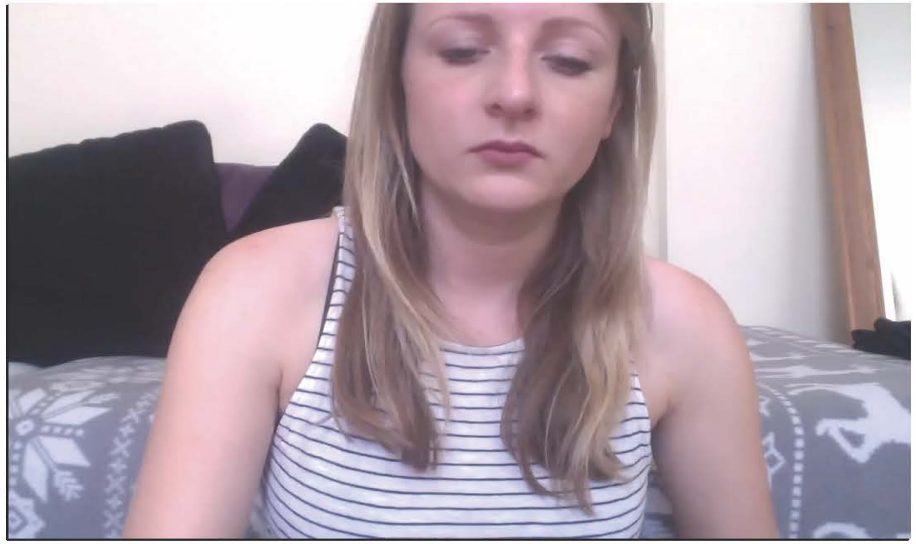

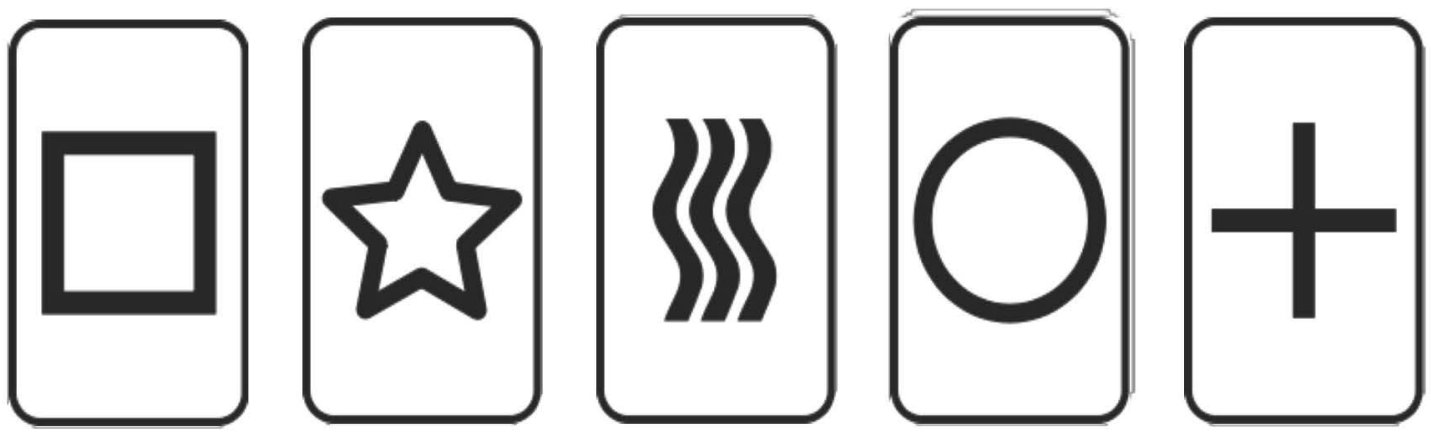

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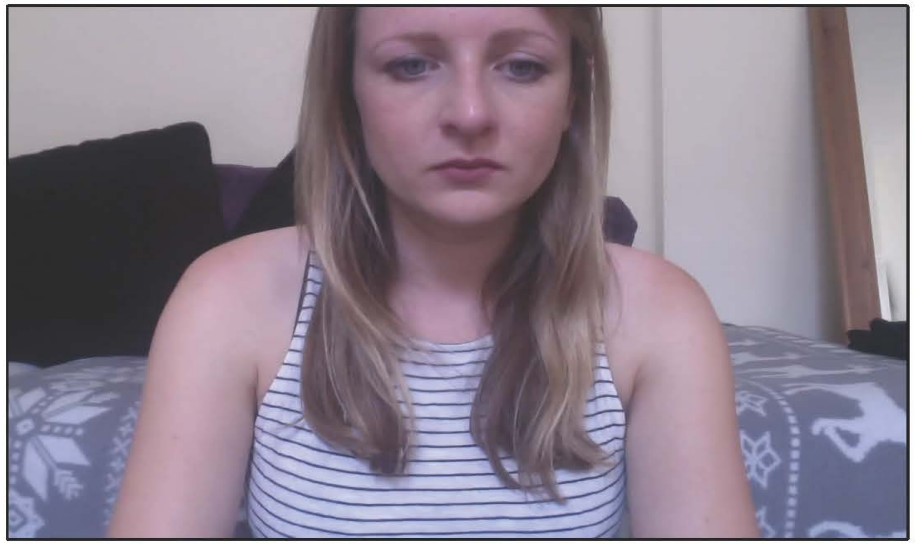

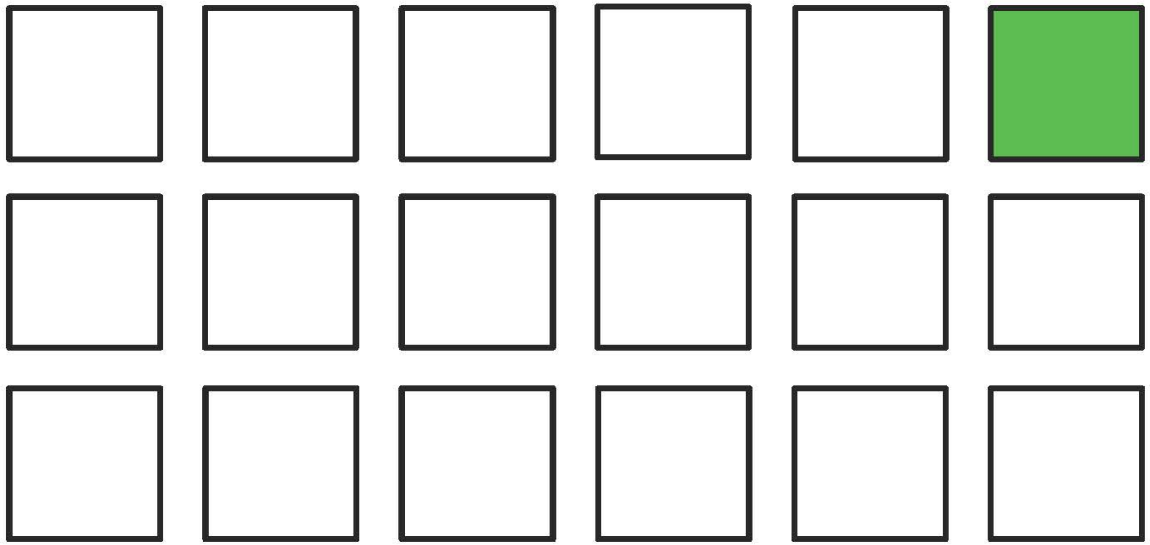

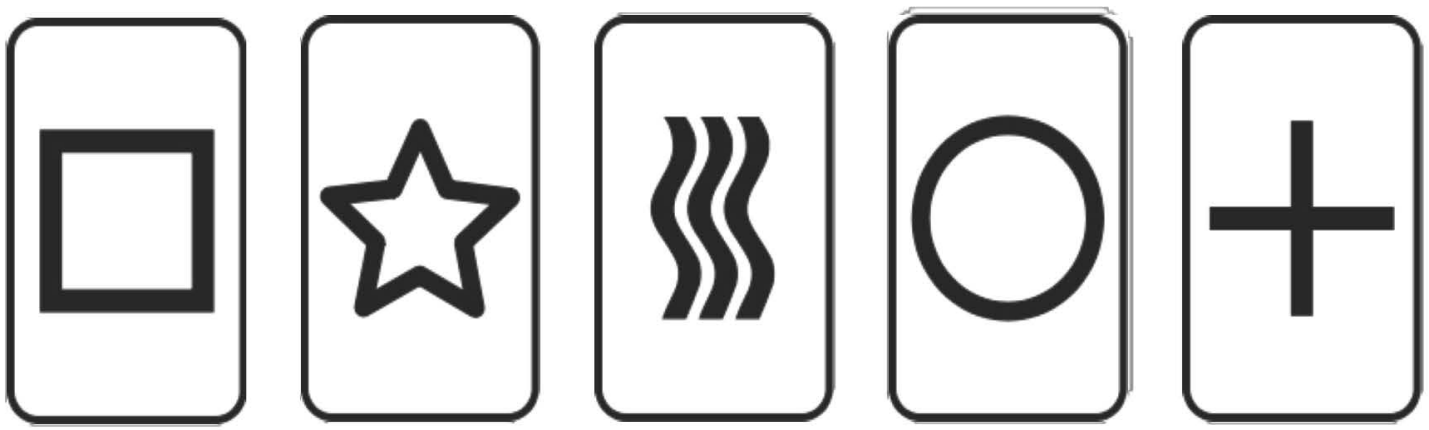

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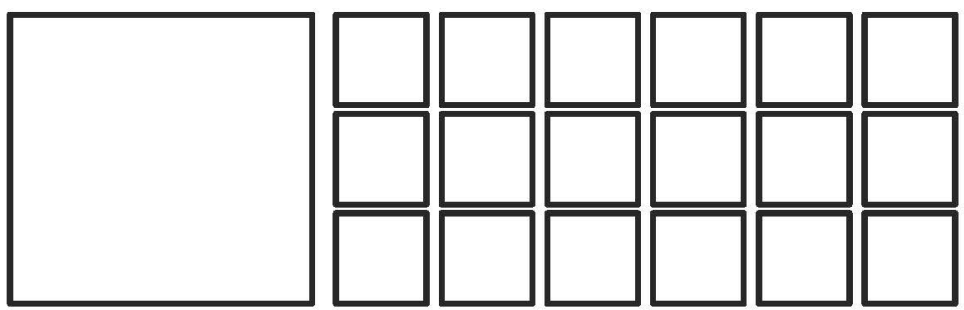

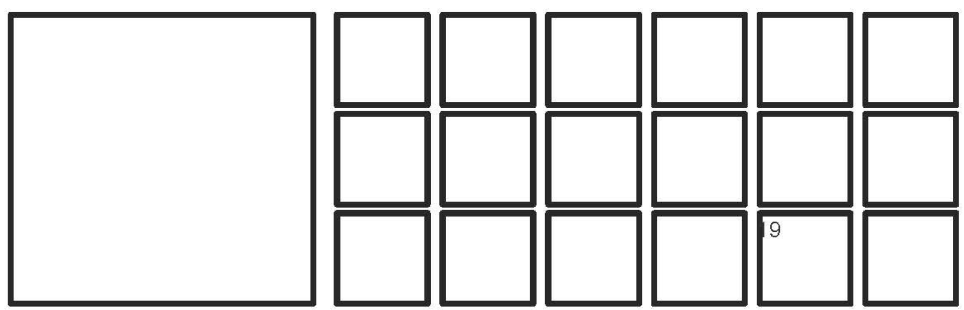

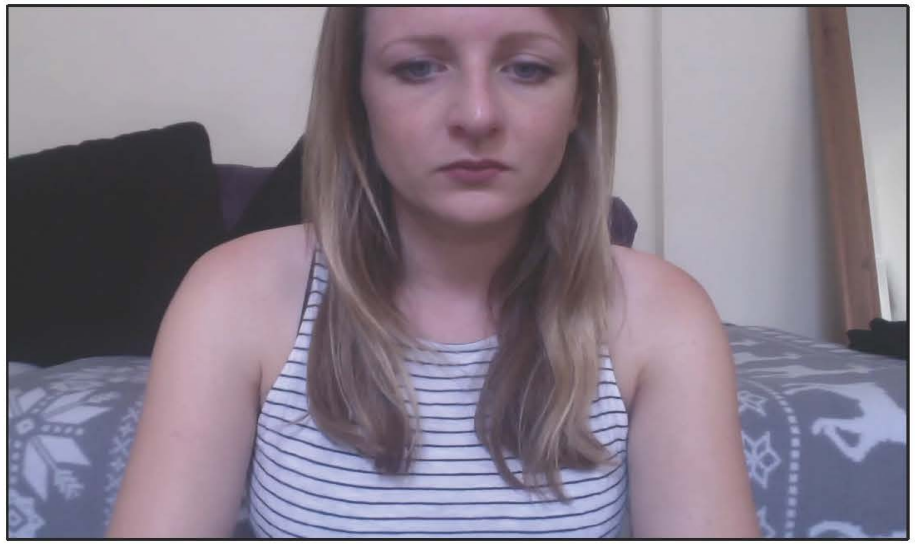

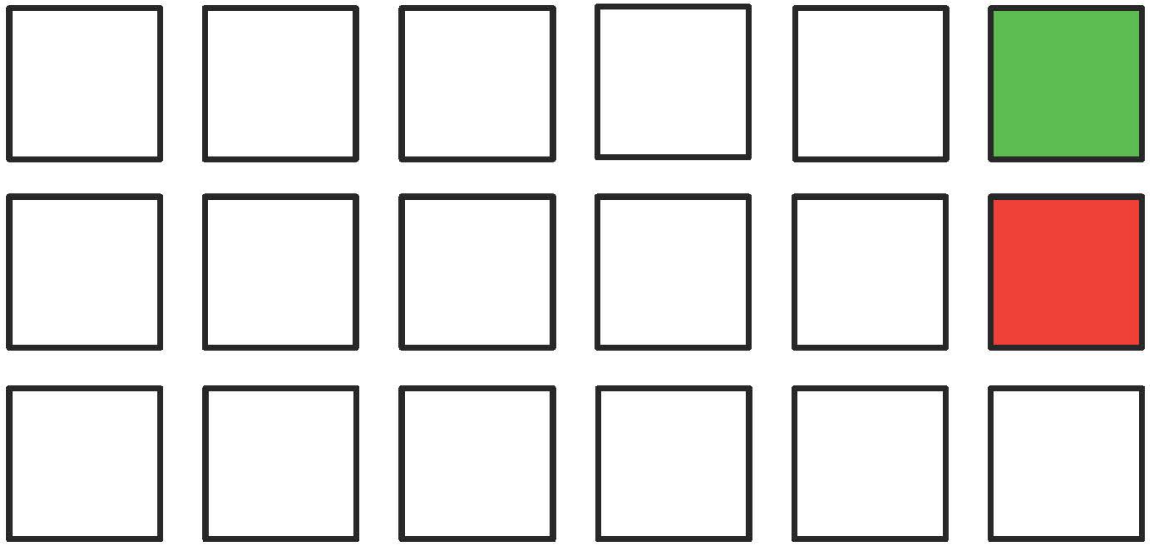

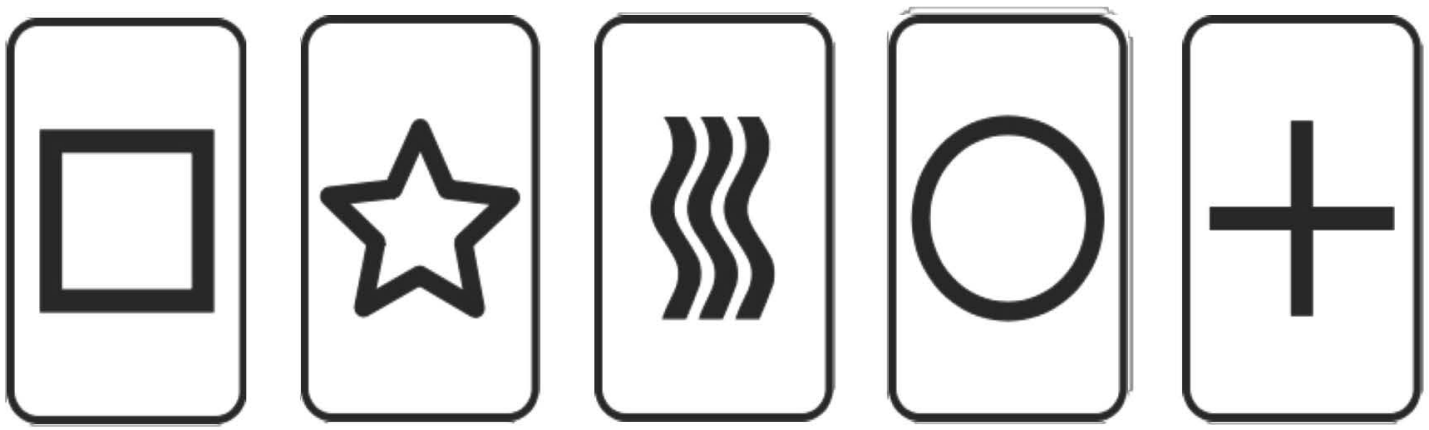

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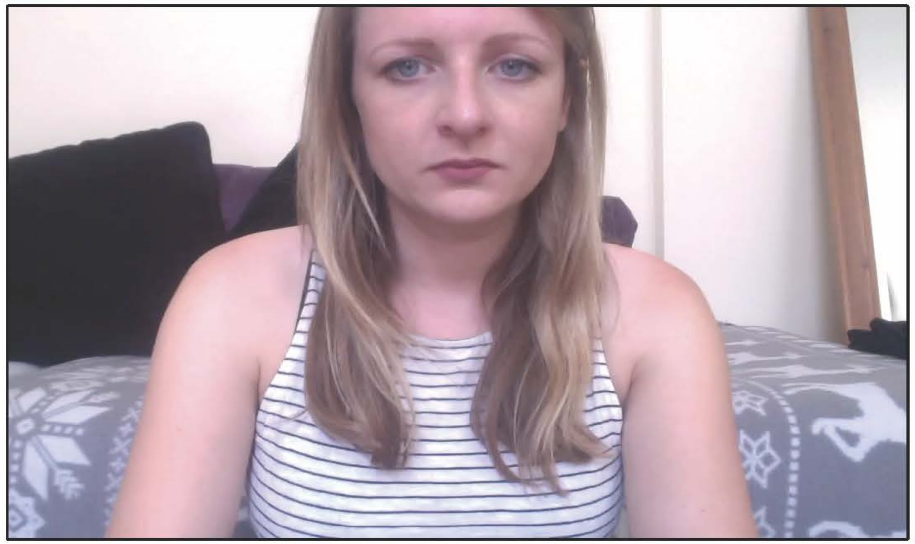

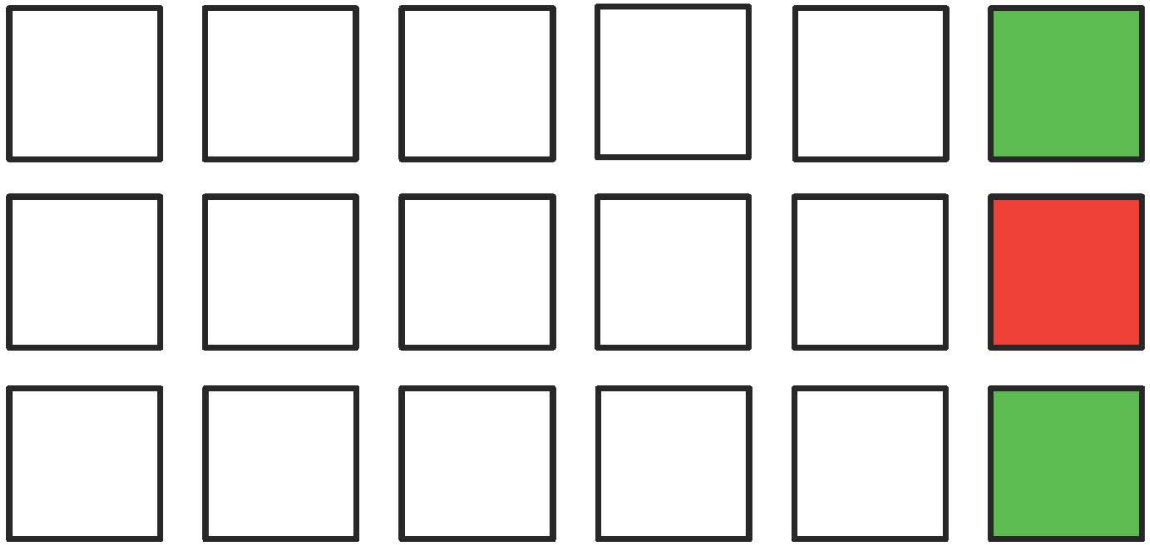

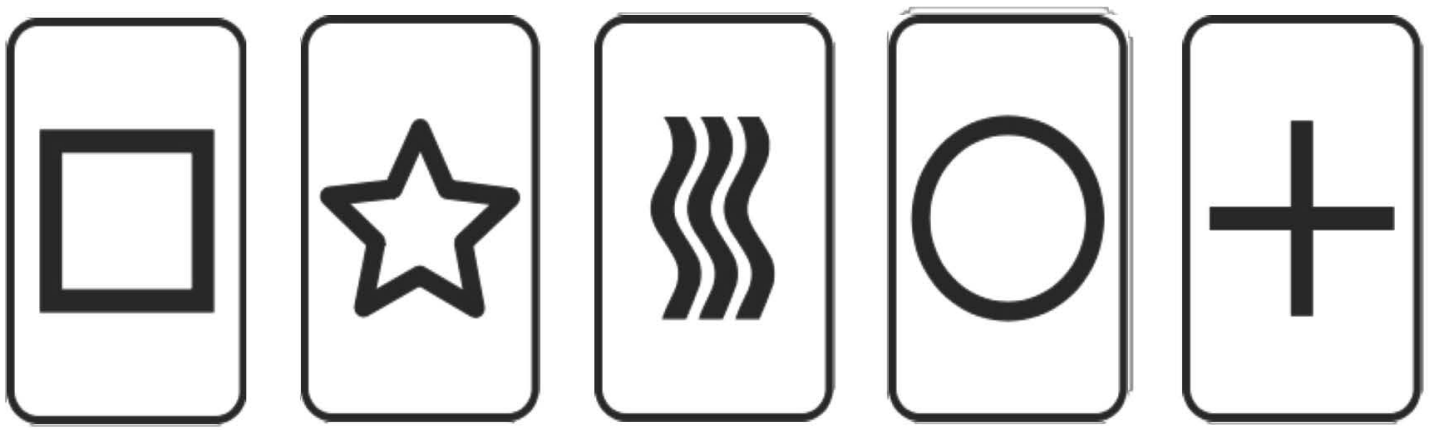

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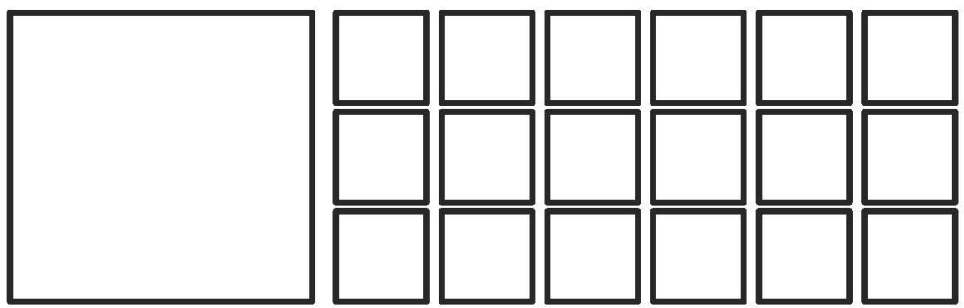

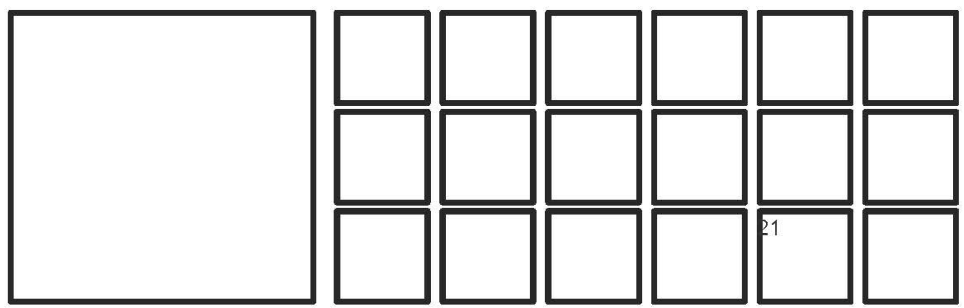

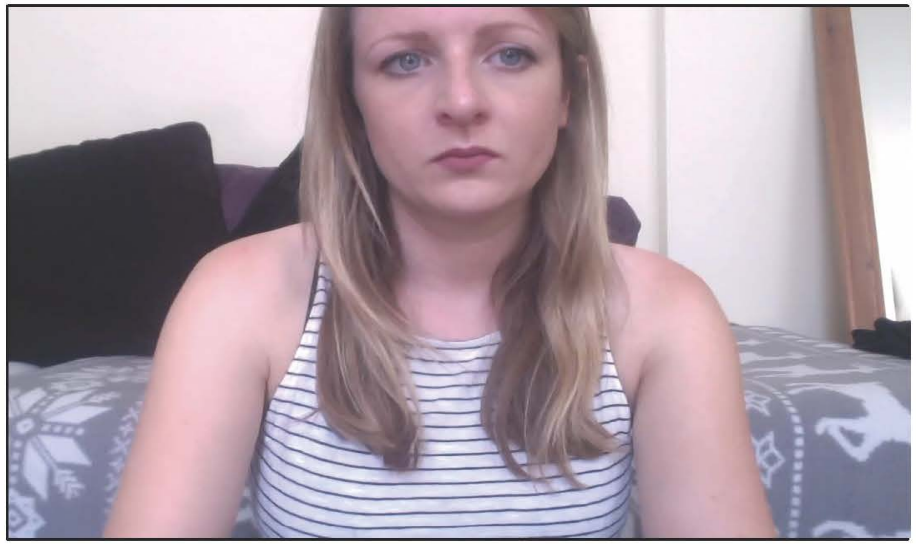

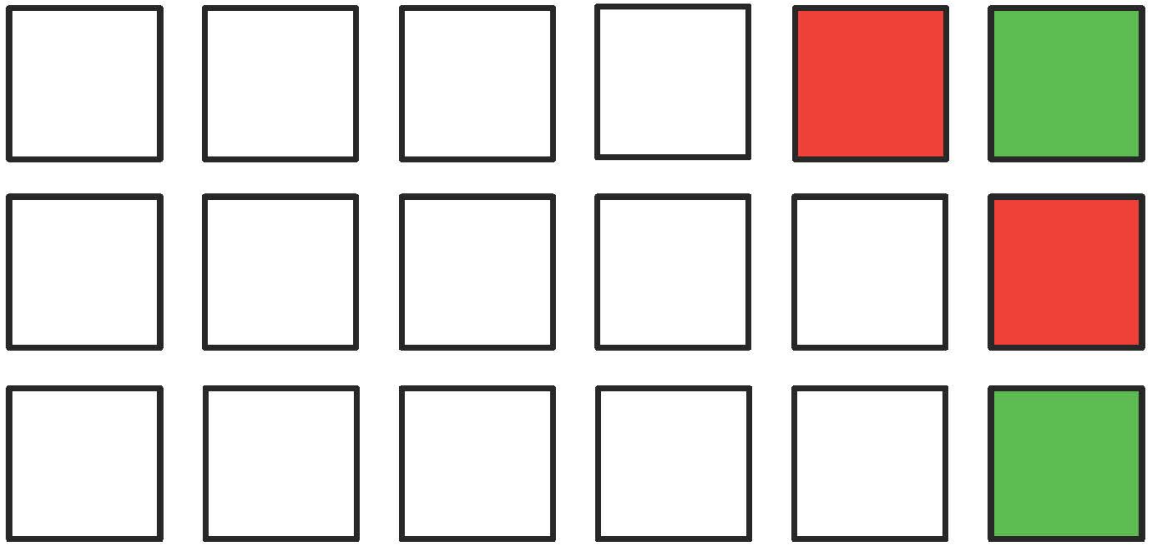

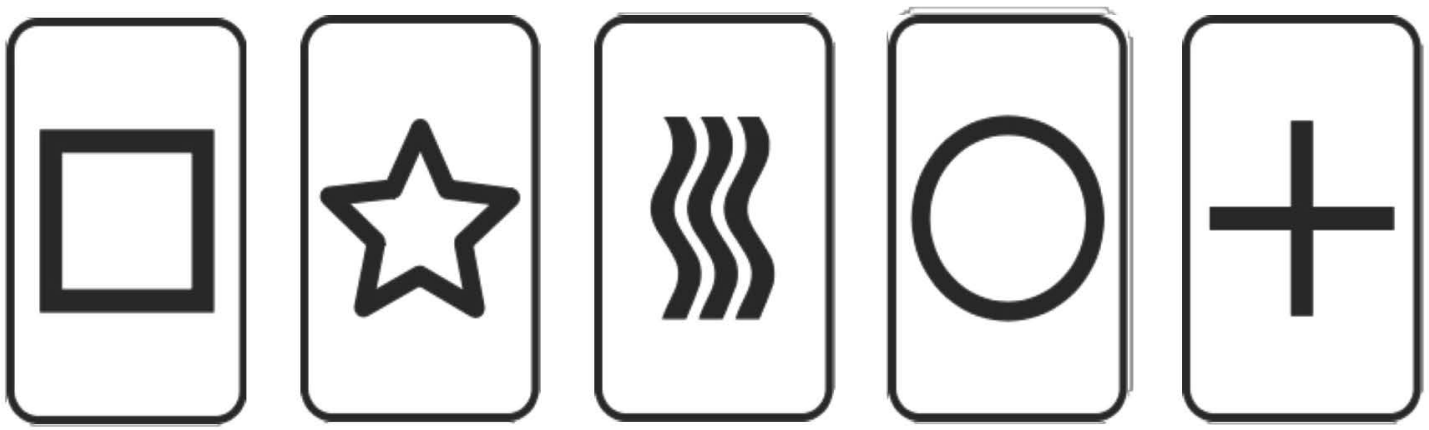

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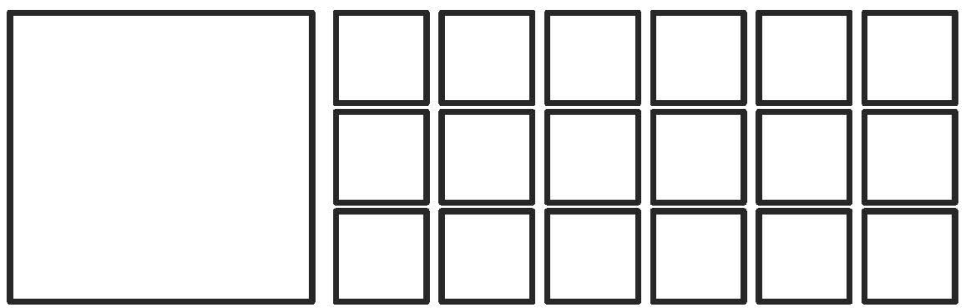

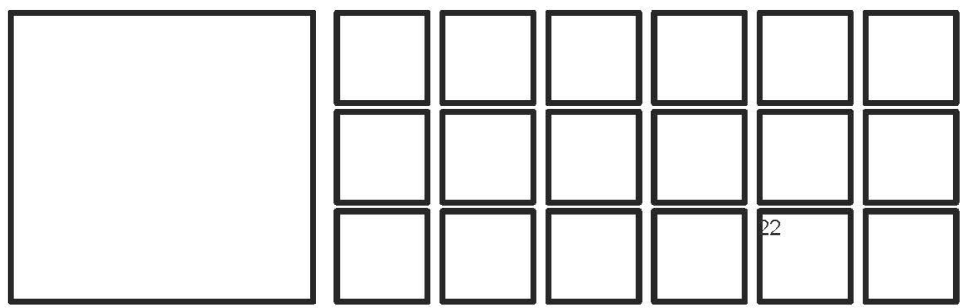

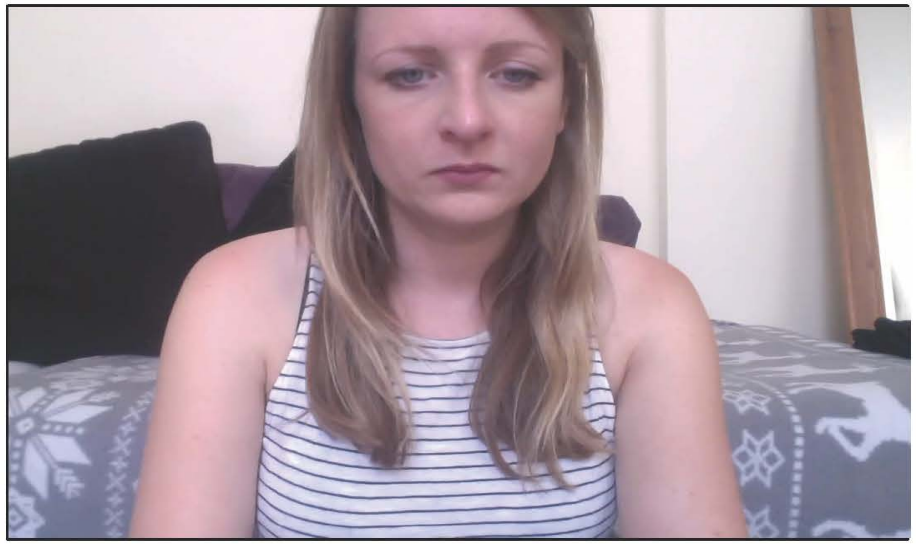

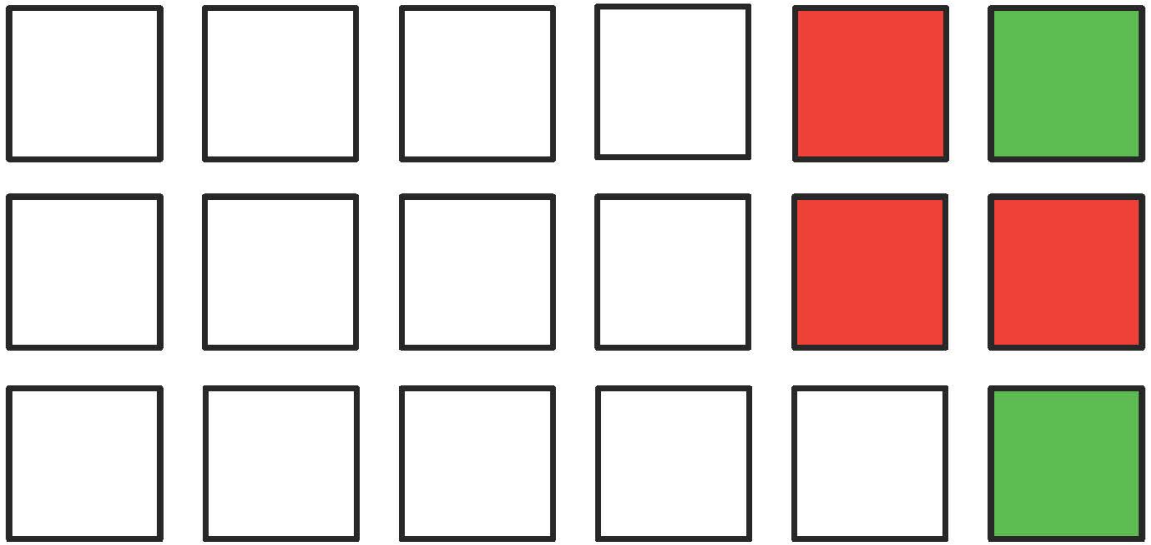

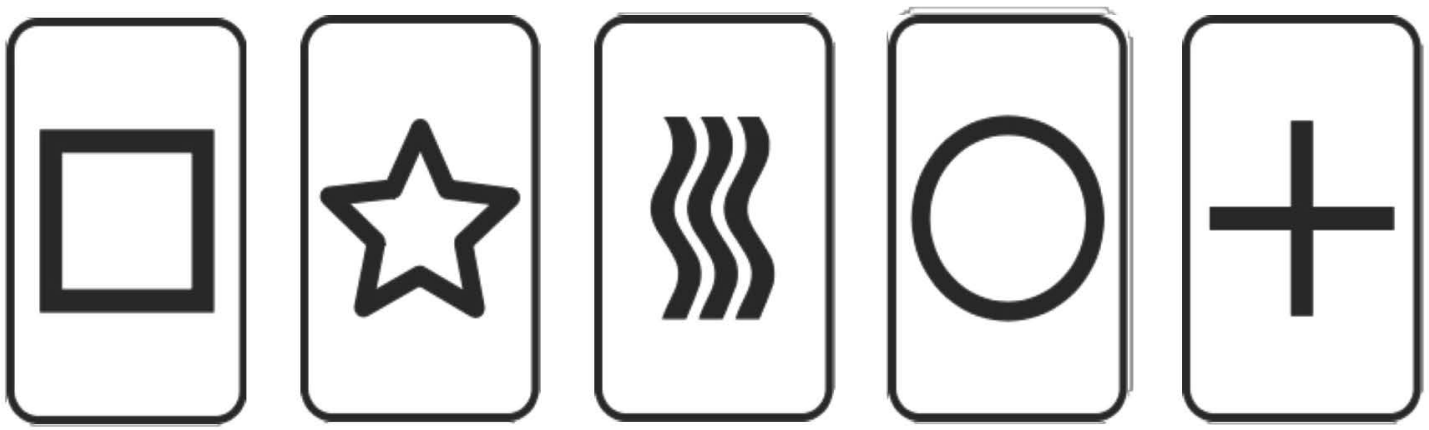

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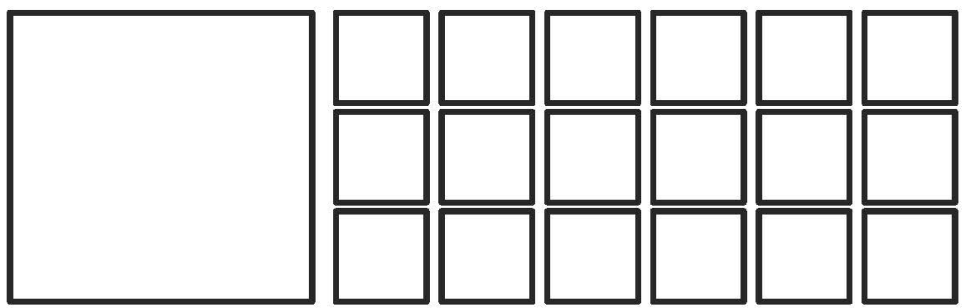

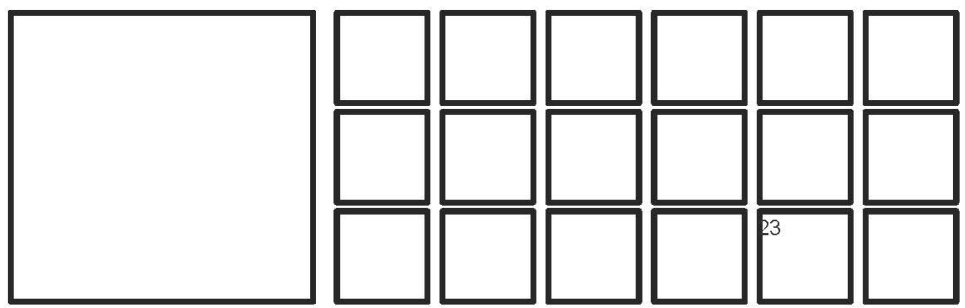

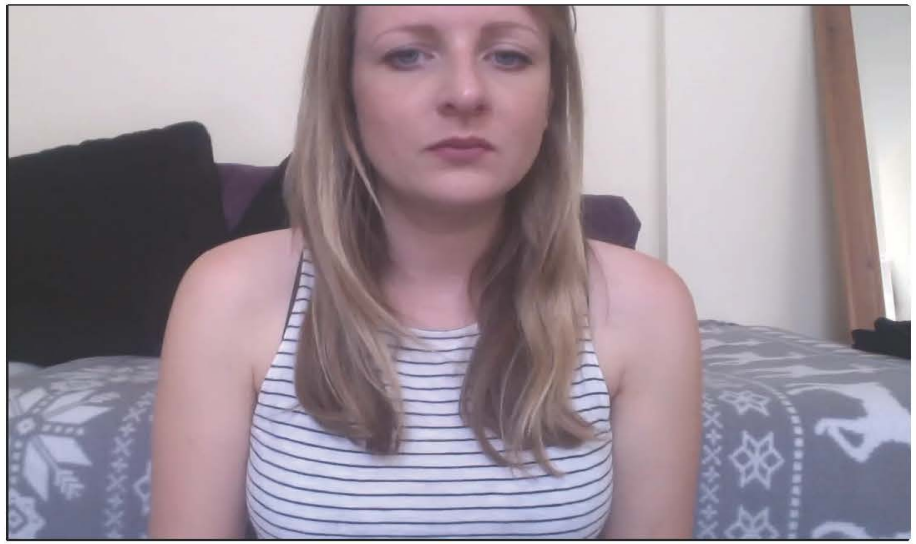

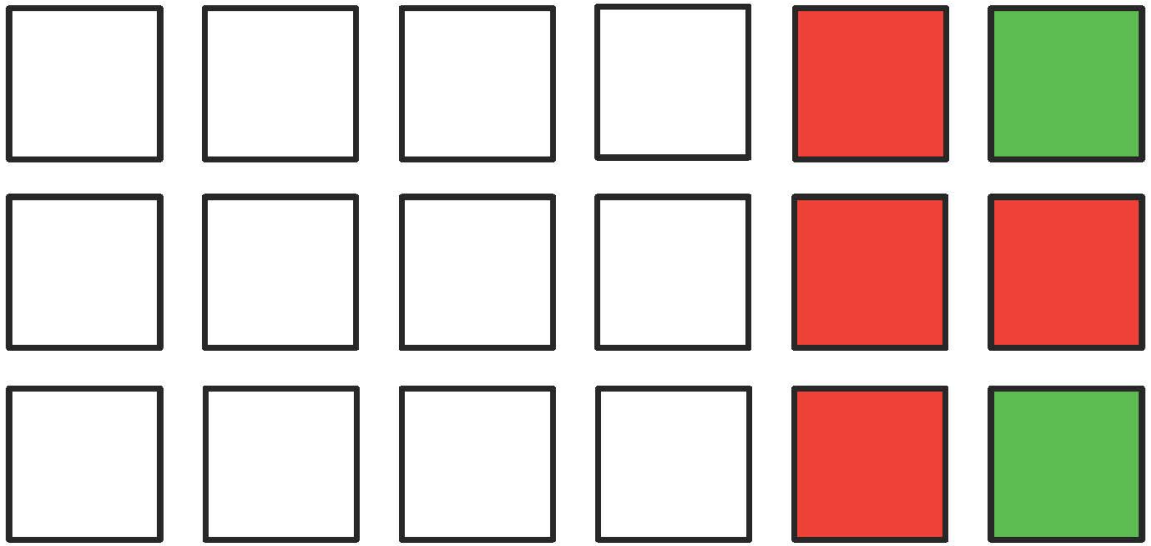

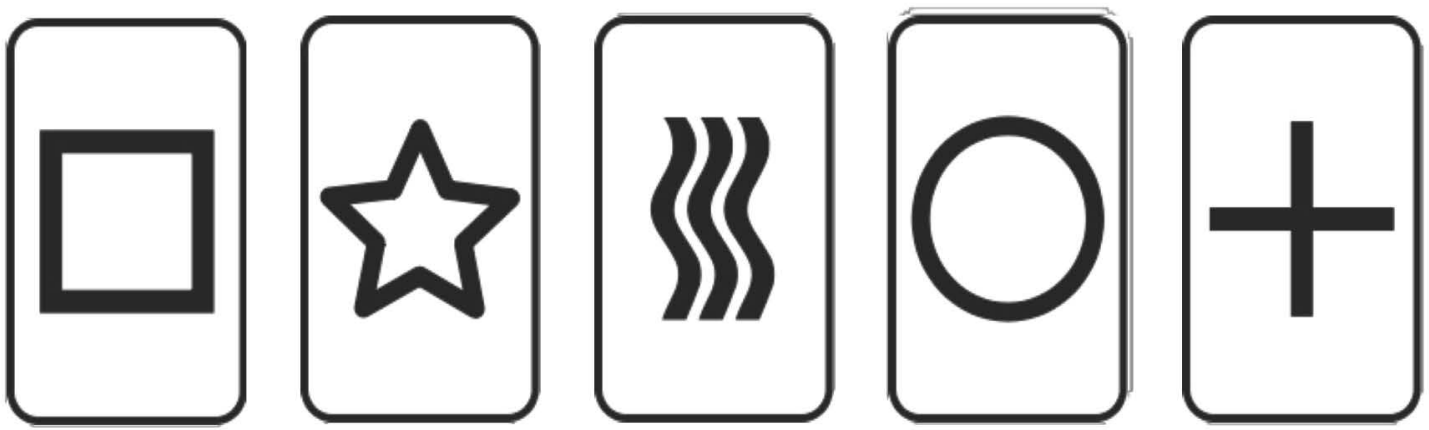

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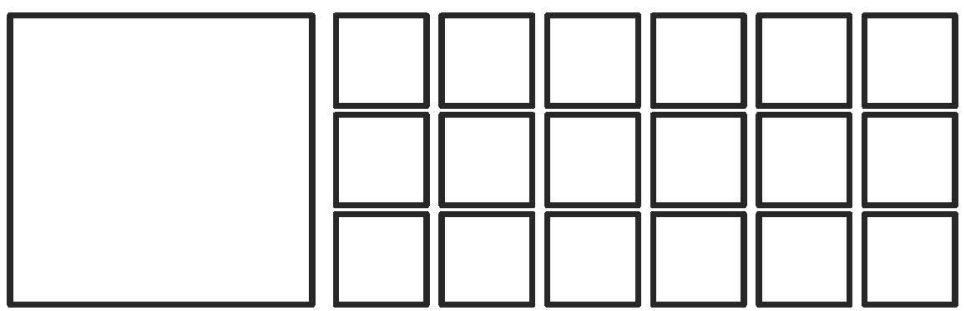

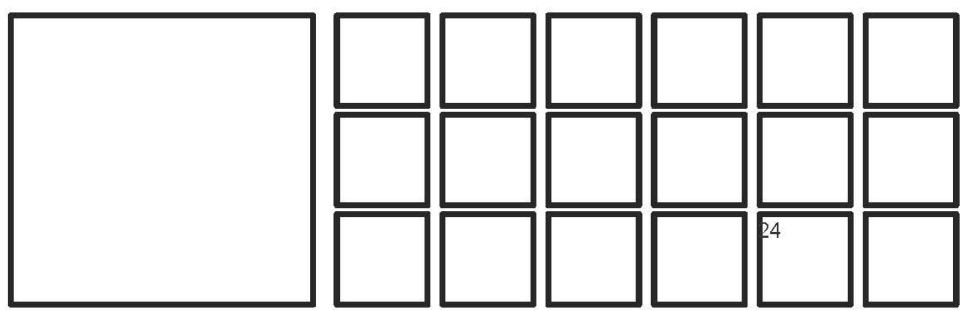

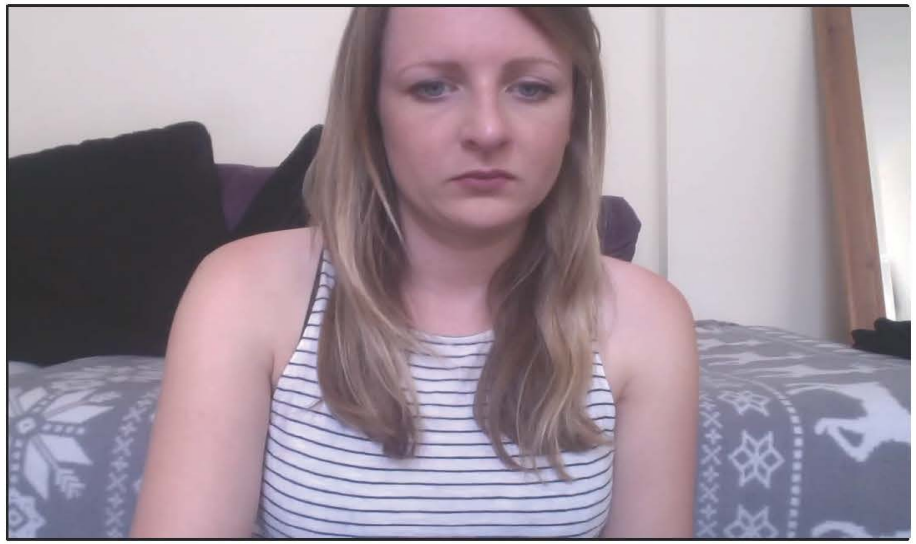

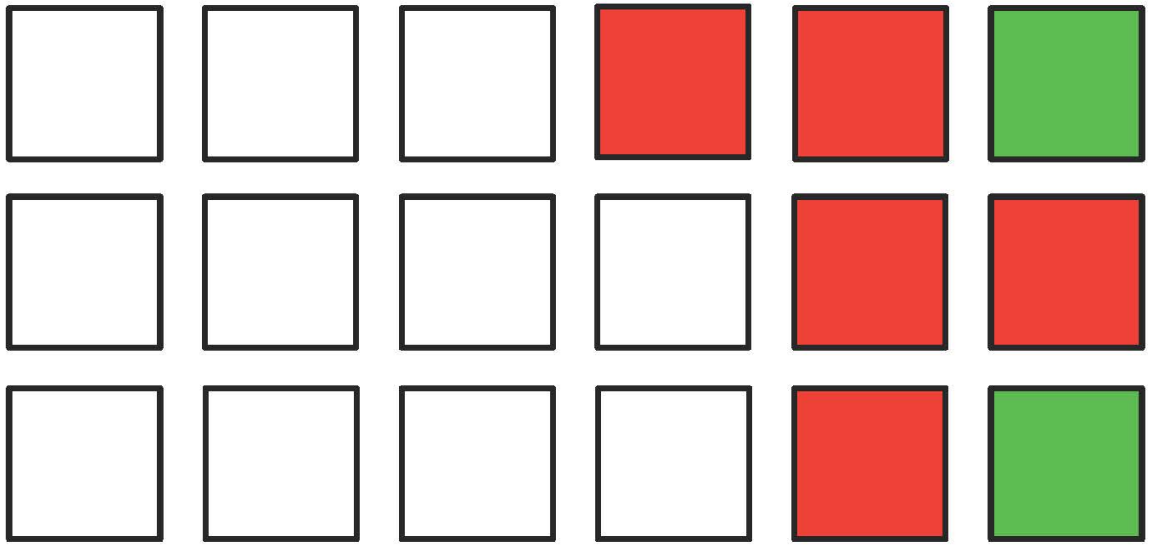

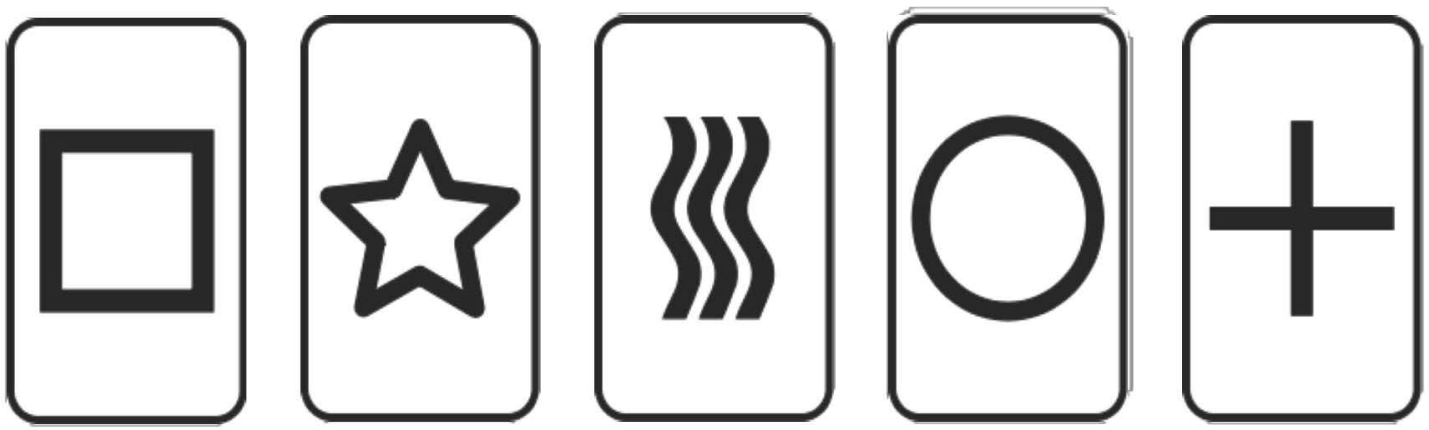

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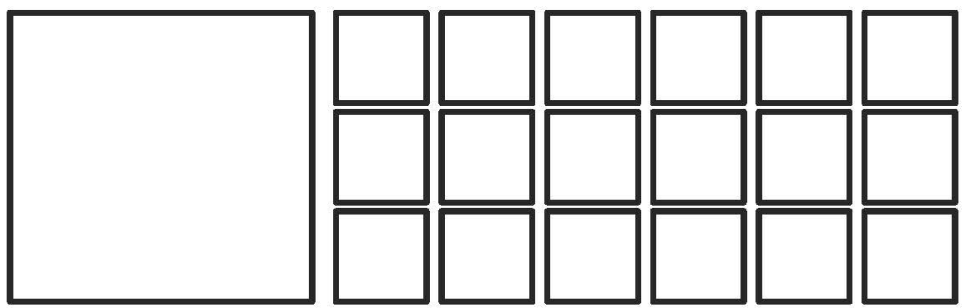

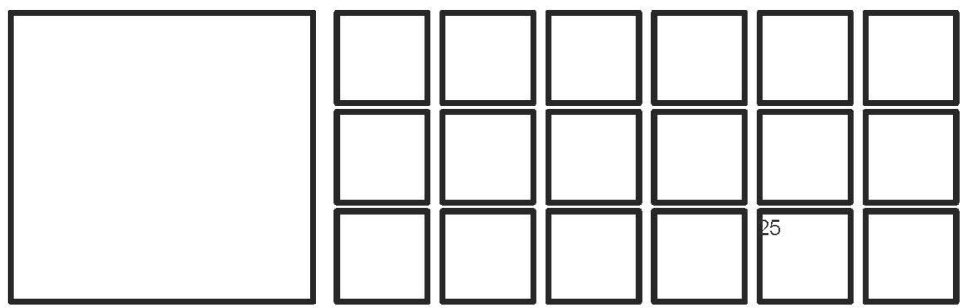

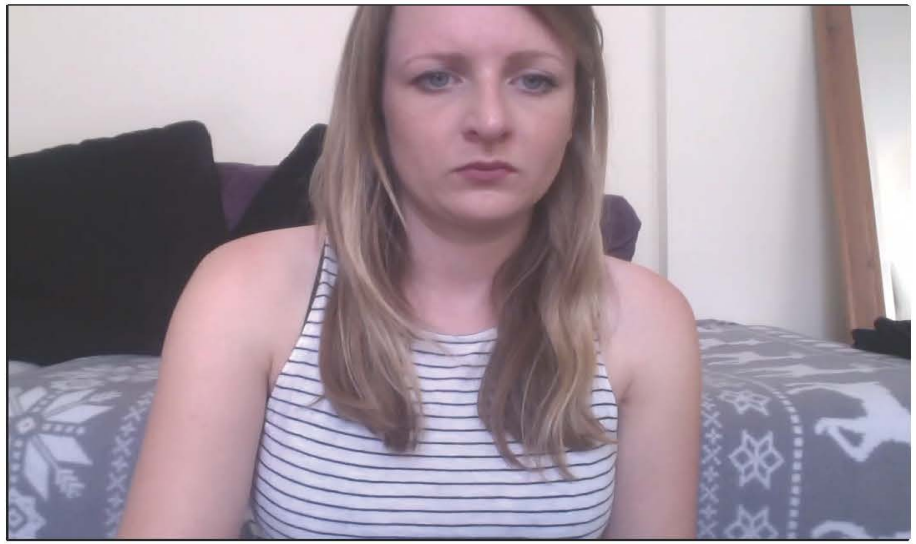

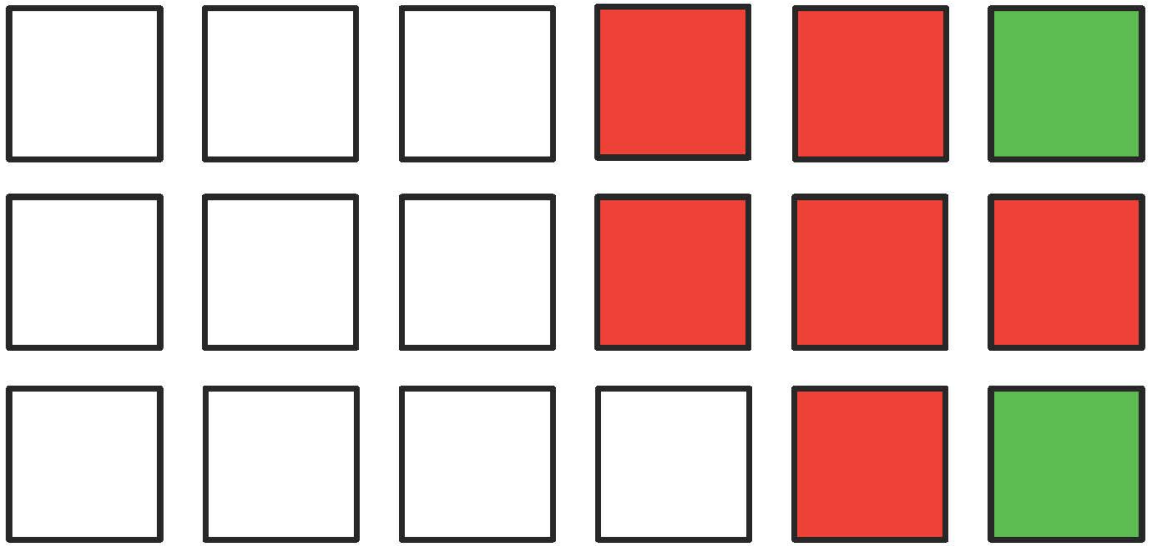

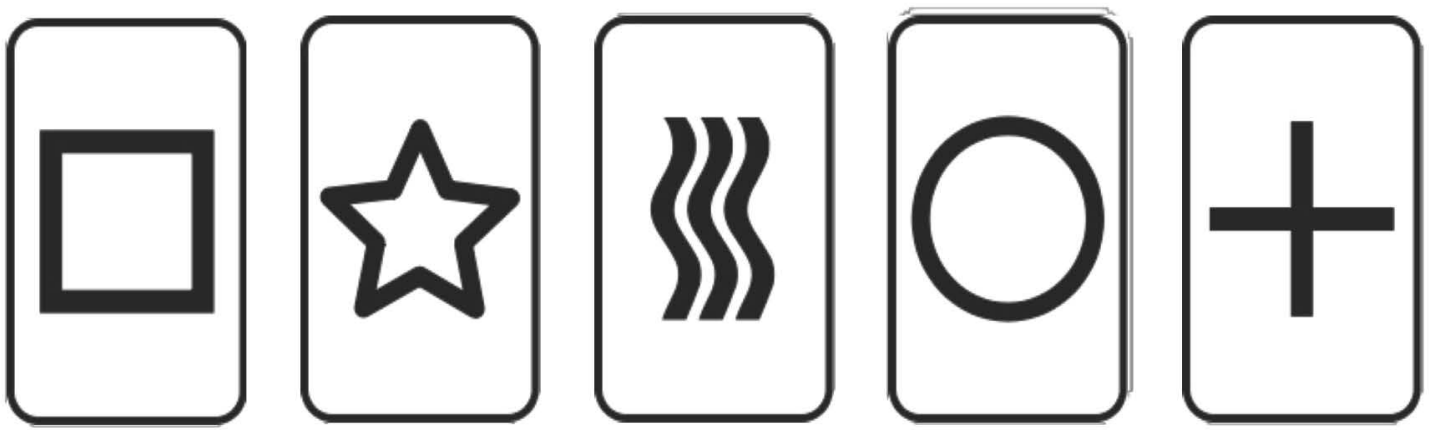

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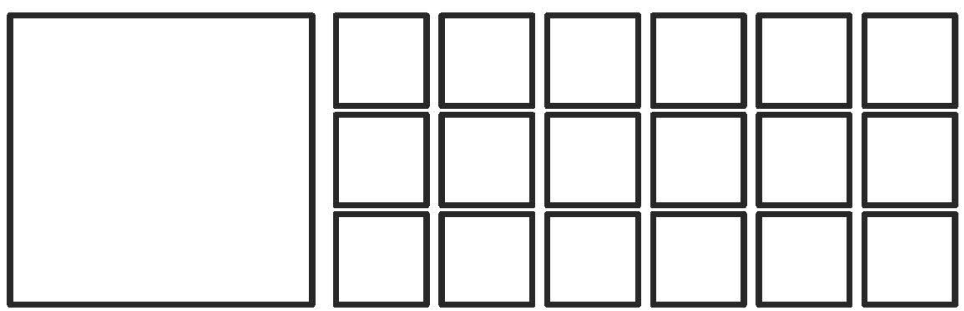

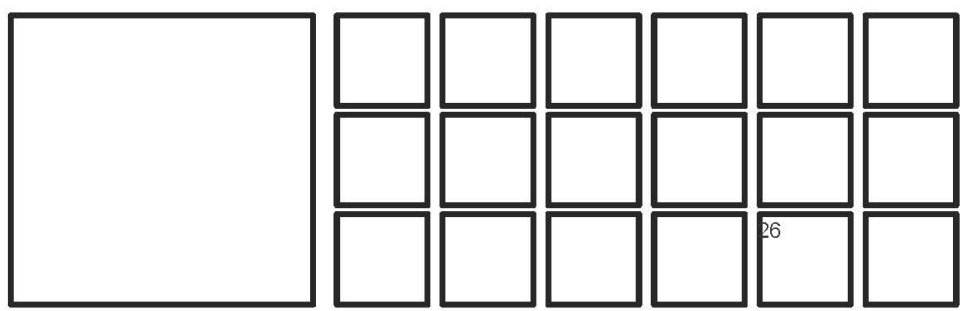

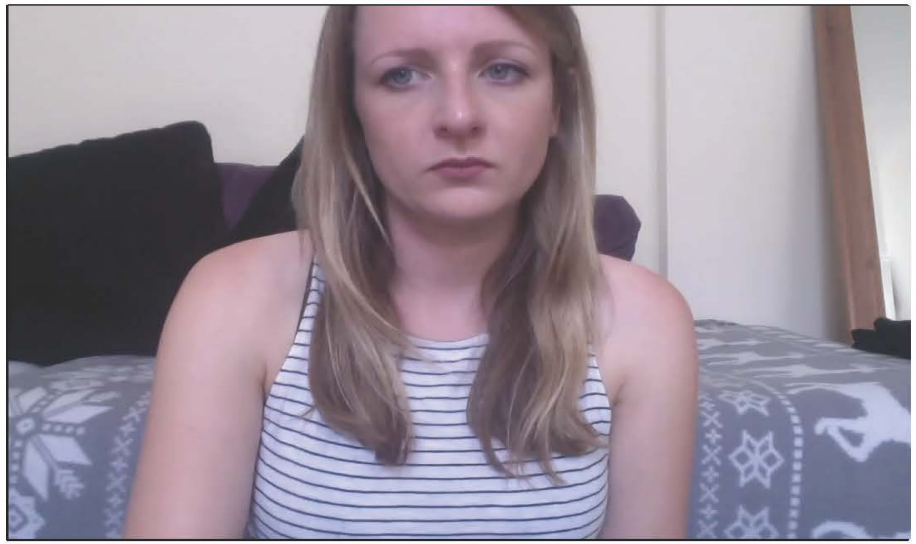

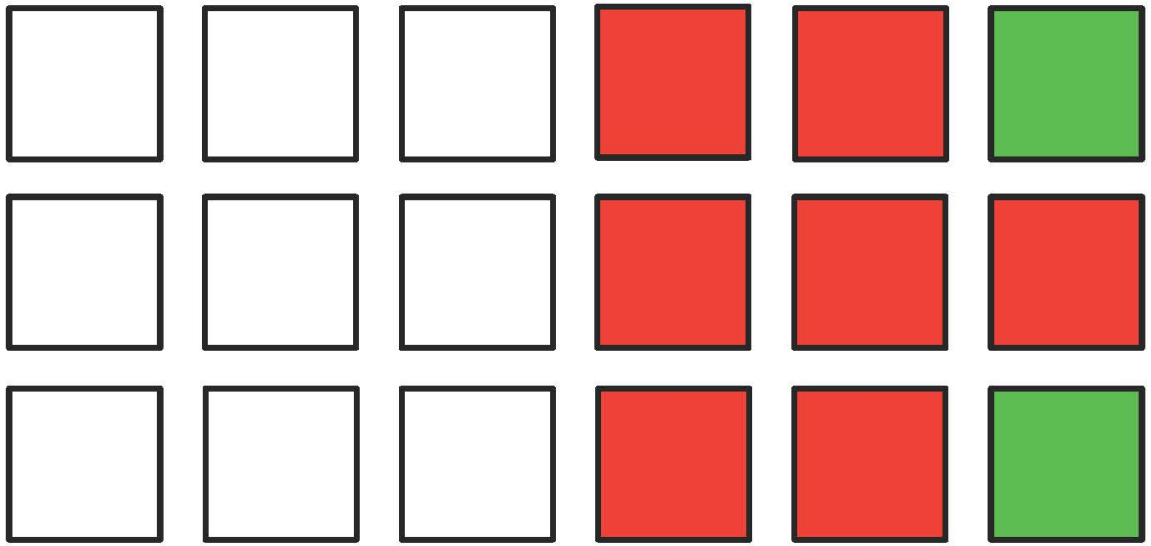

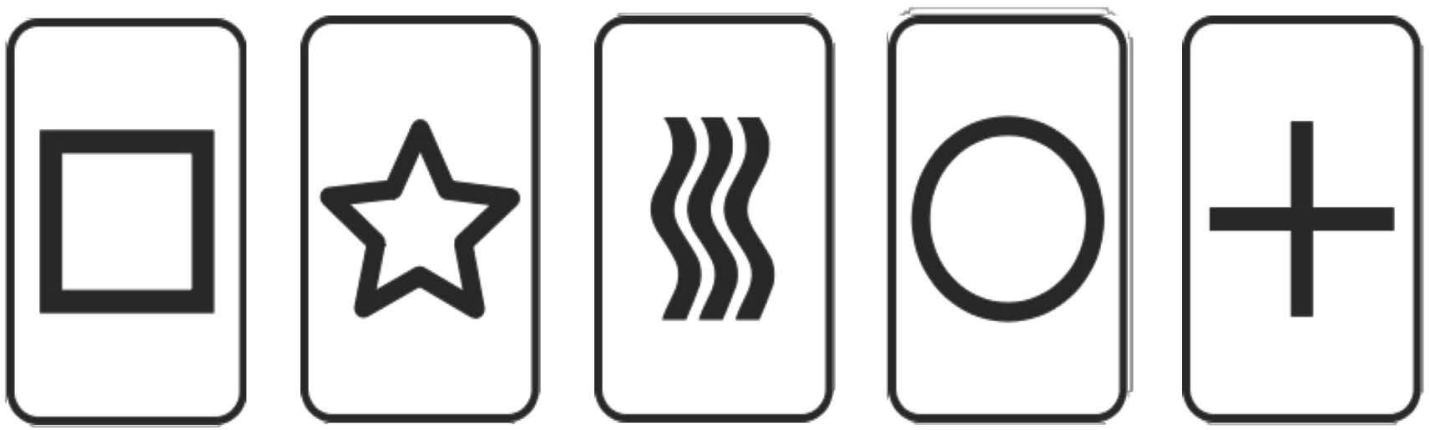

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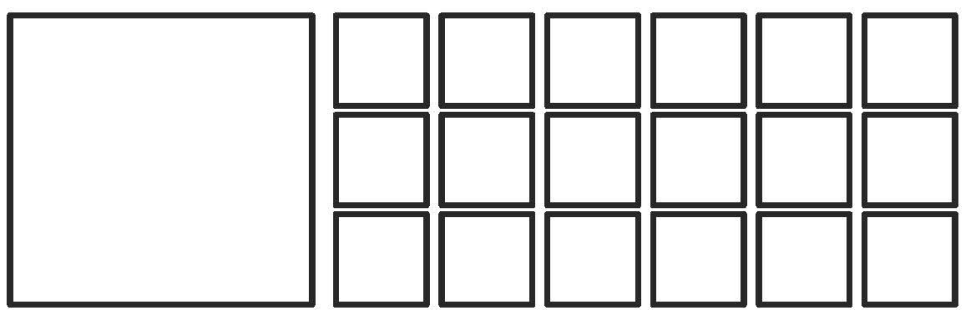

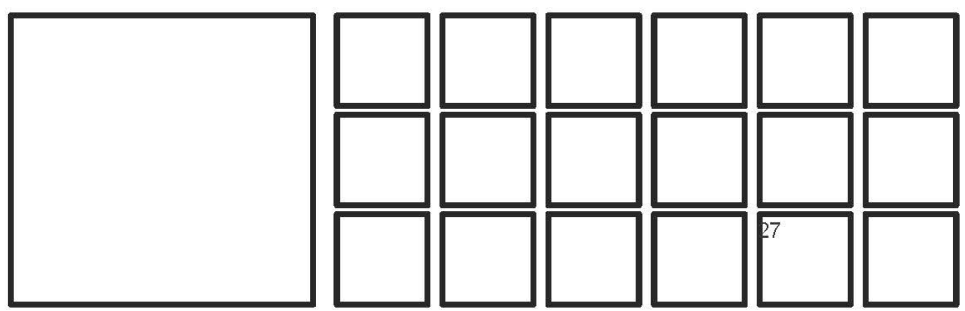

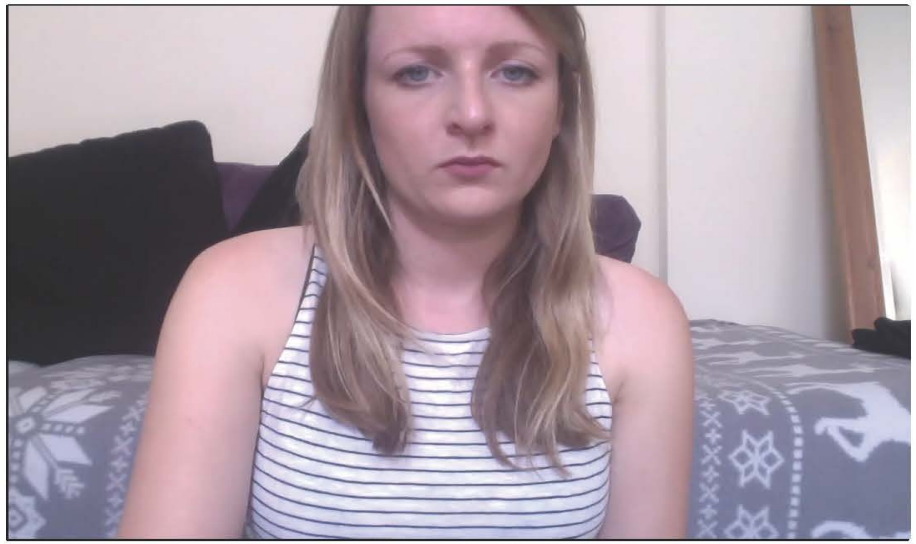

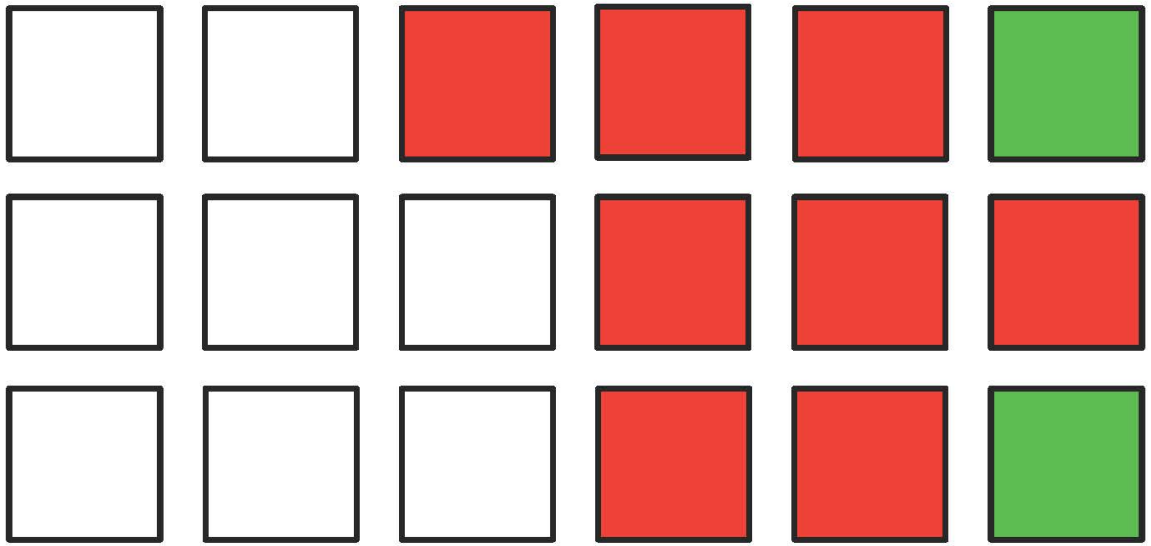

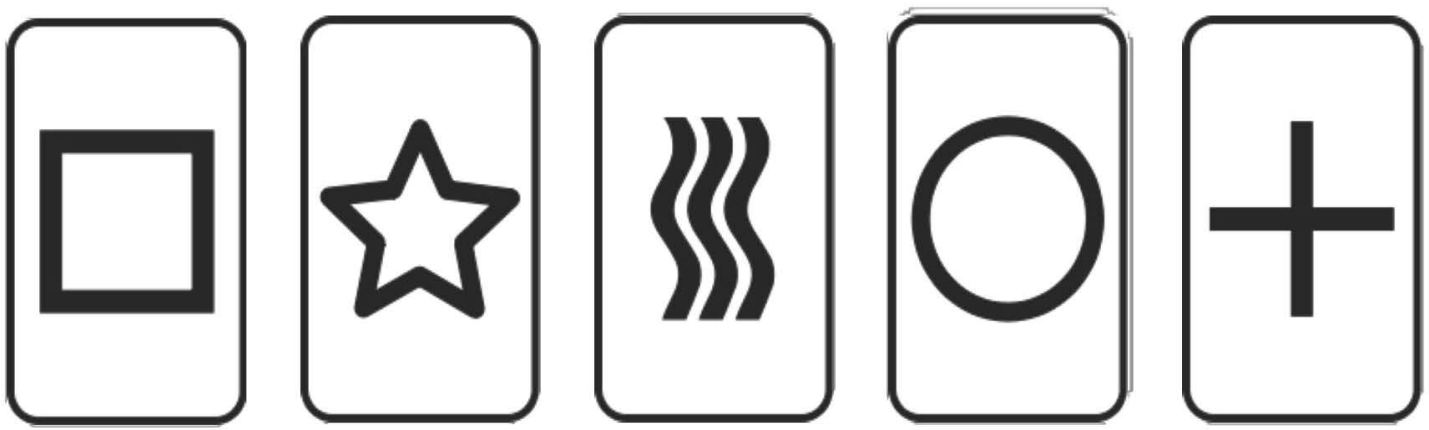

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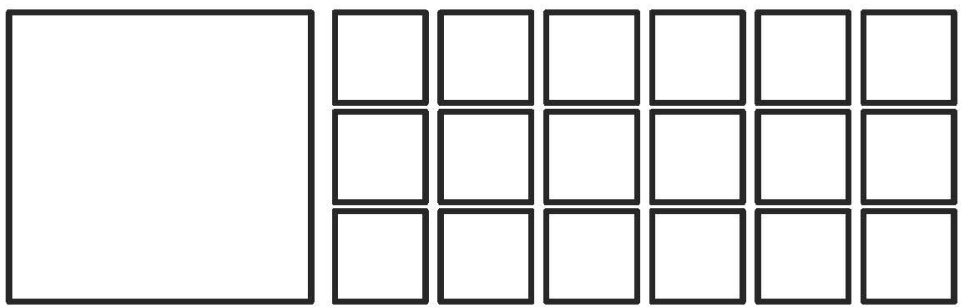

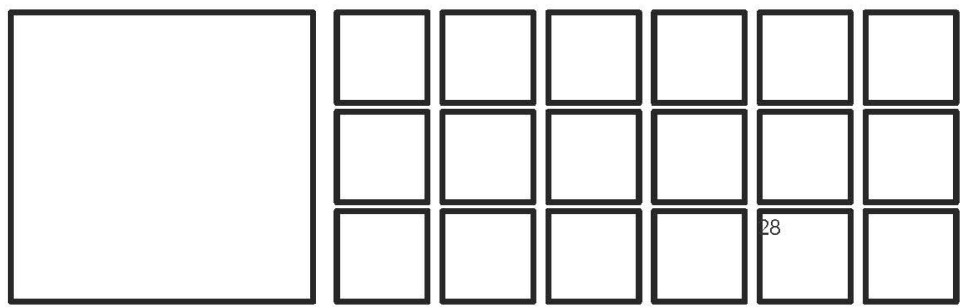

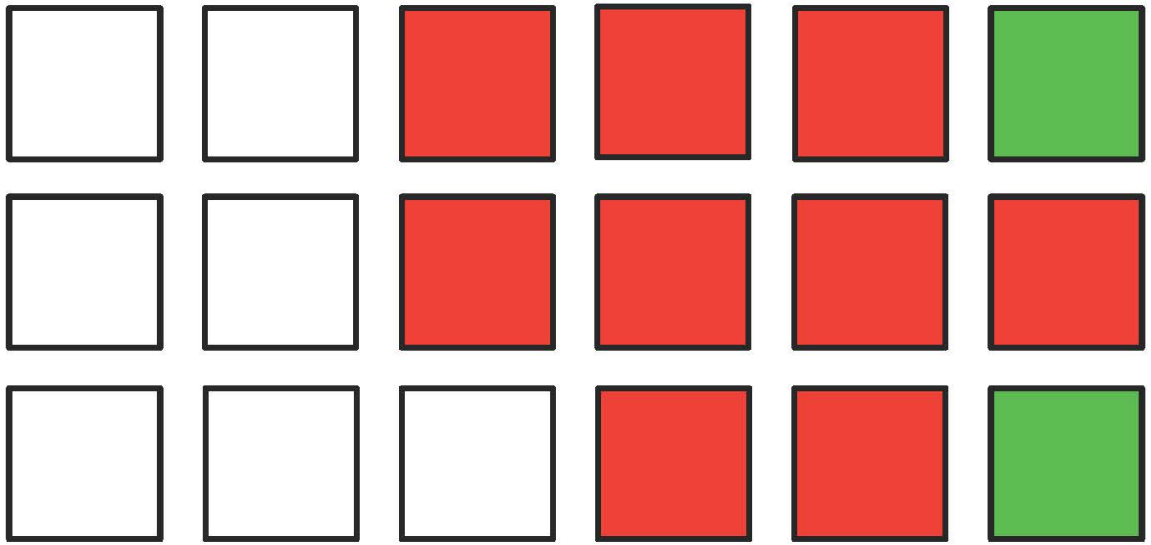

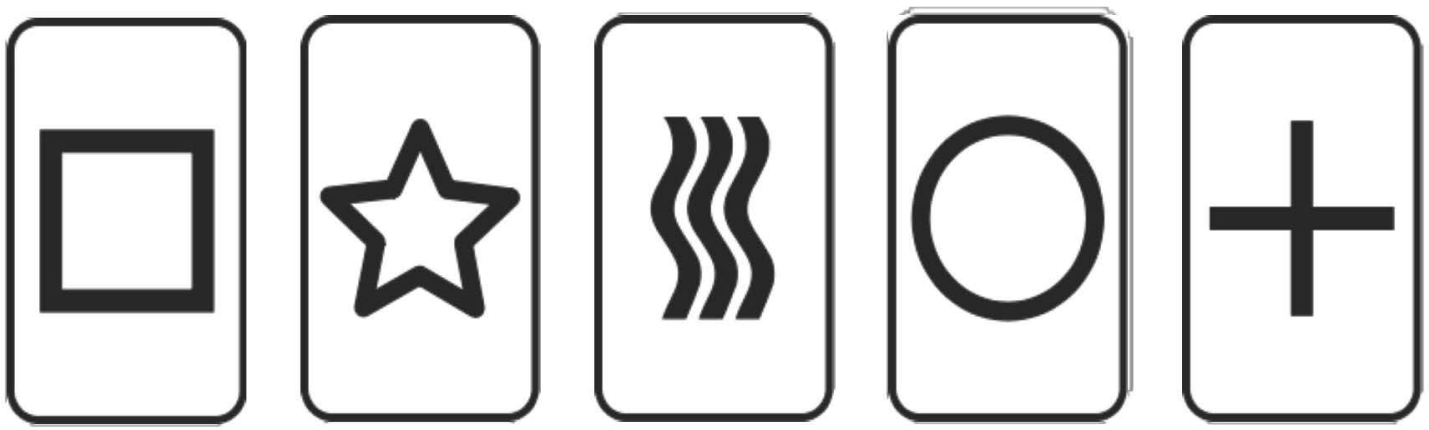

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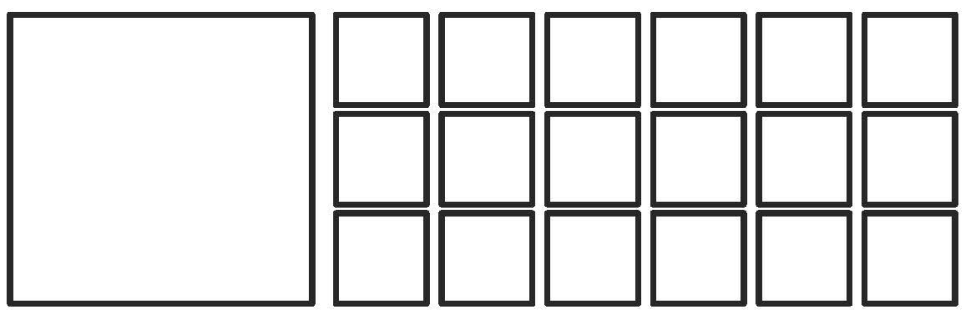

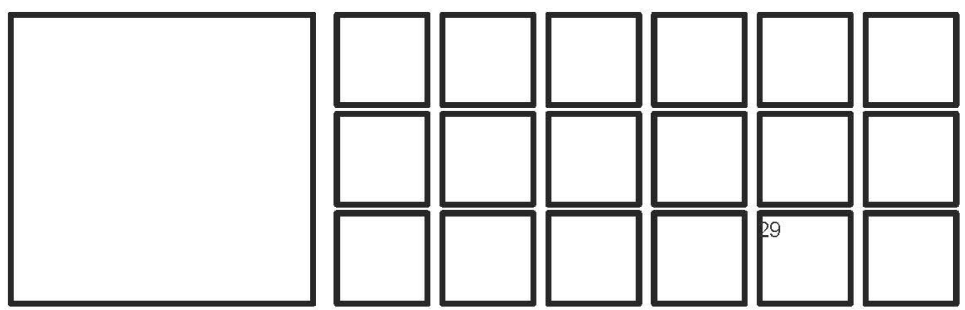

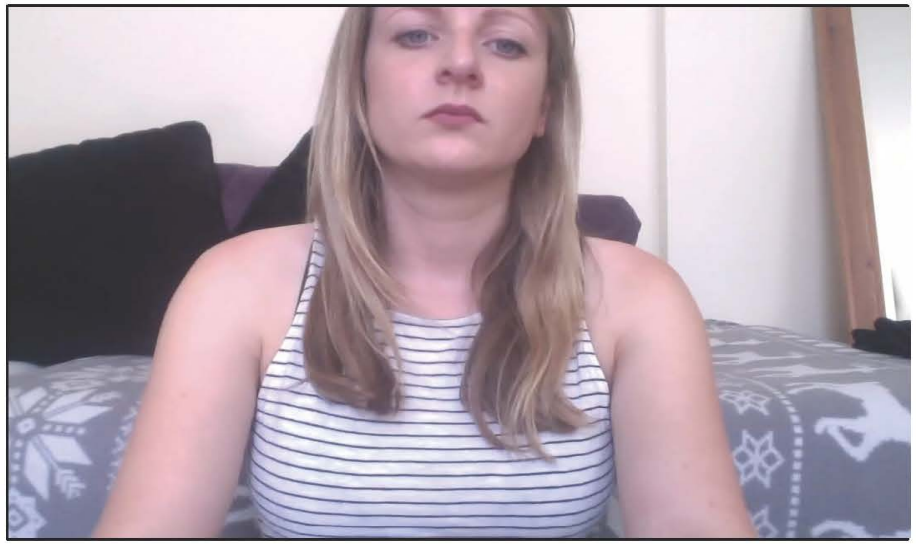

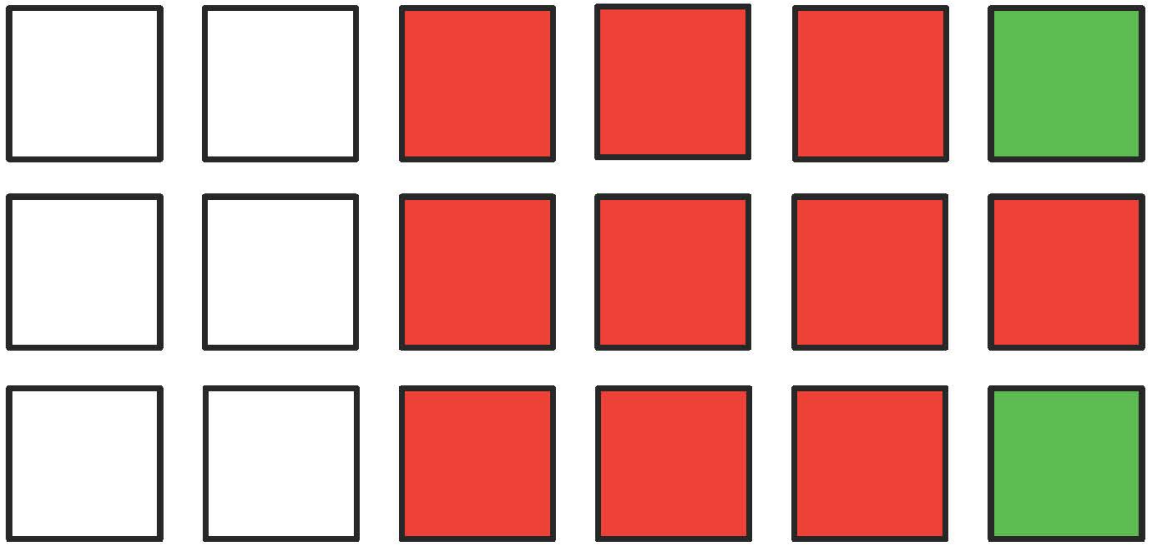

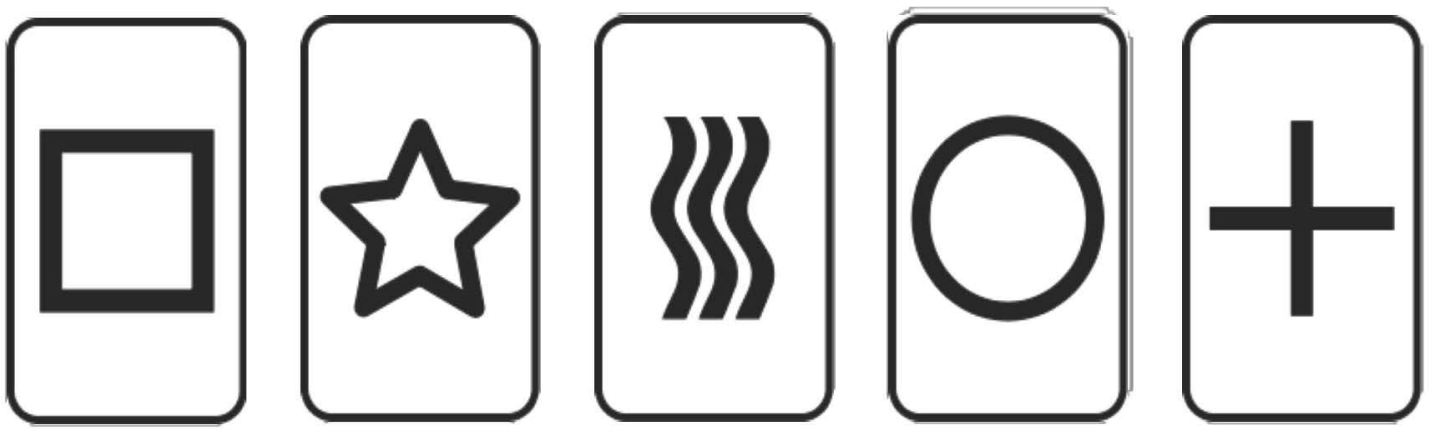

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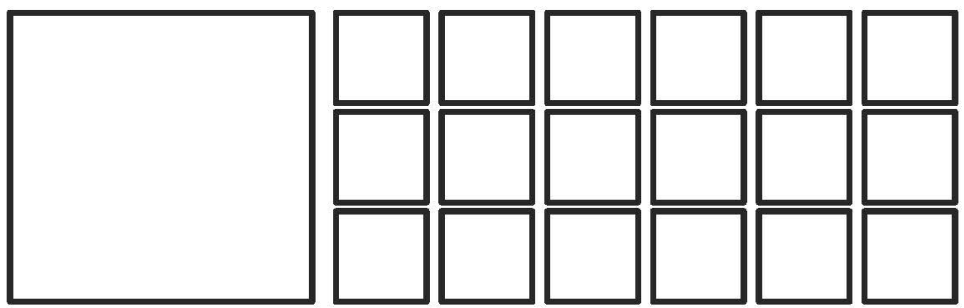

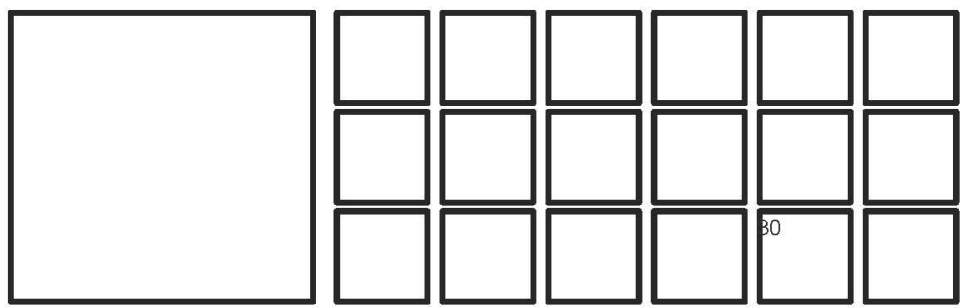

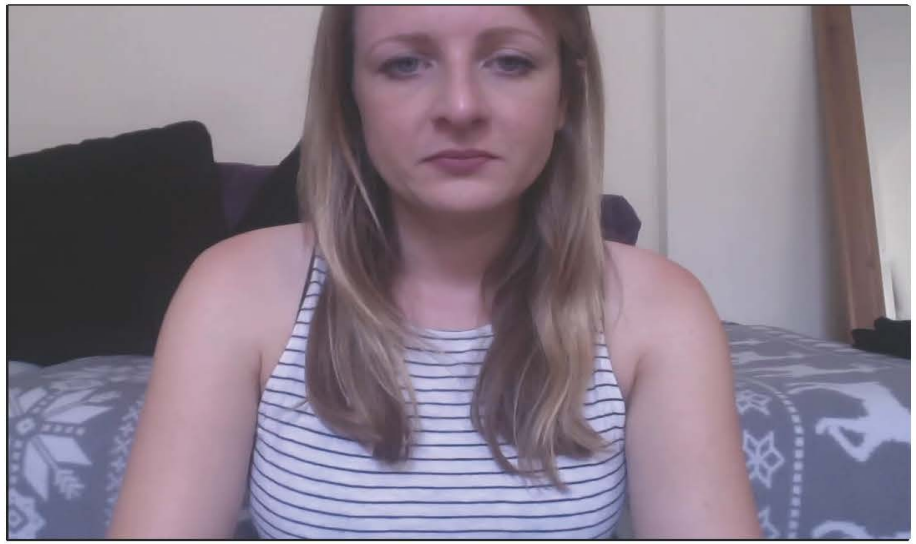

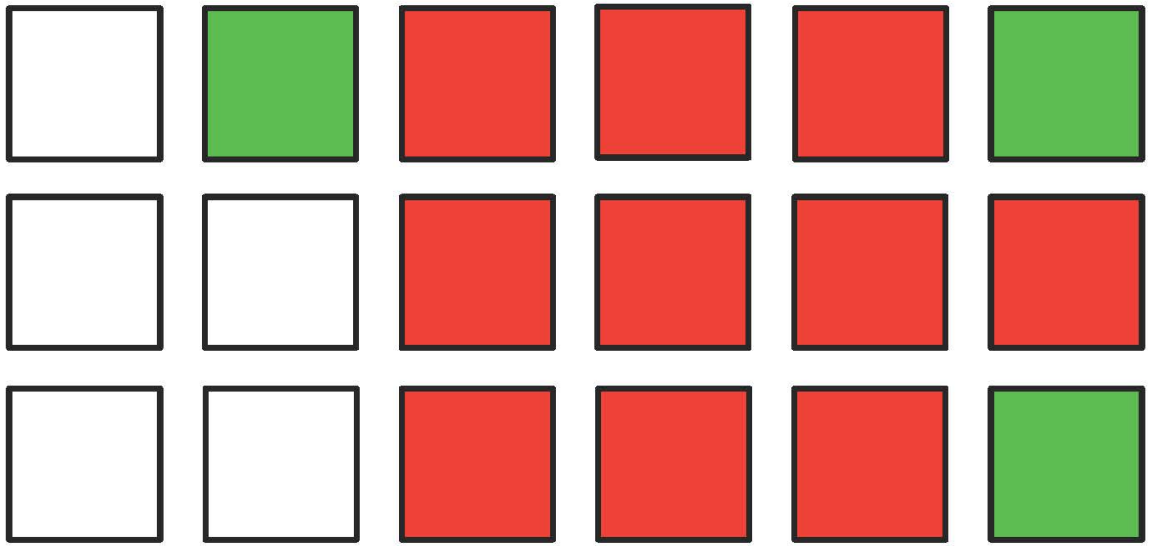

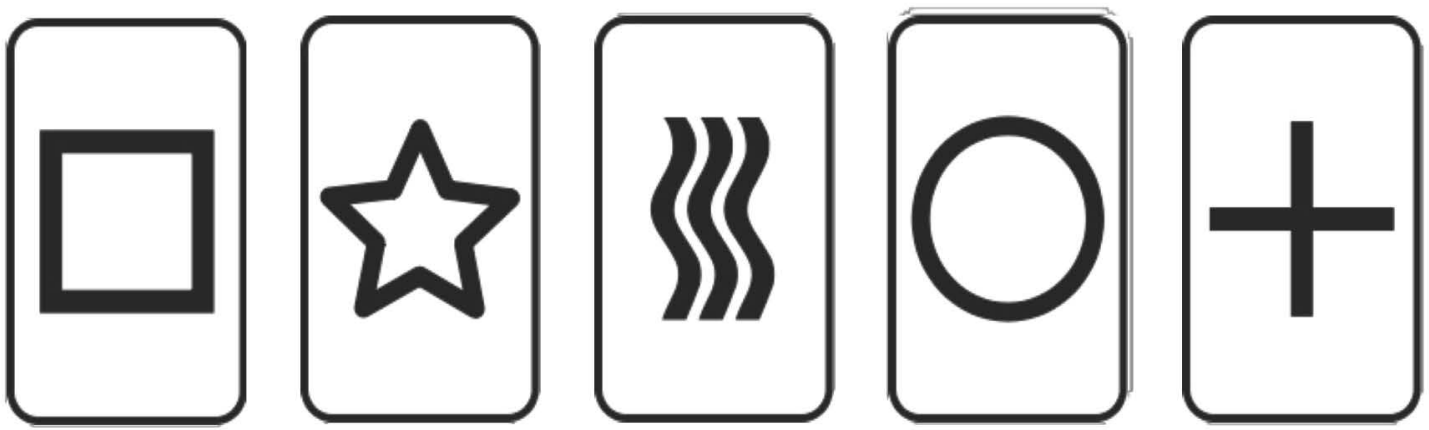

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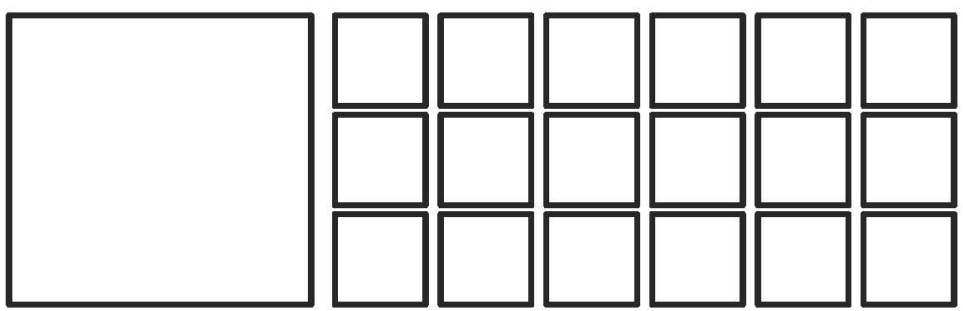

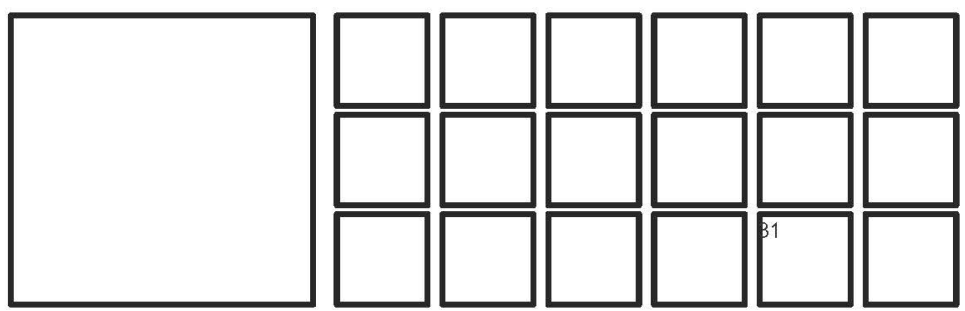

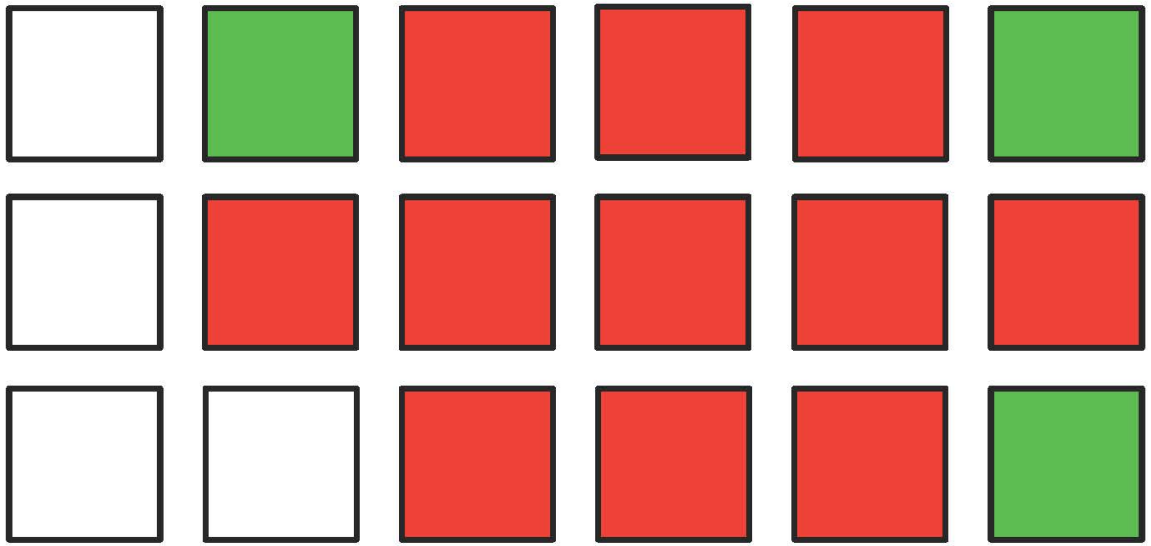

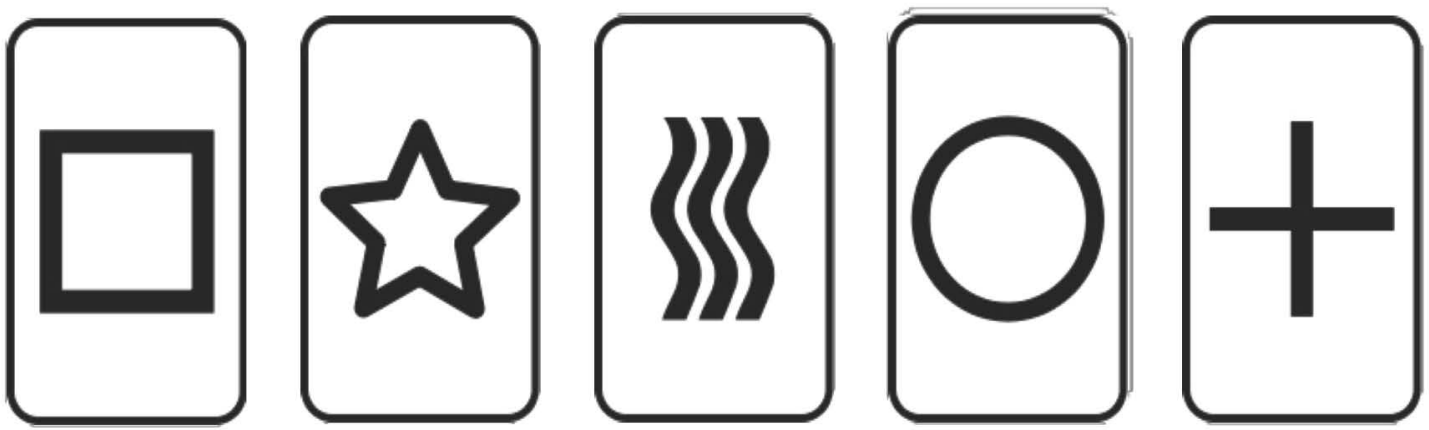

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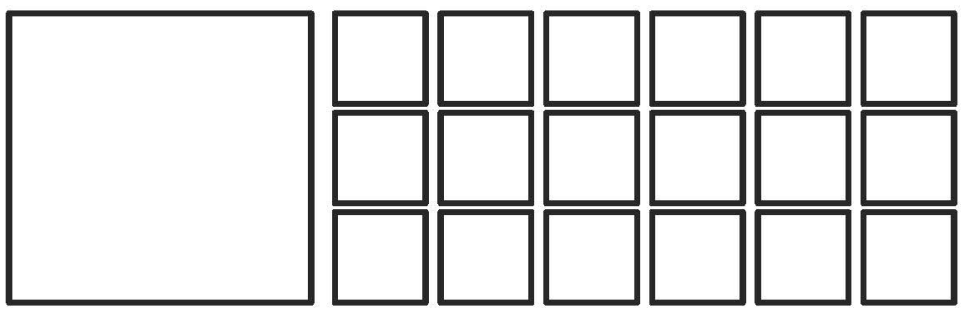

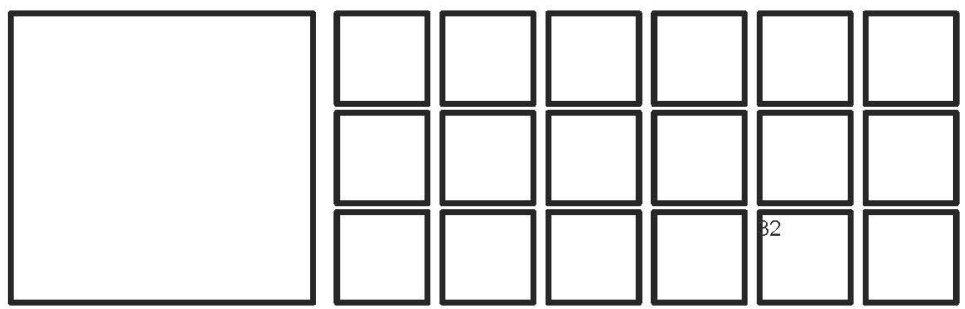

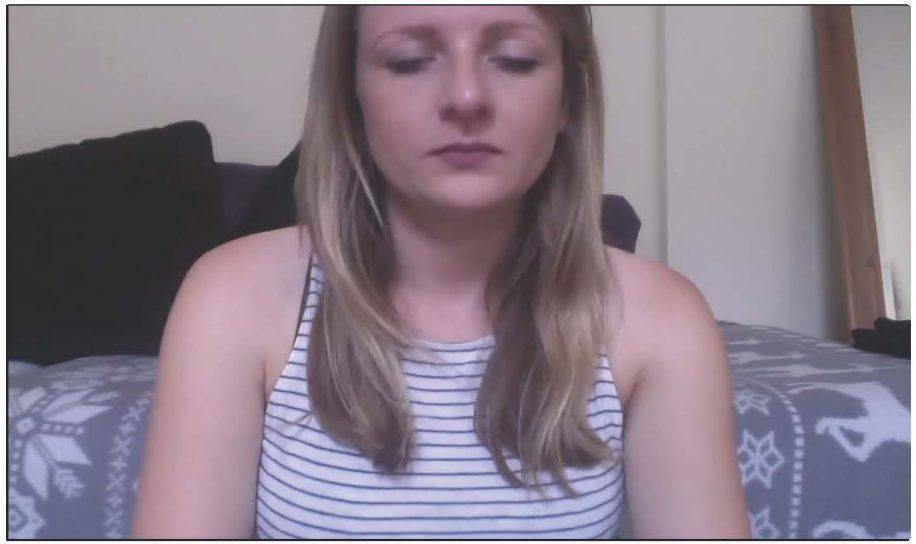

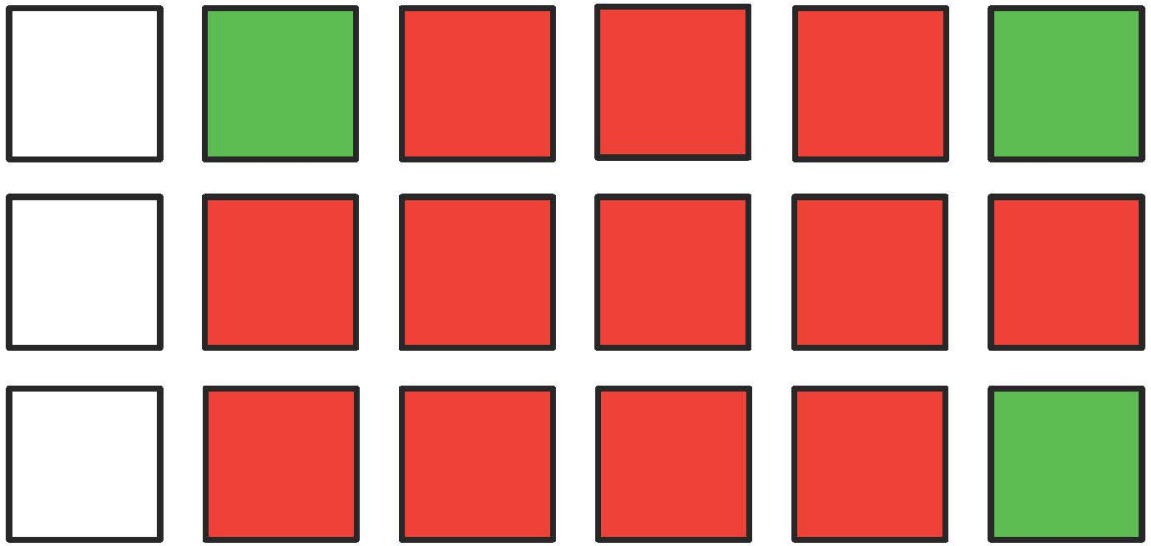

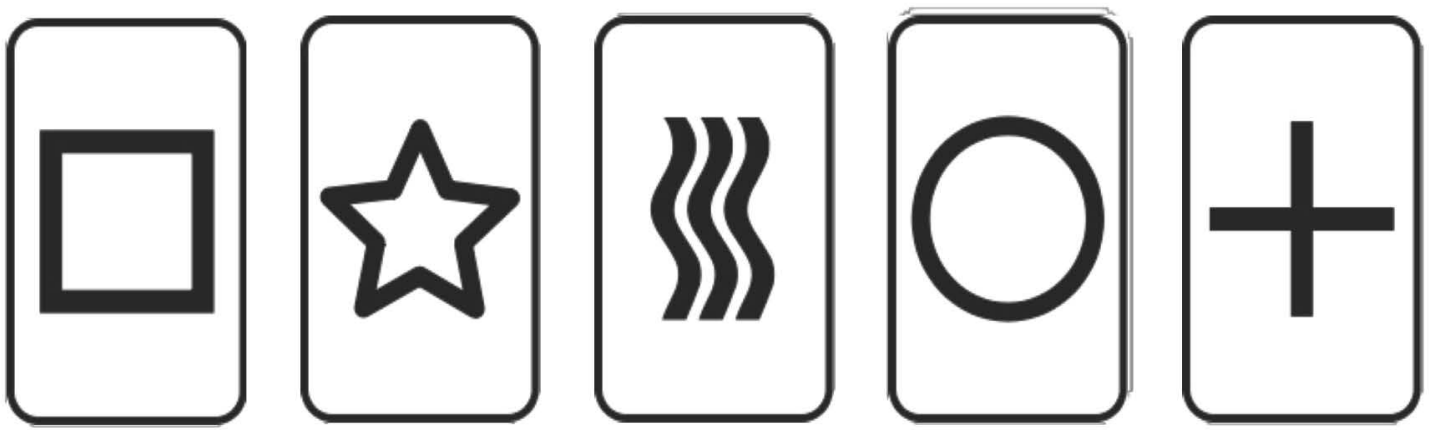

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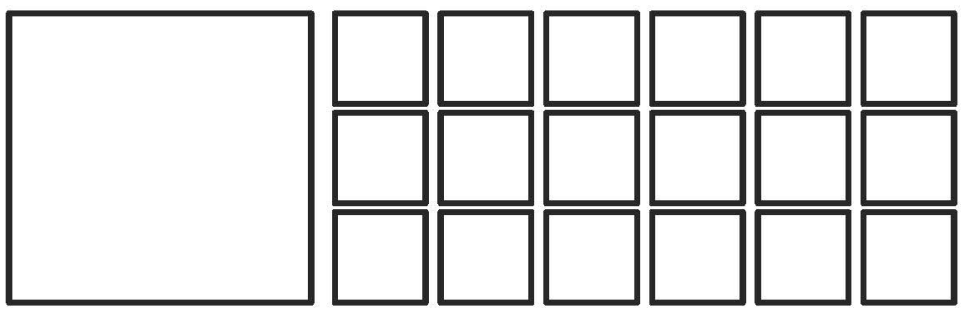

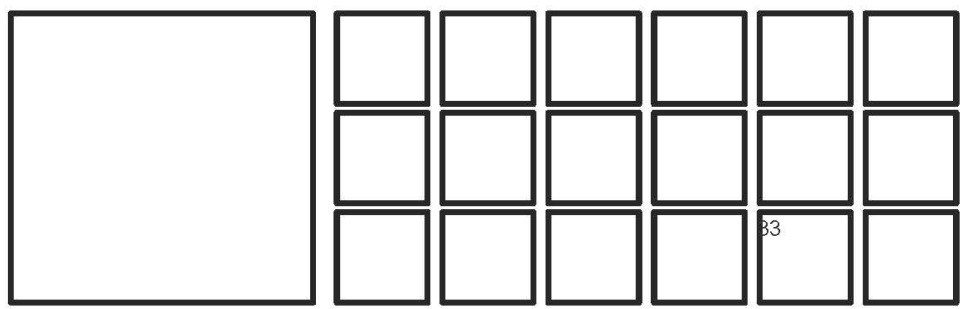

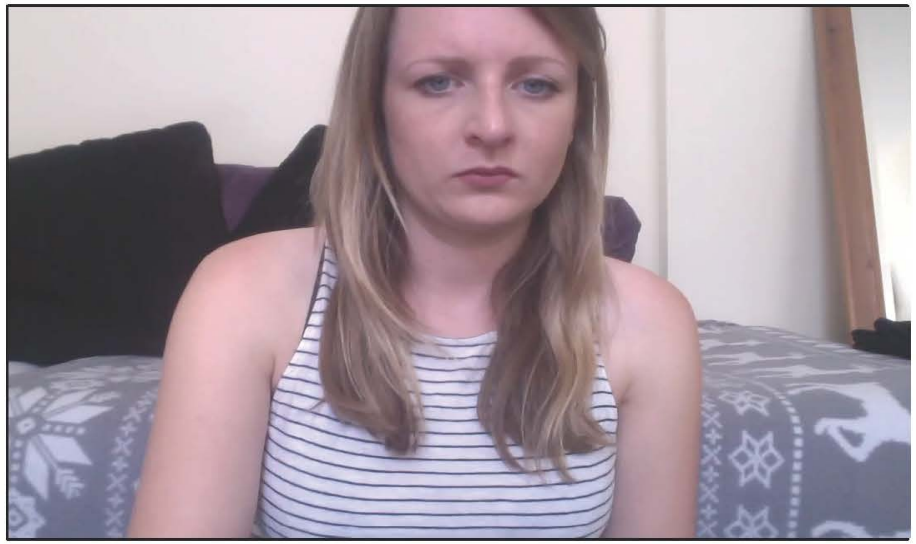

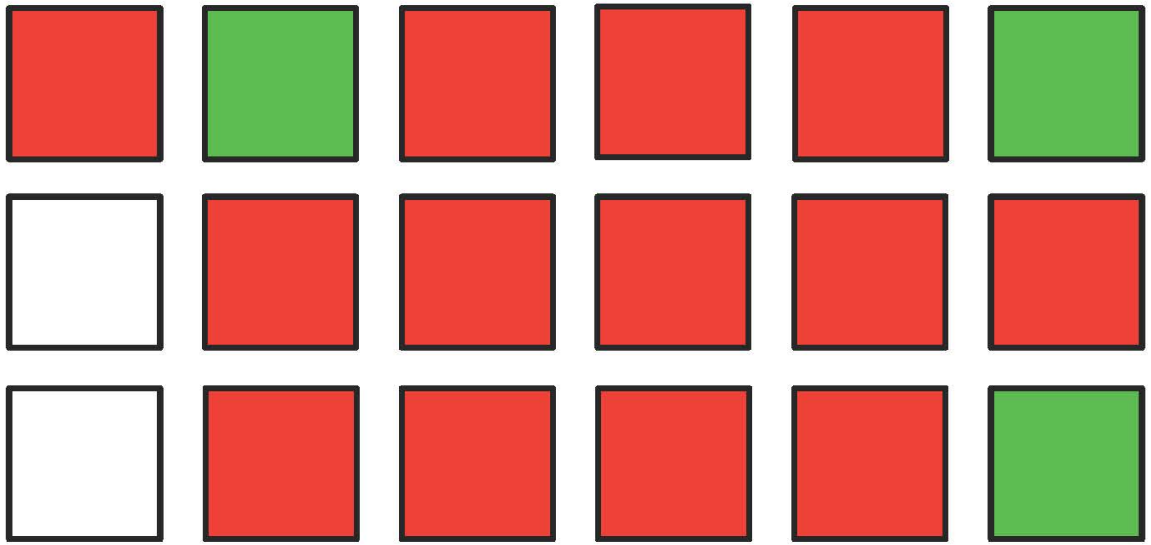

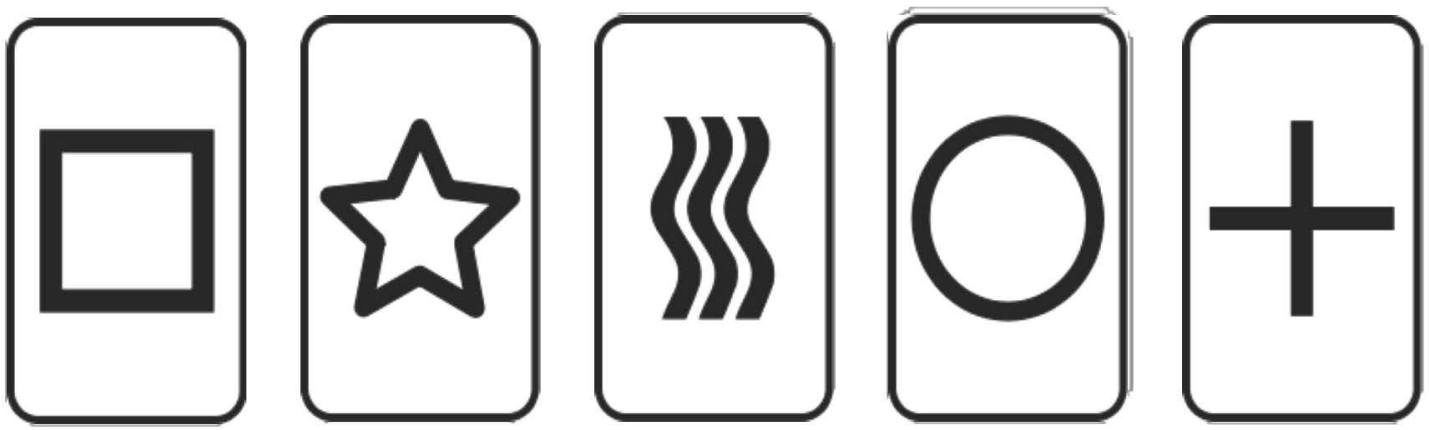

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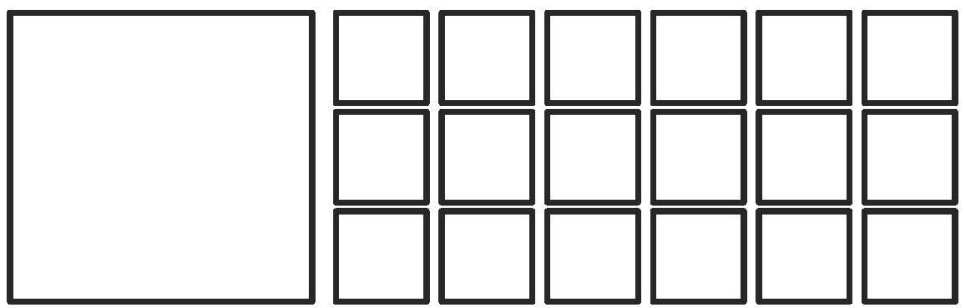

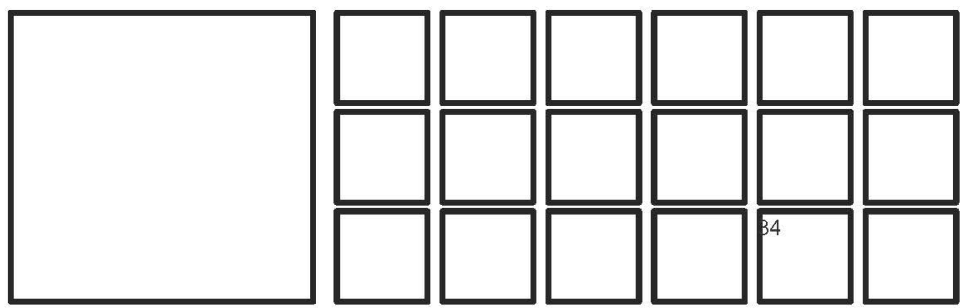

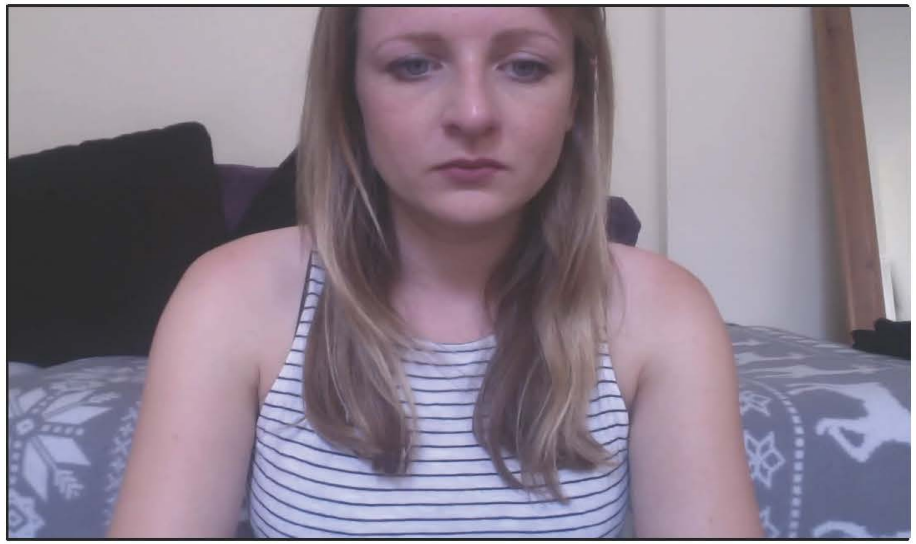

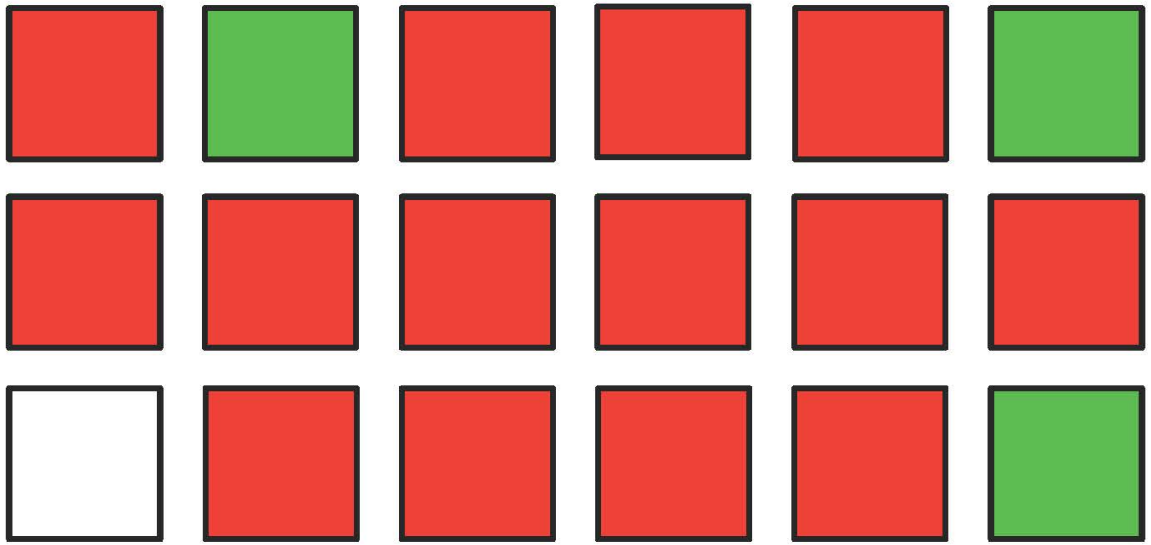

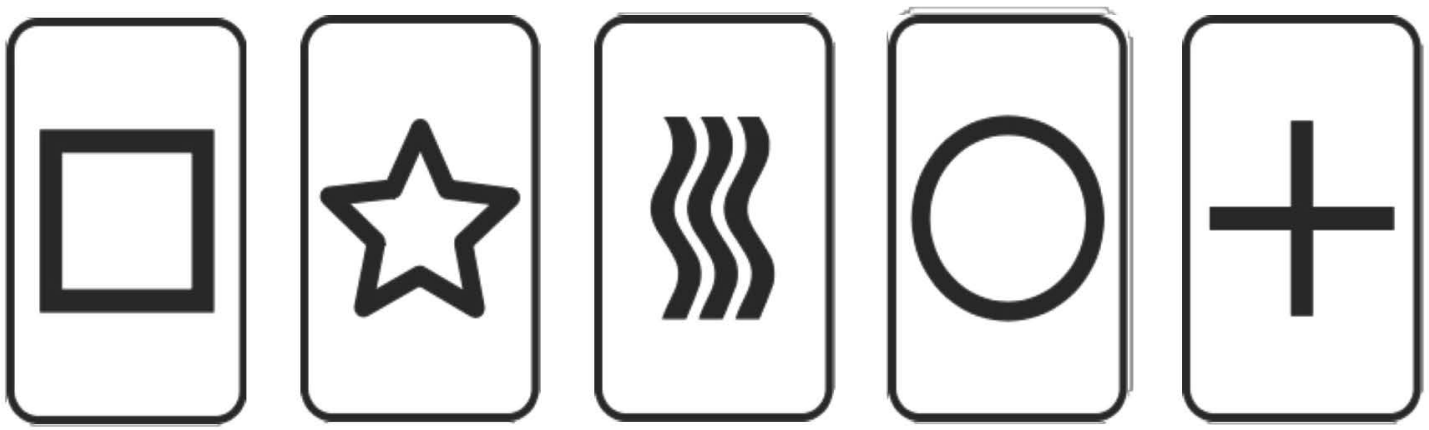

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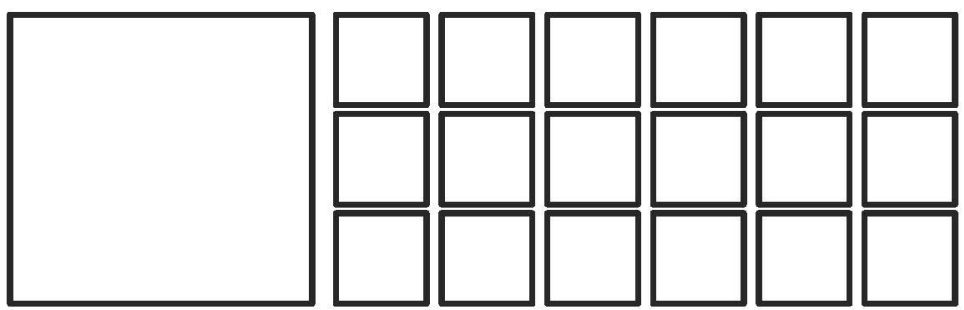

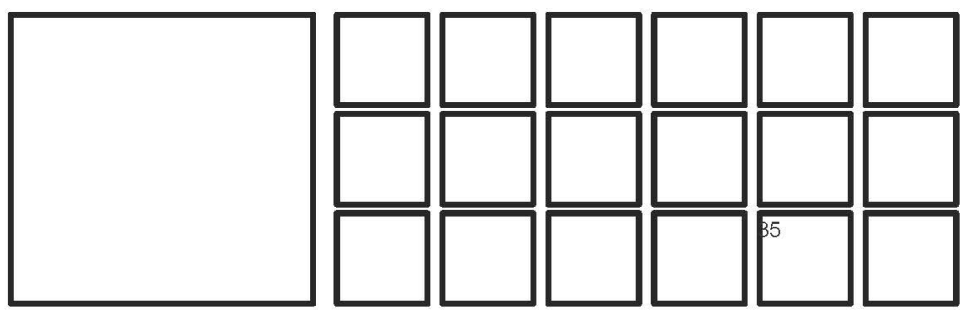

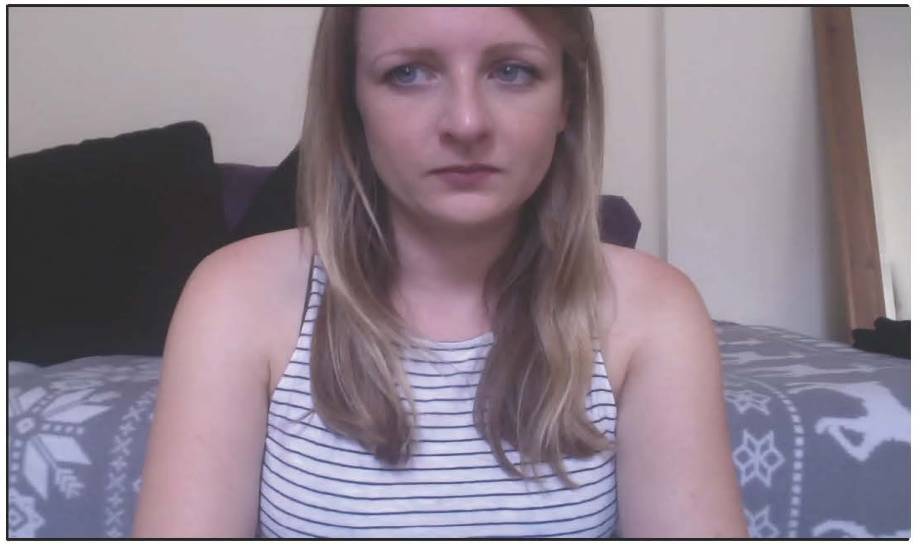

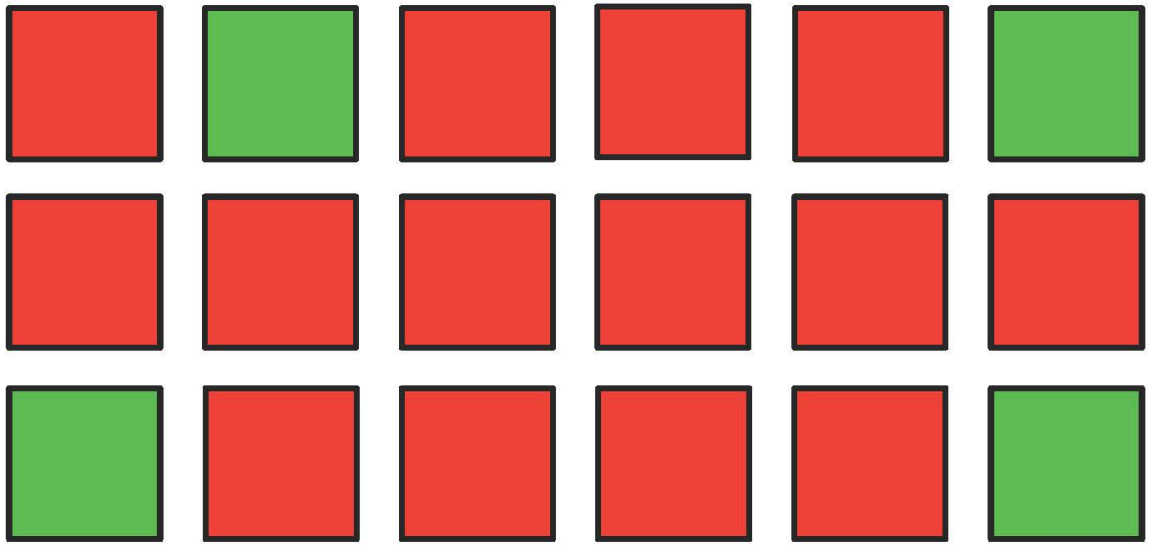

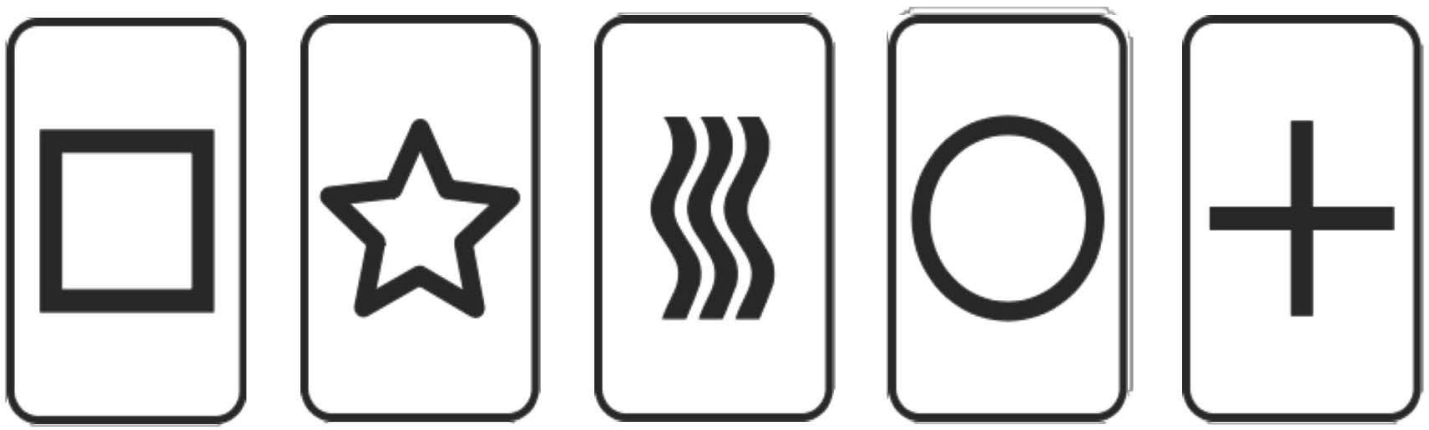

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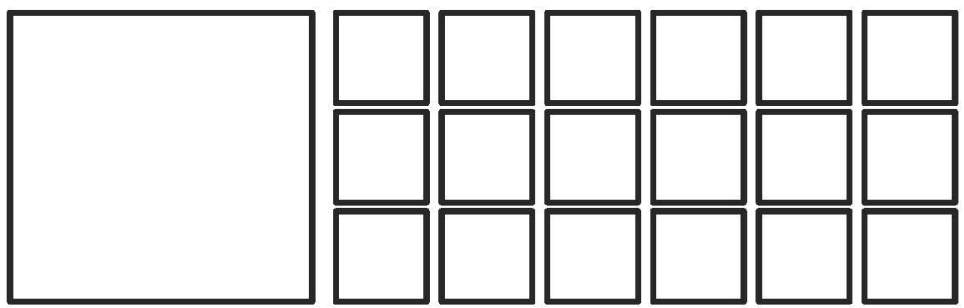
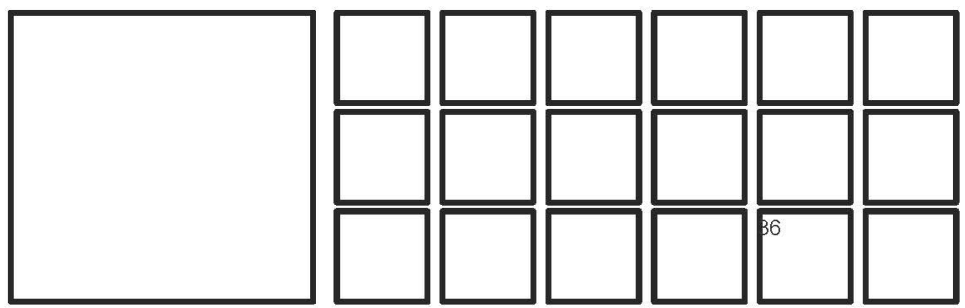
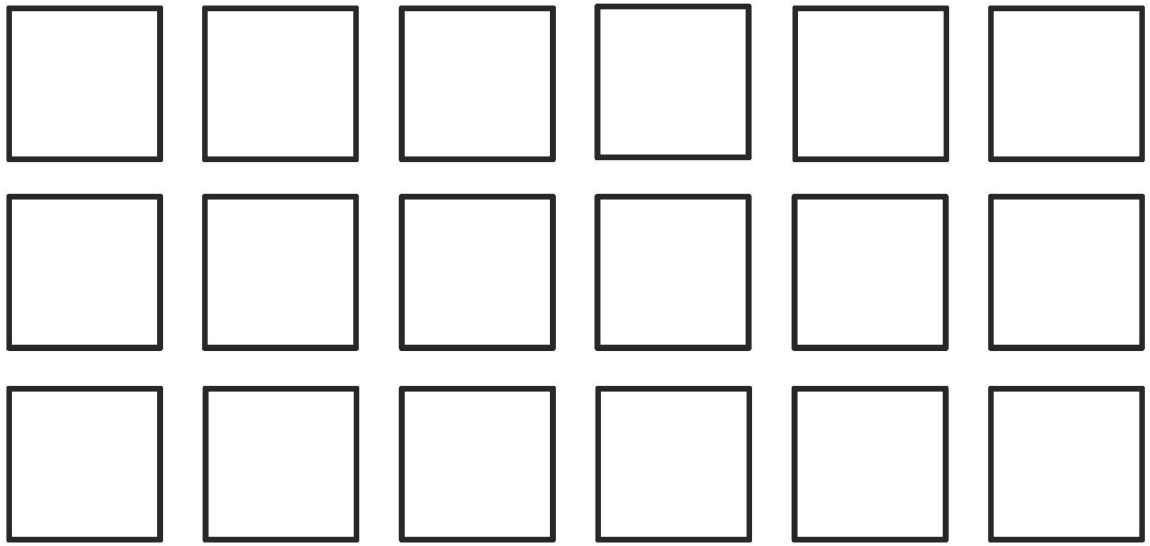
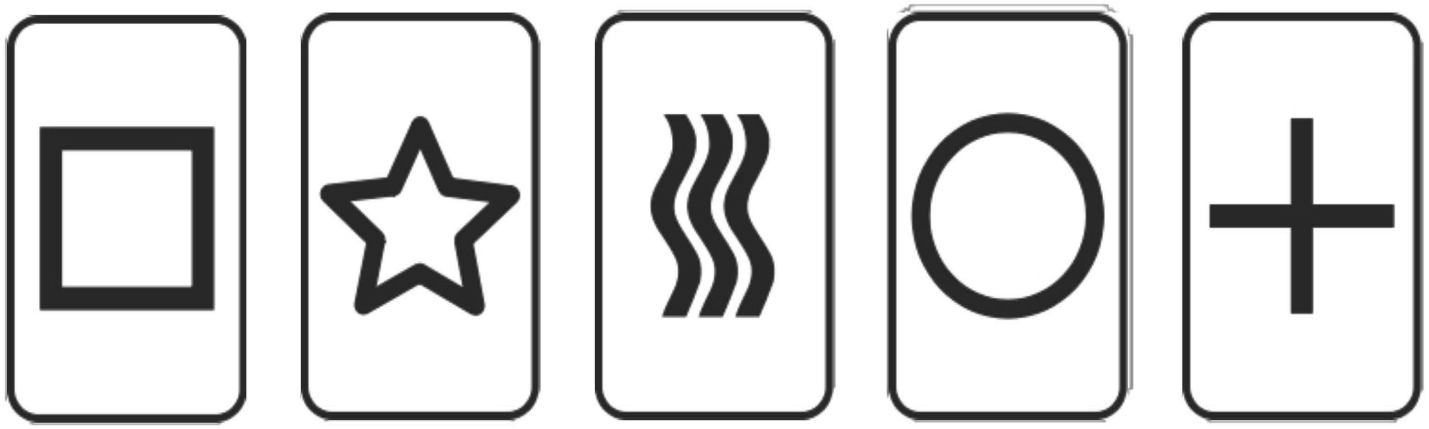




Thank you.
The next player is being selected.
After a short countdown the test will begin again.





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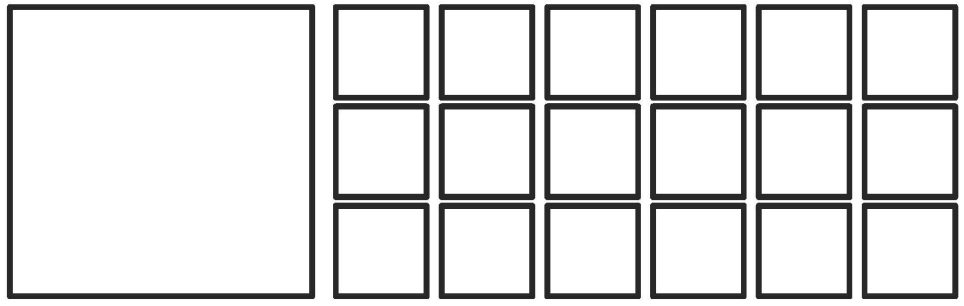

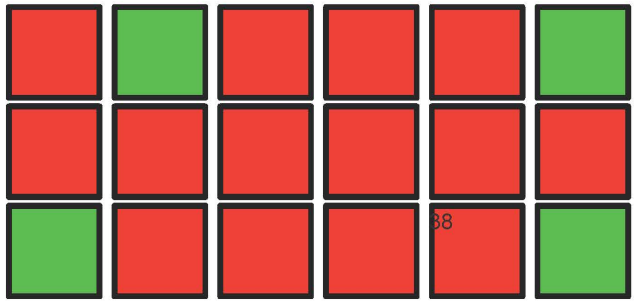

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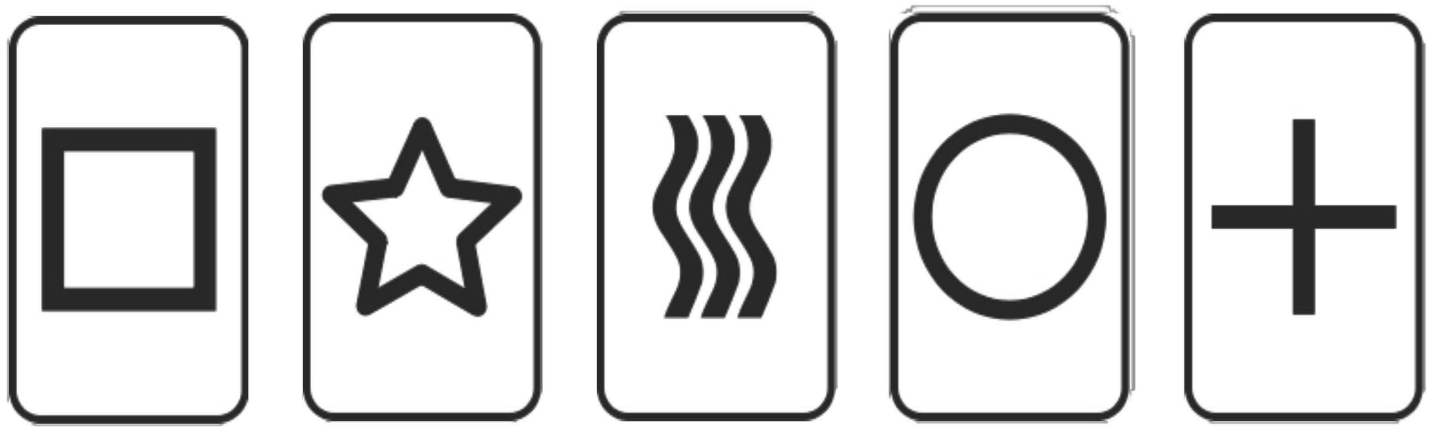

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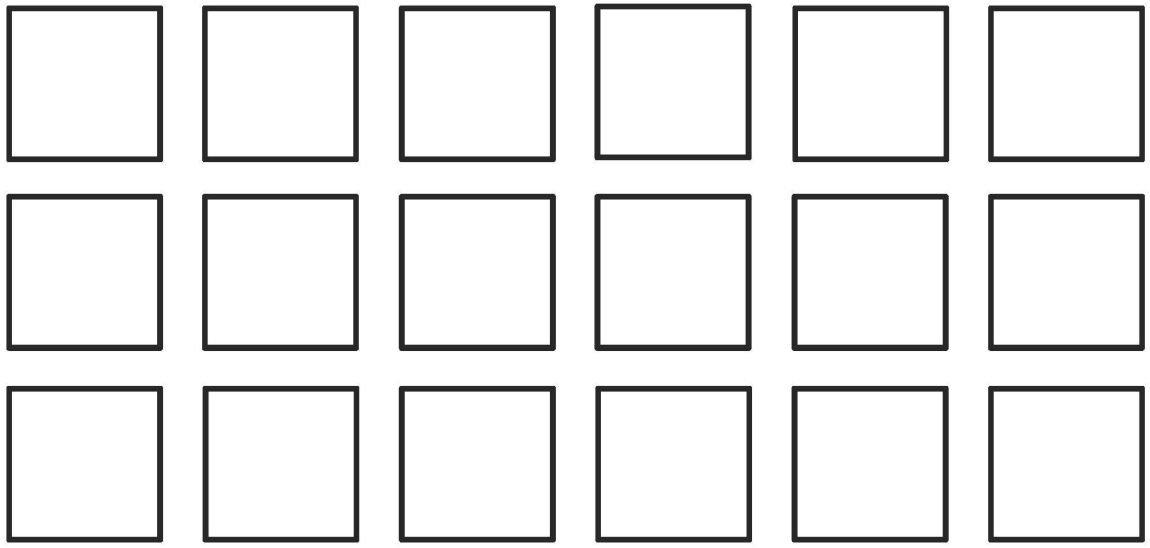

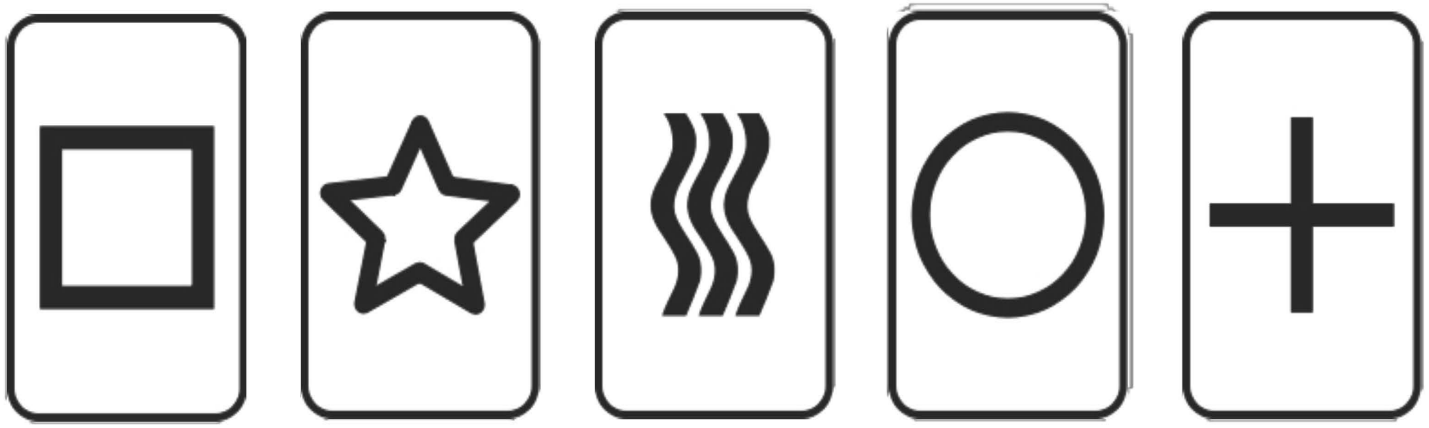

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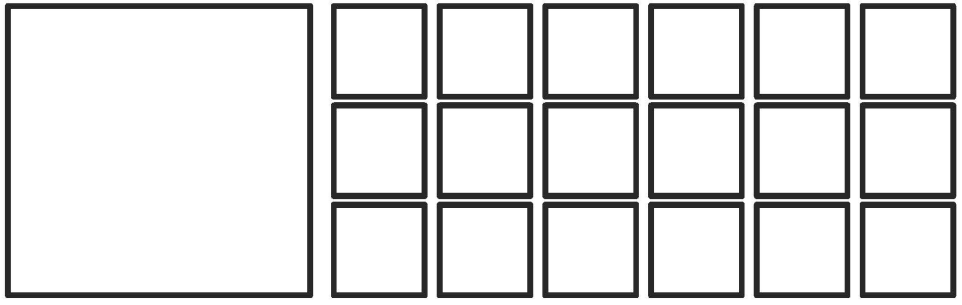

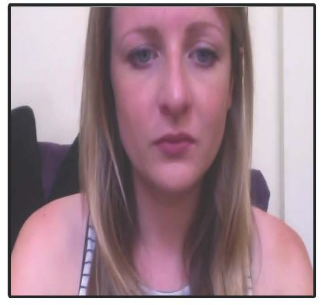

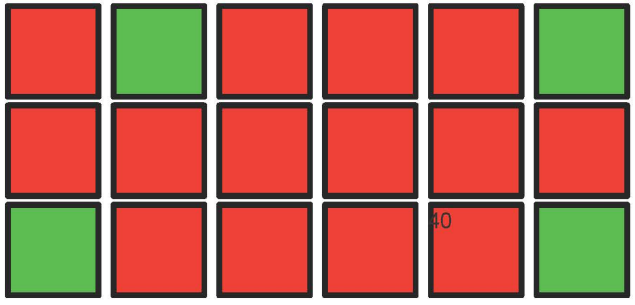

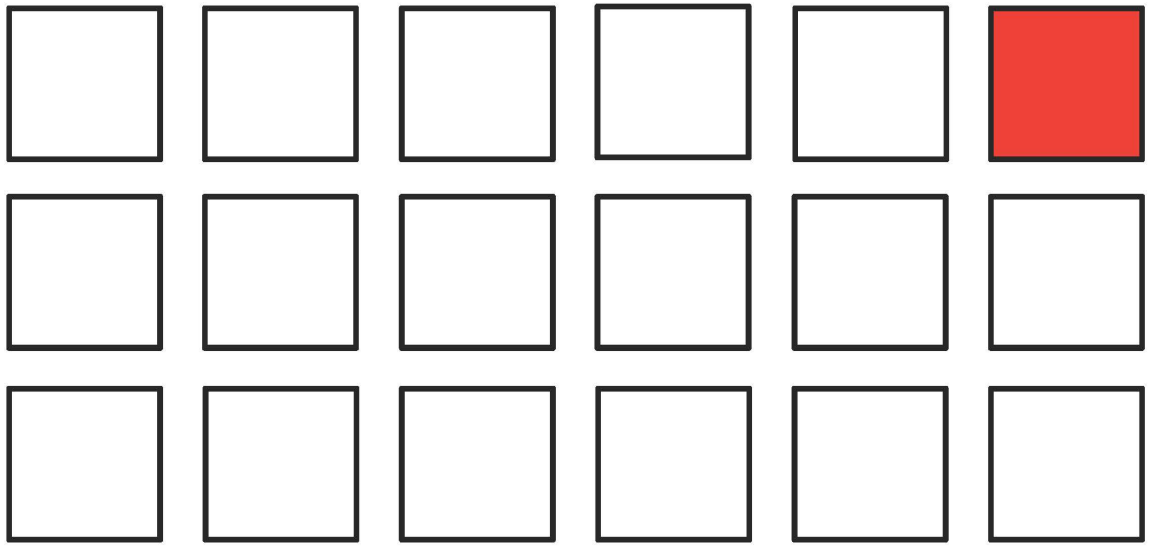

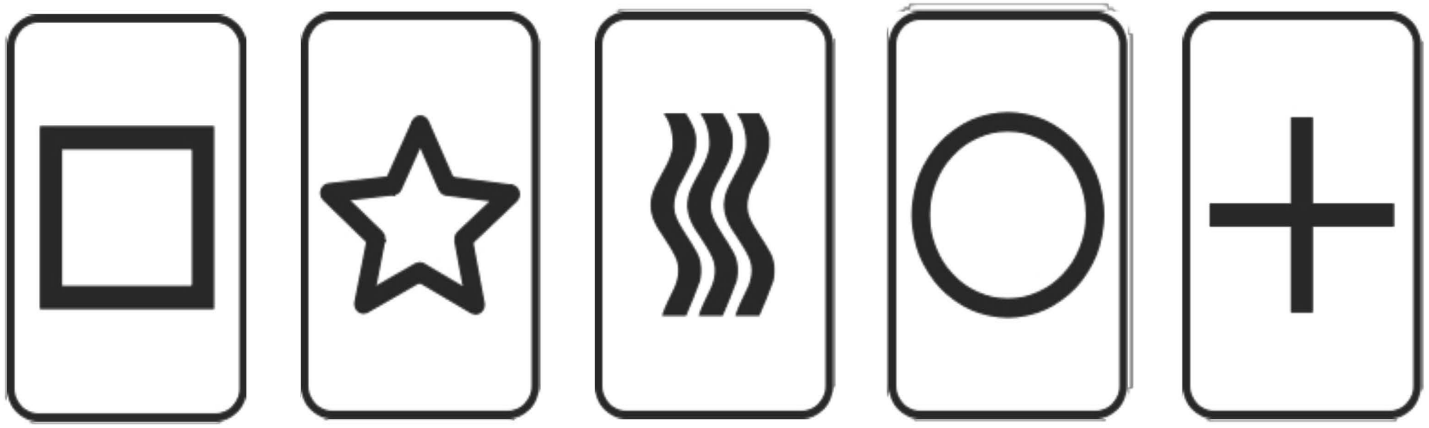

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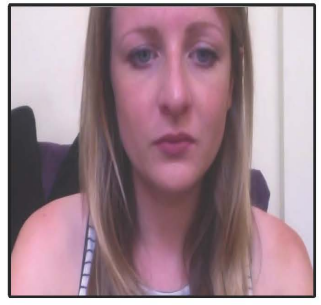

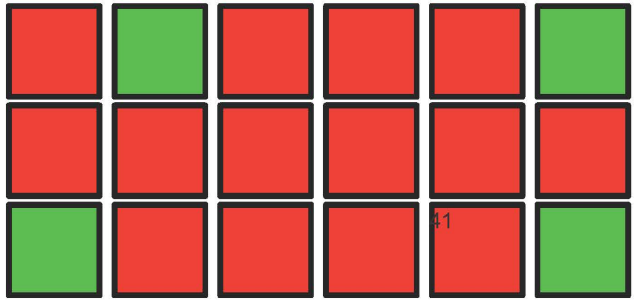

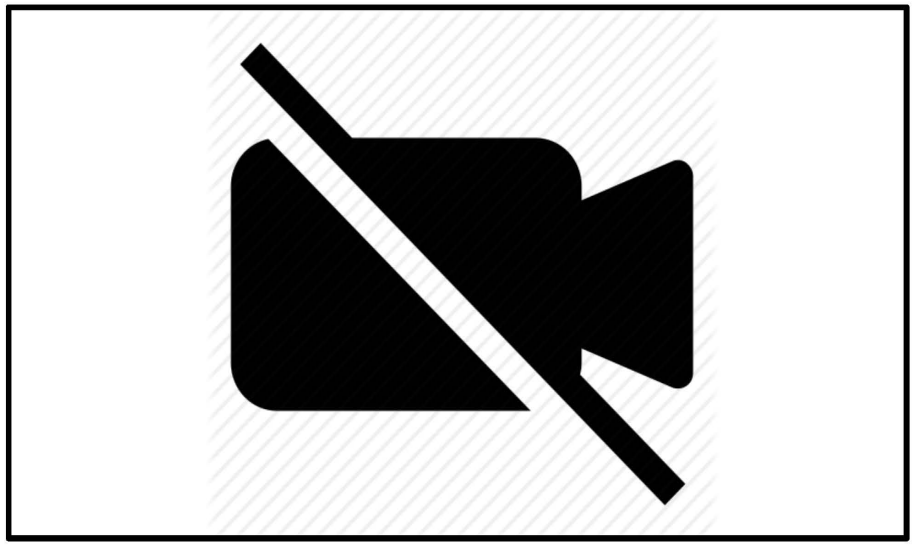

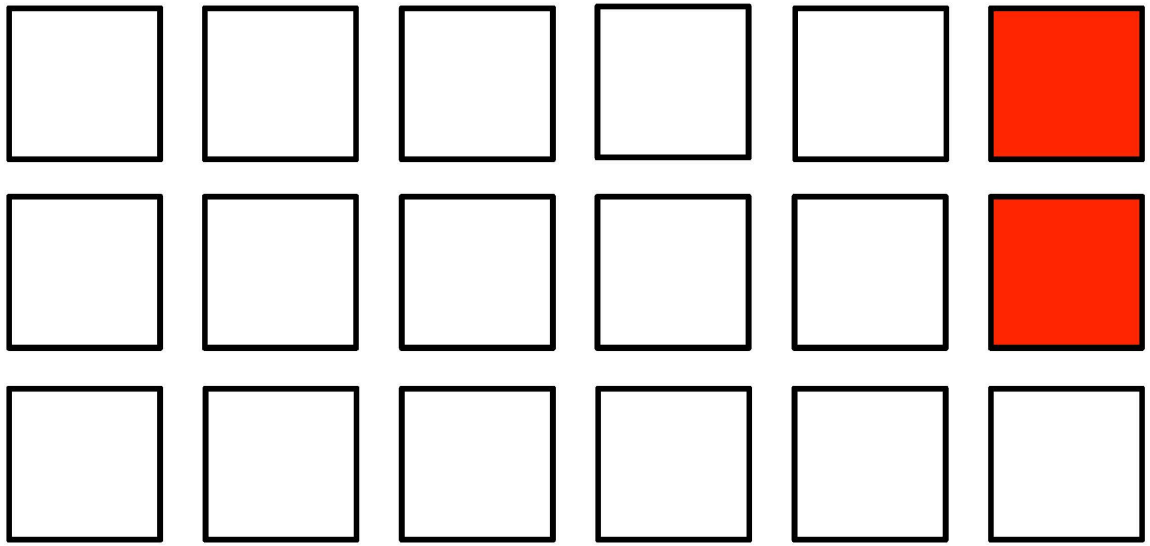

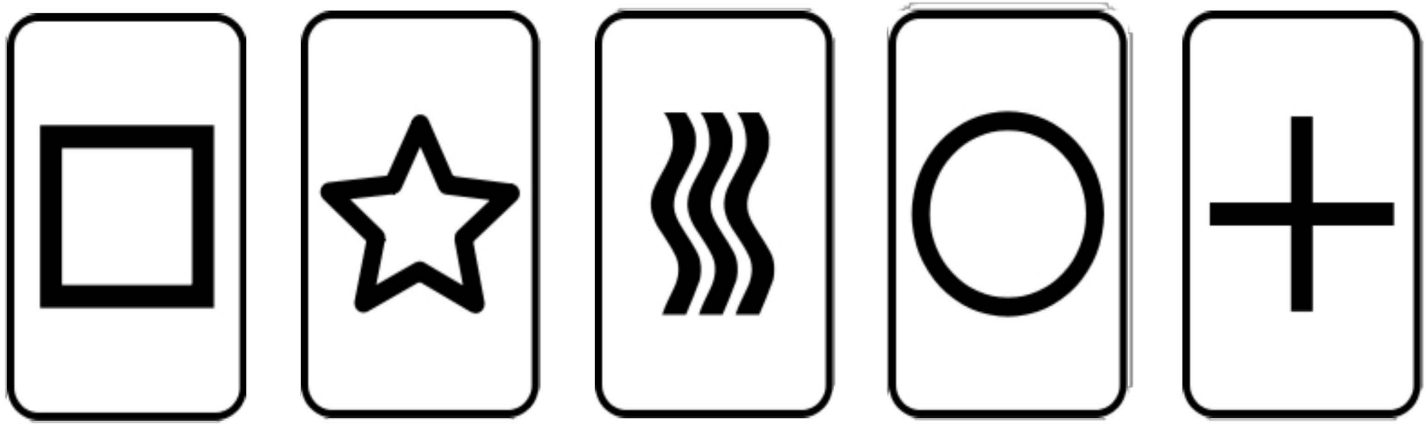

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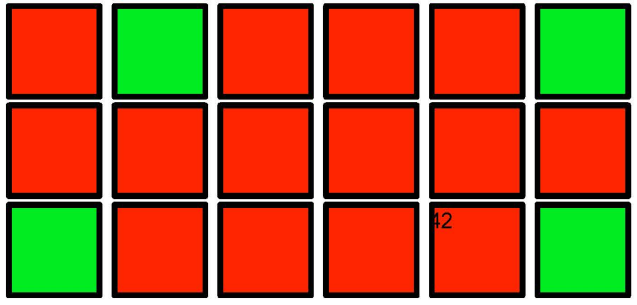

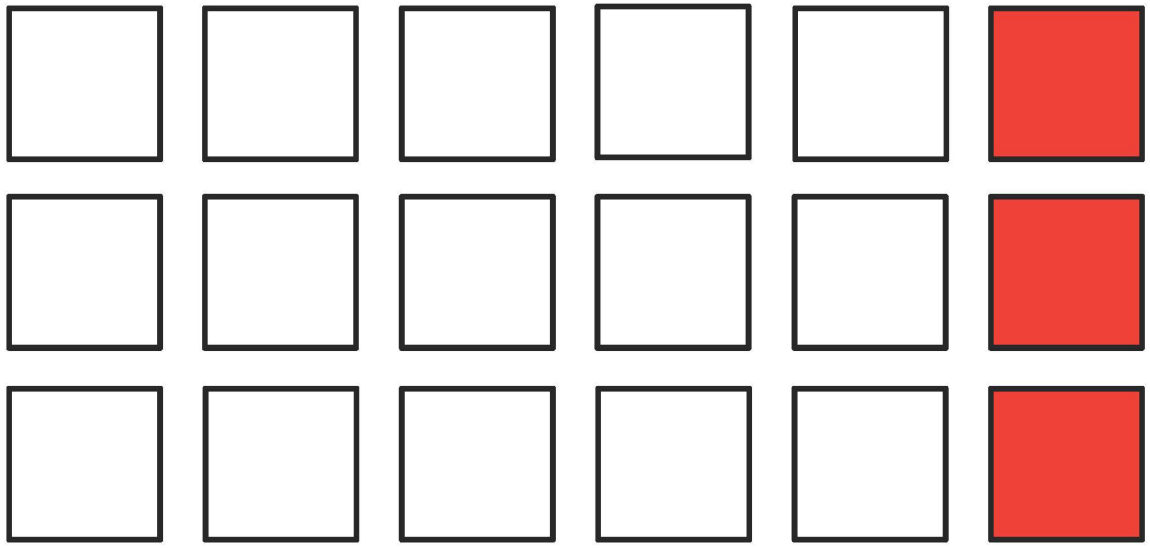

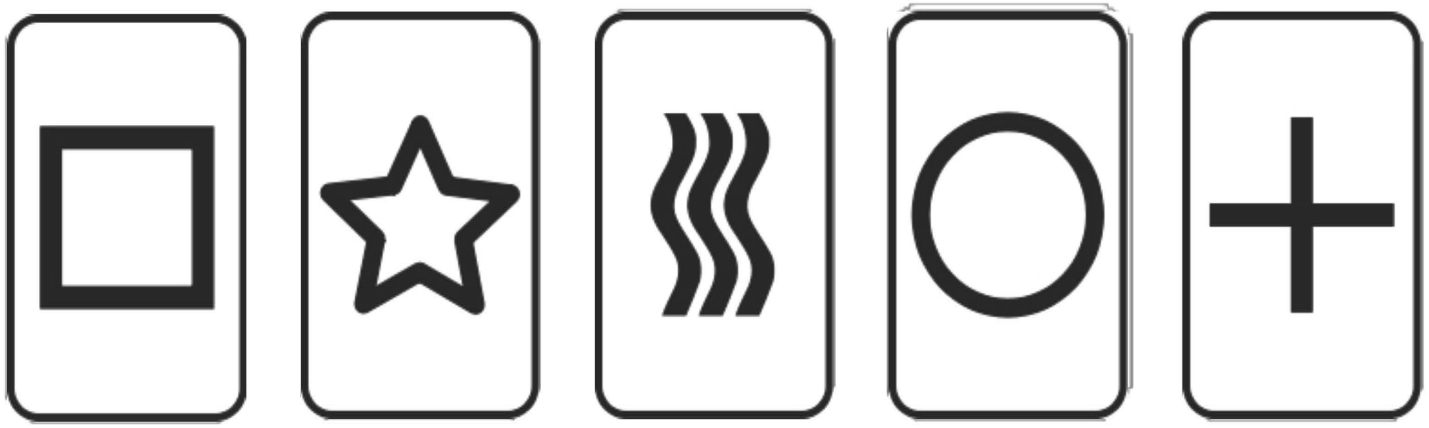

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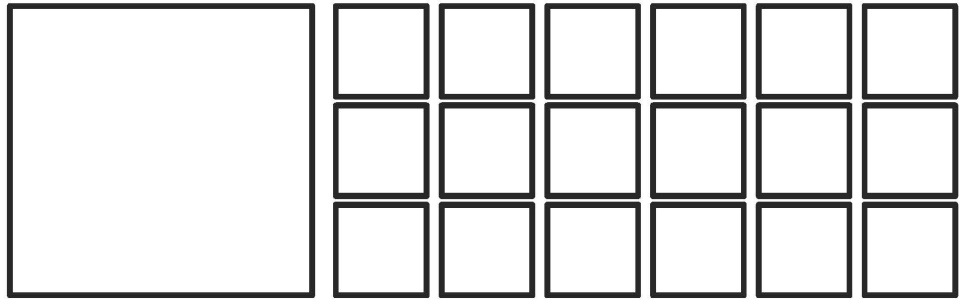

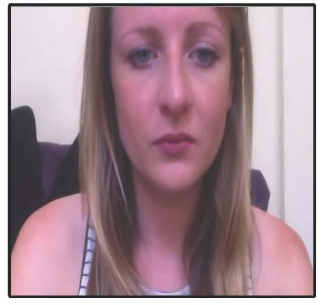

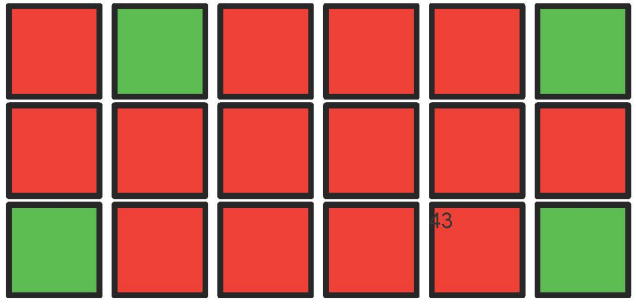

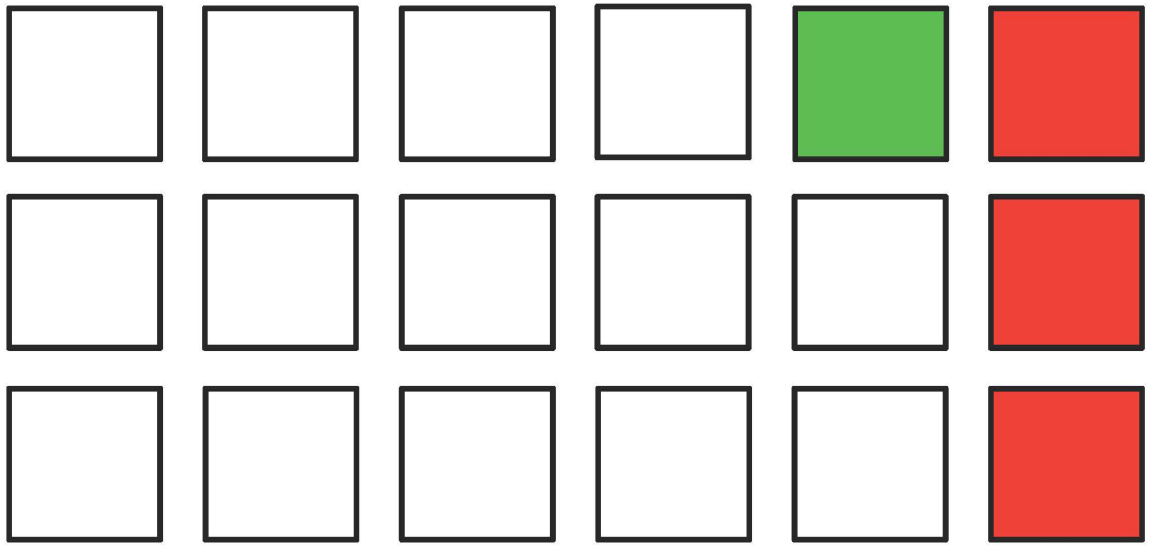

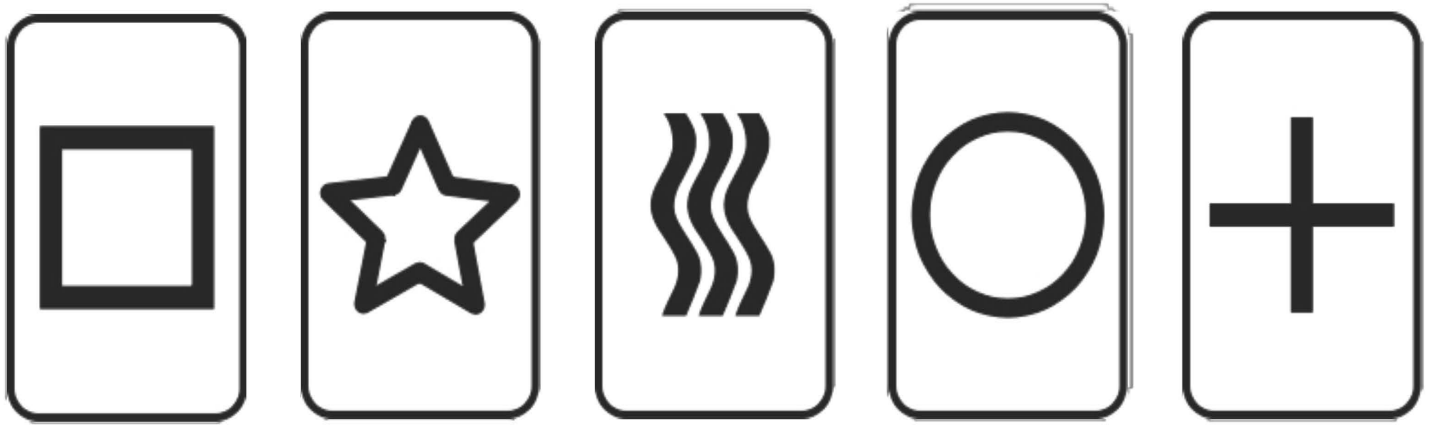

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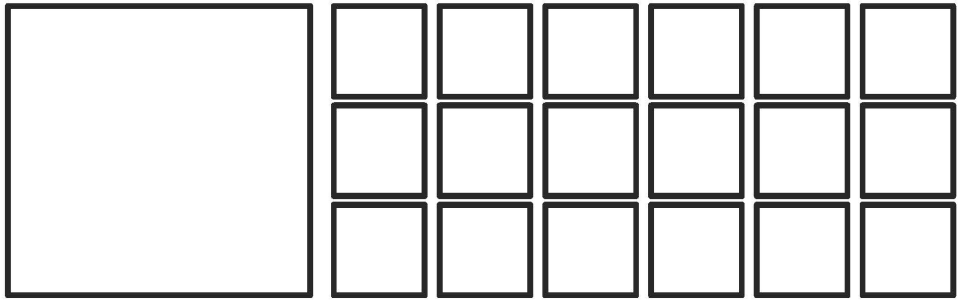

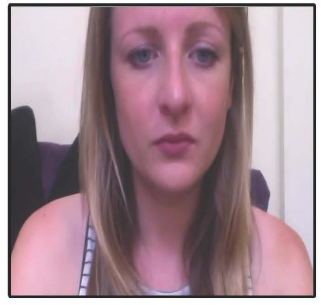

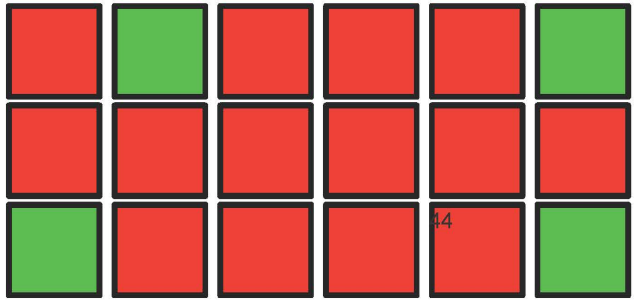

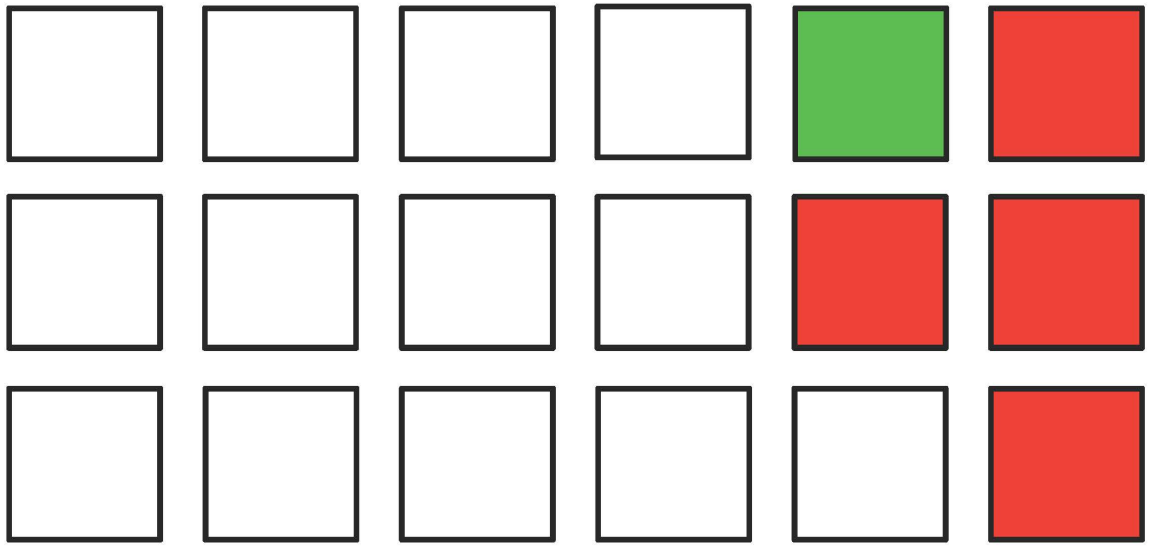

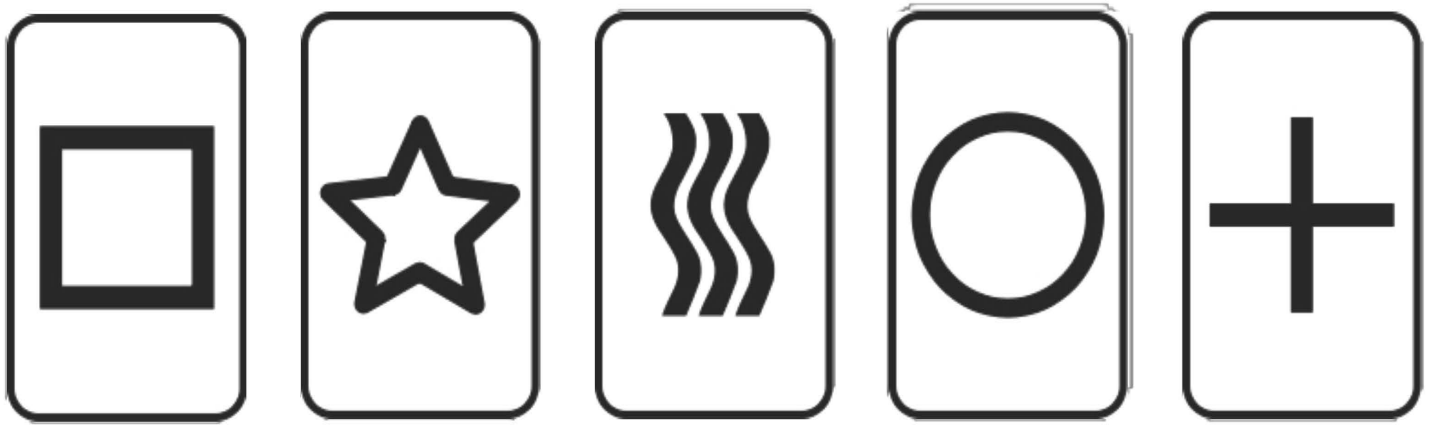

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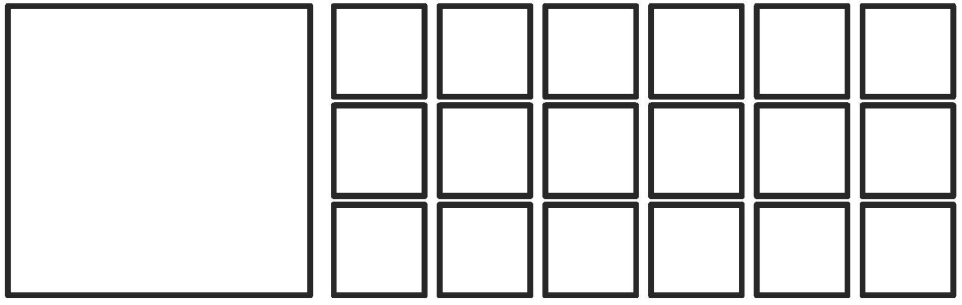

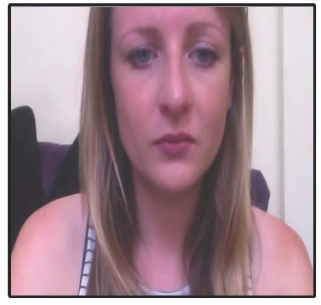

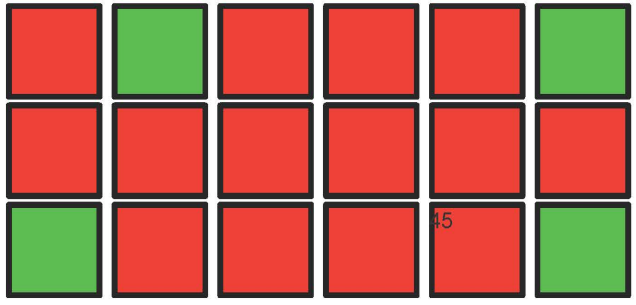

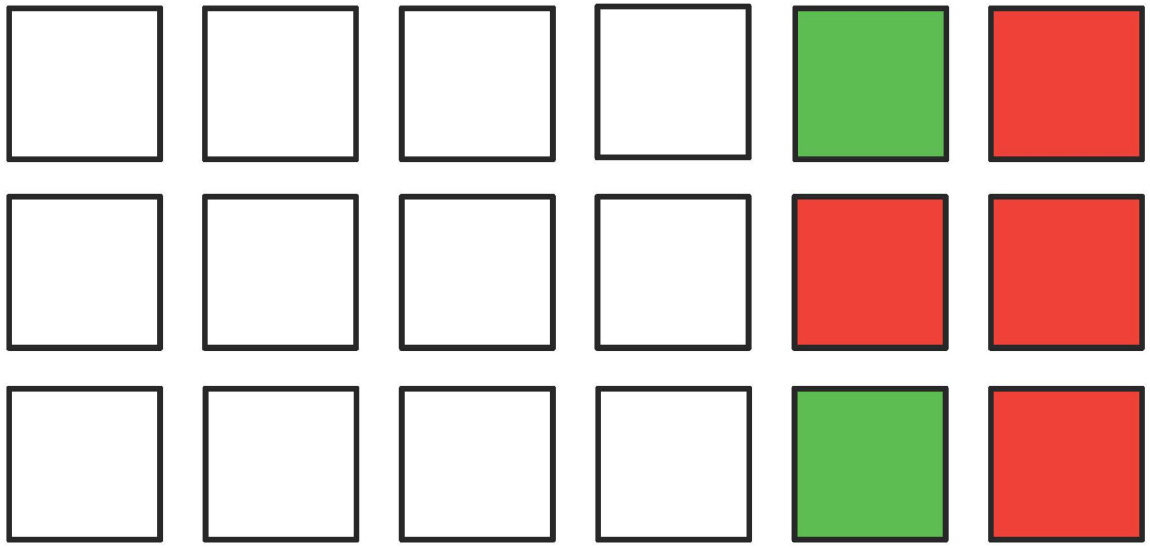

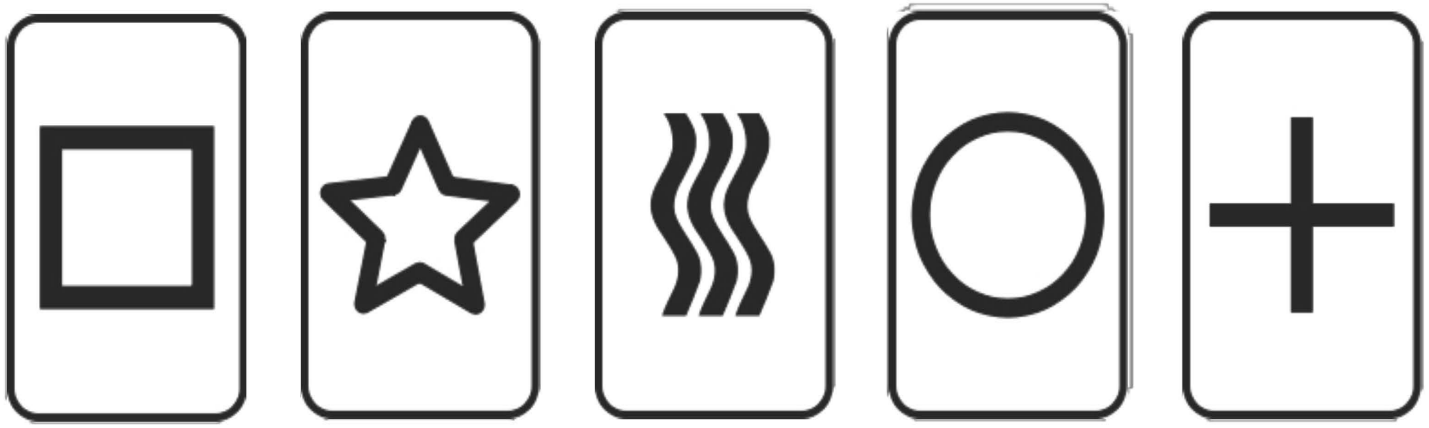

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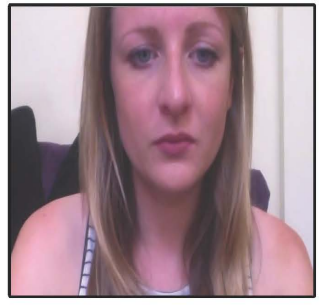

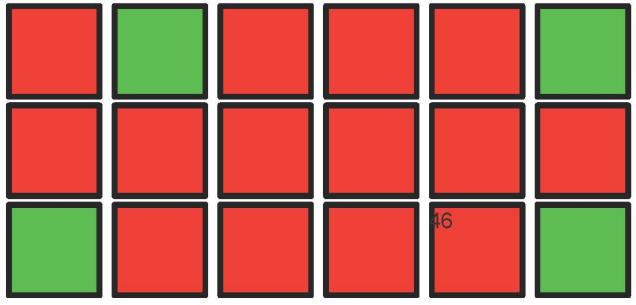

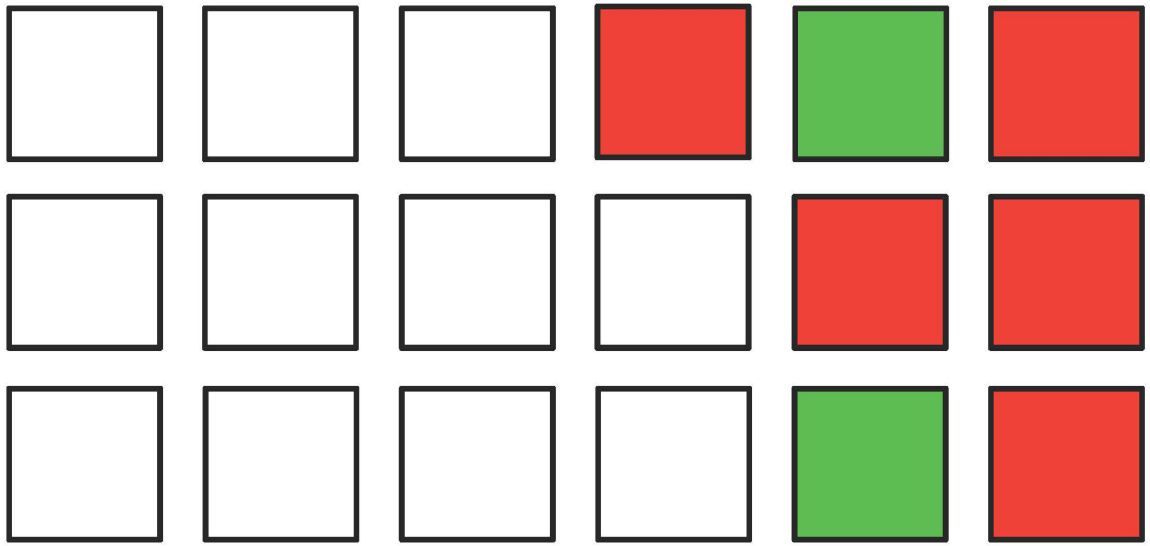

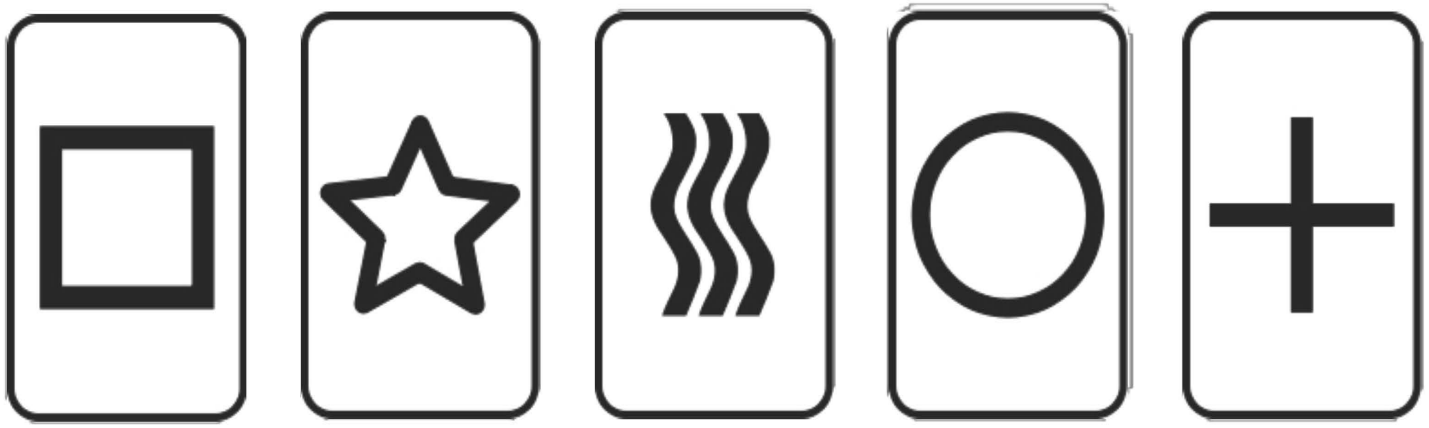

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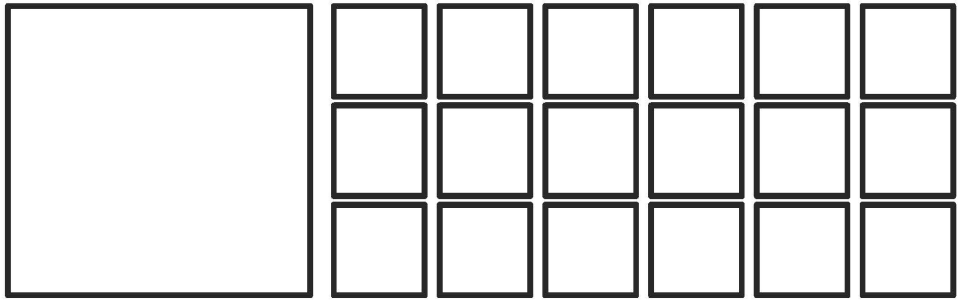

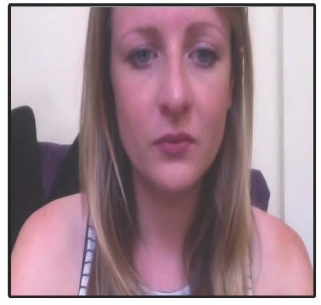

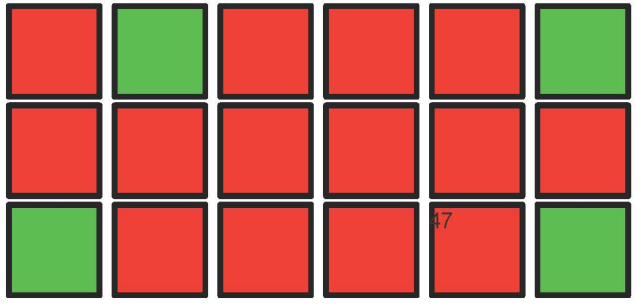

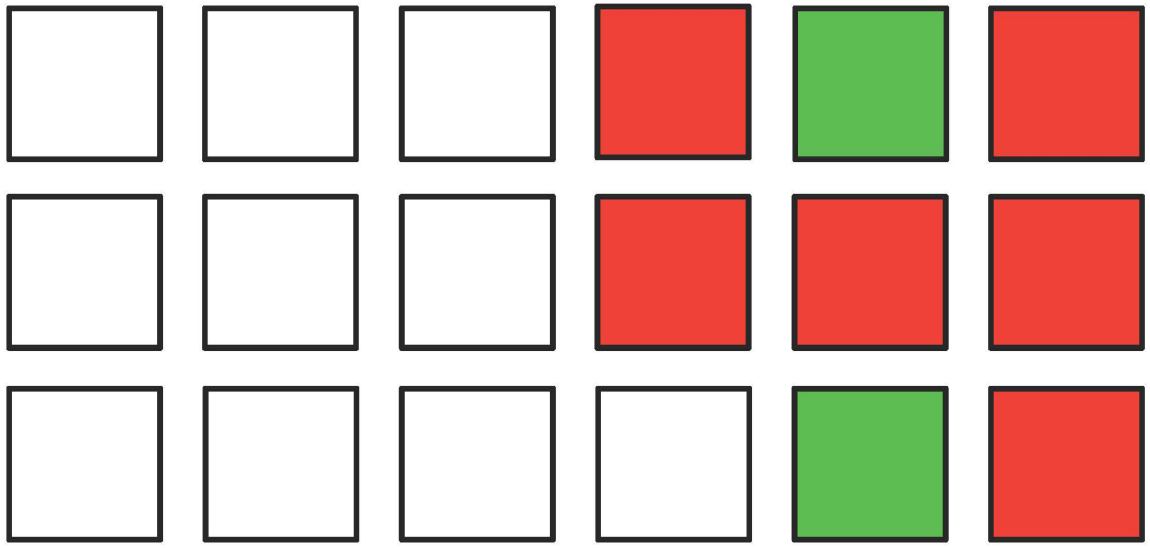

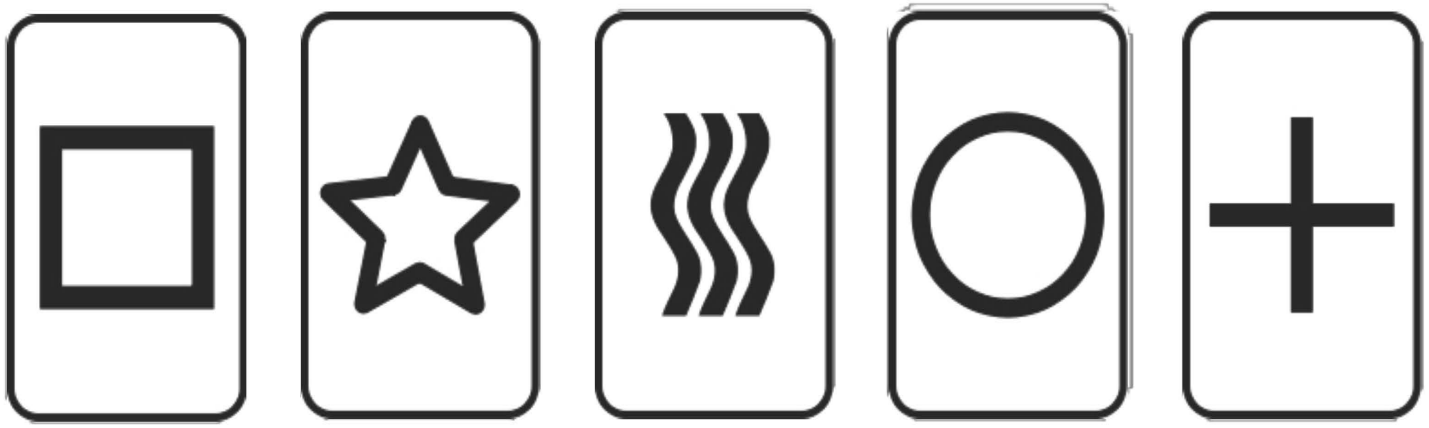

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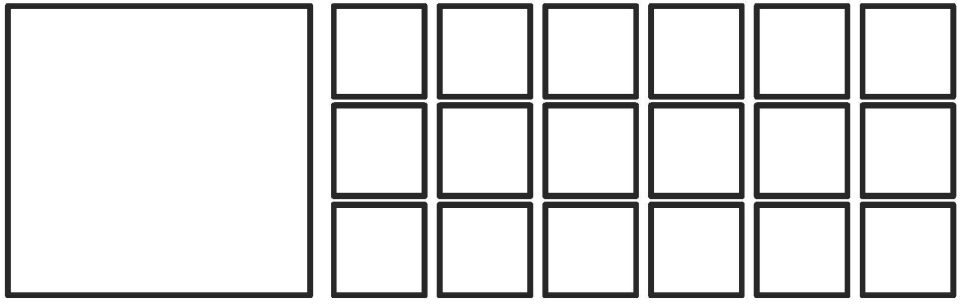

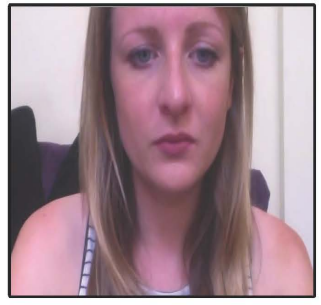

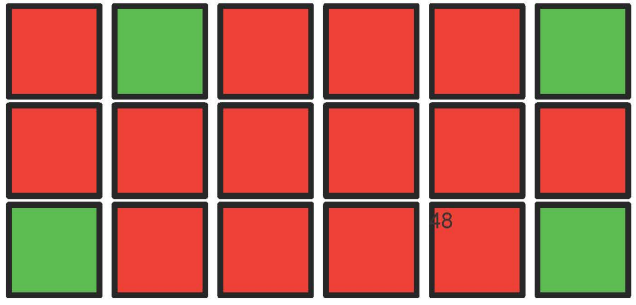

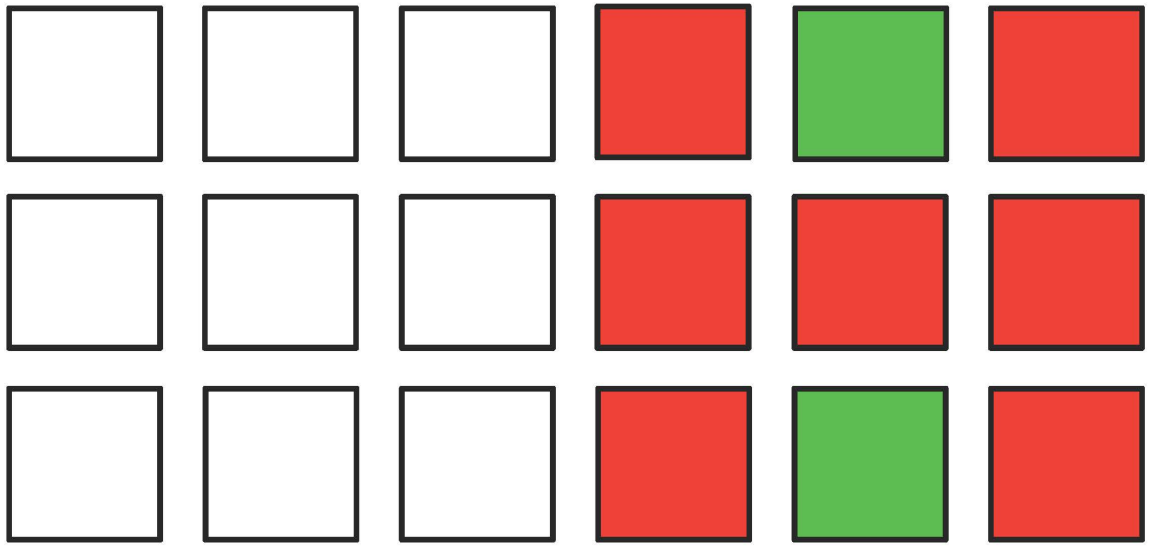

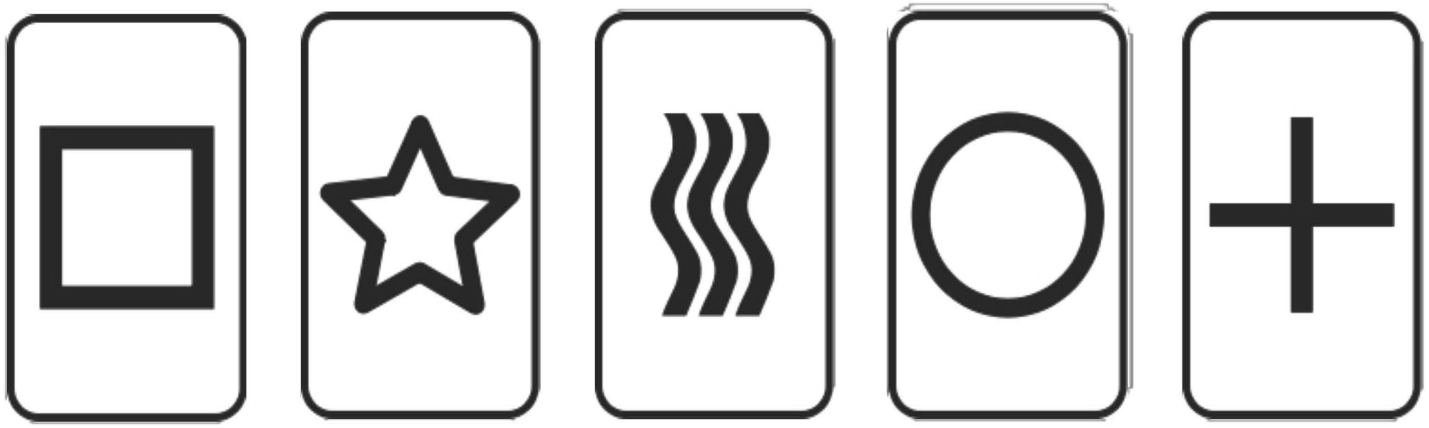

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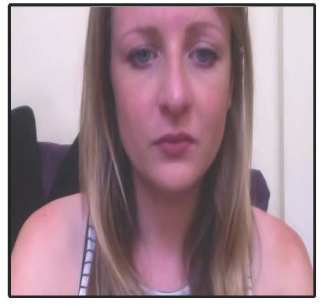

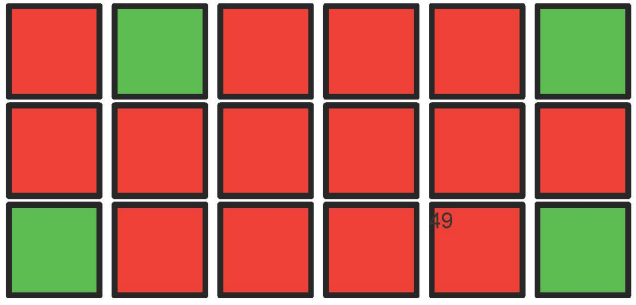

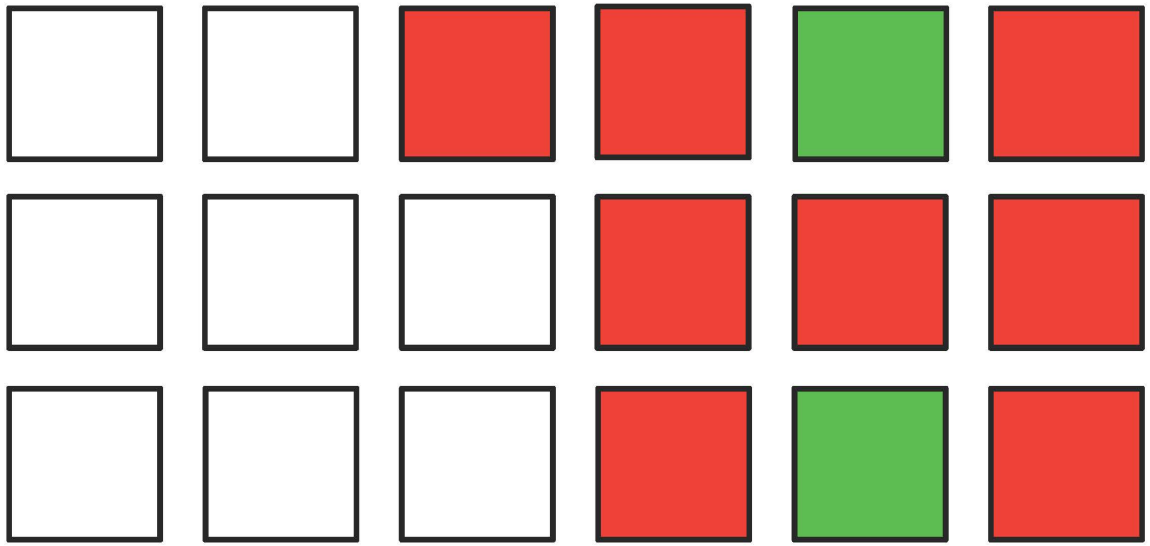

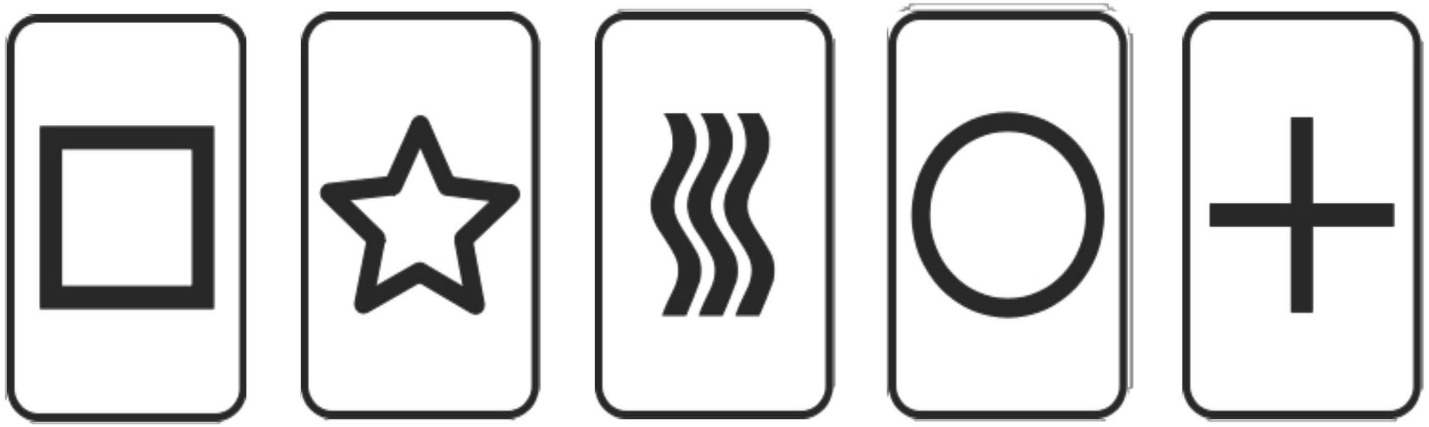

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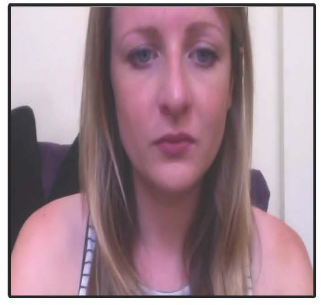

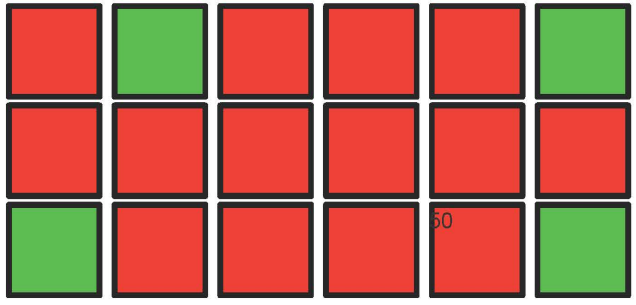

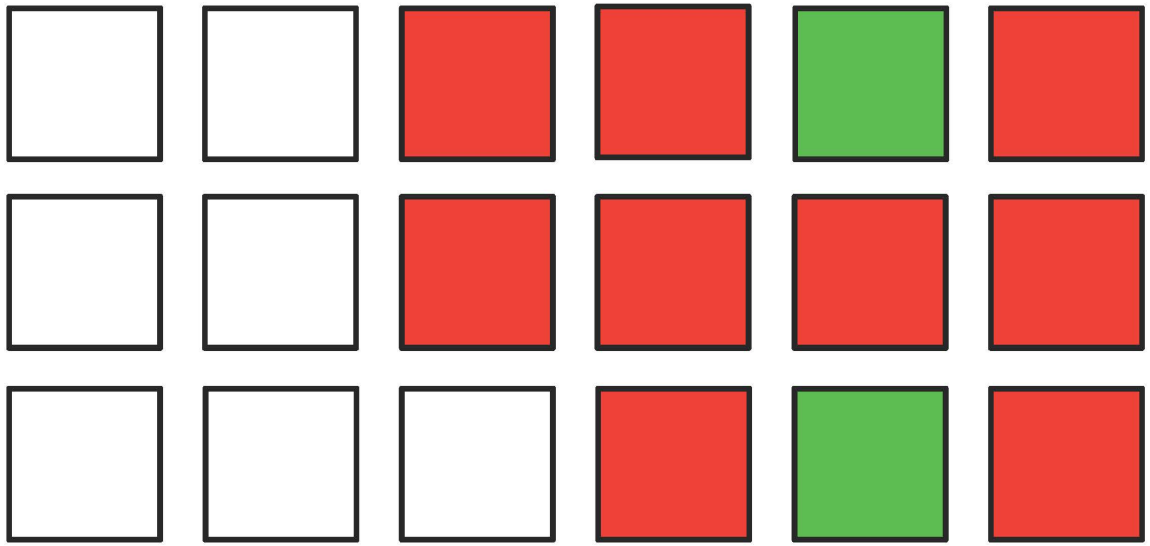

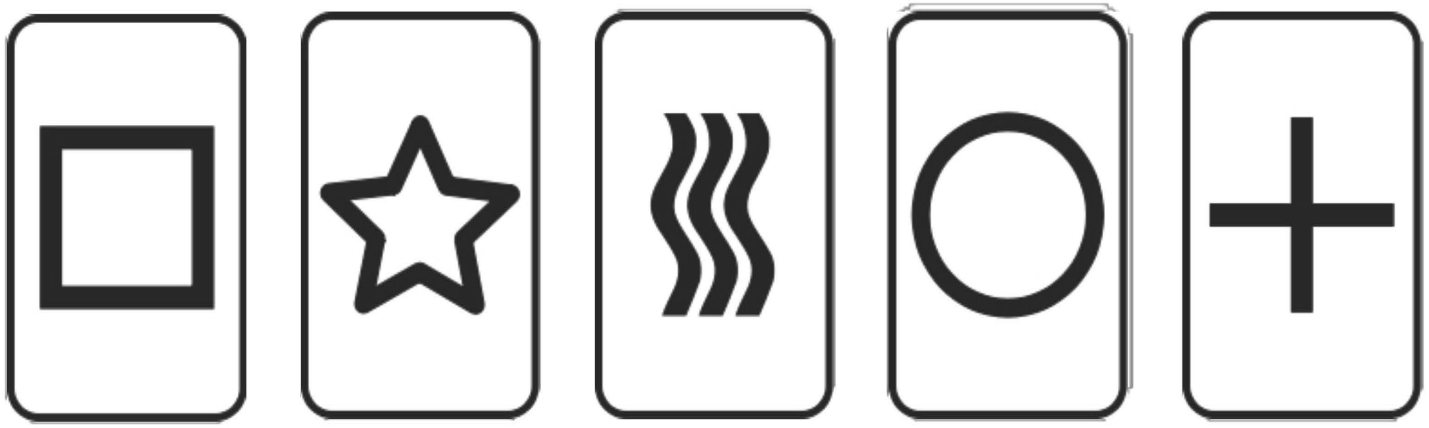

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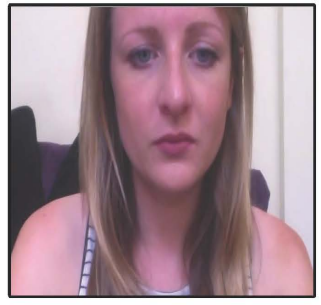

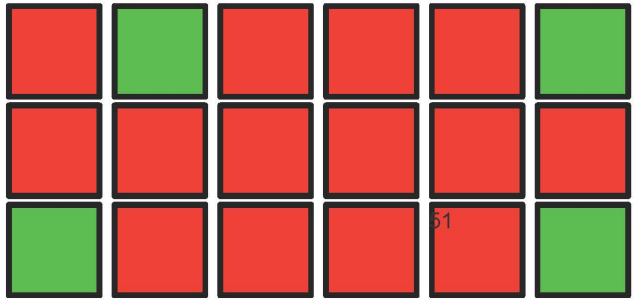

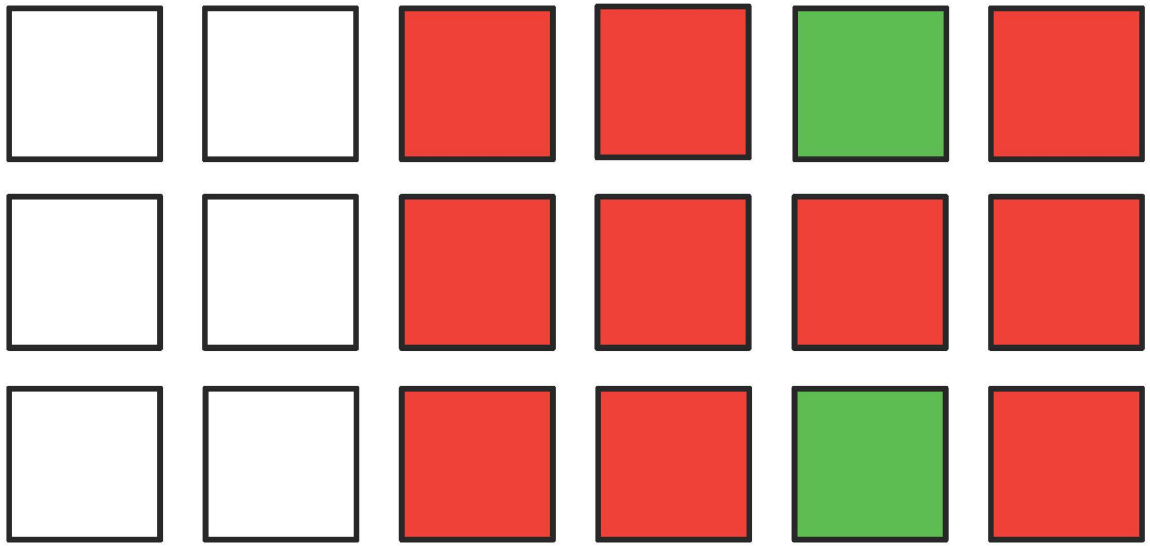

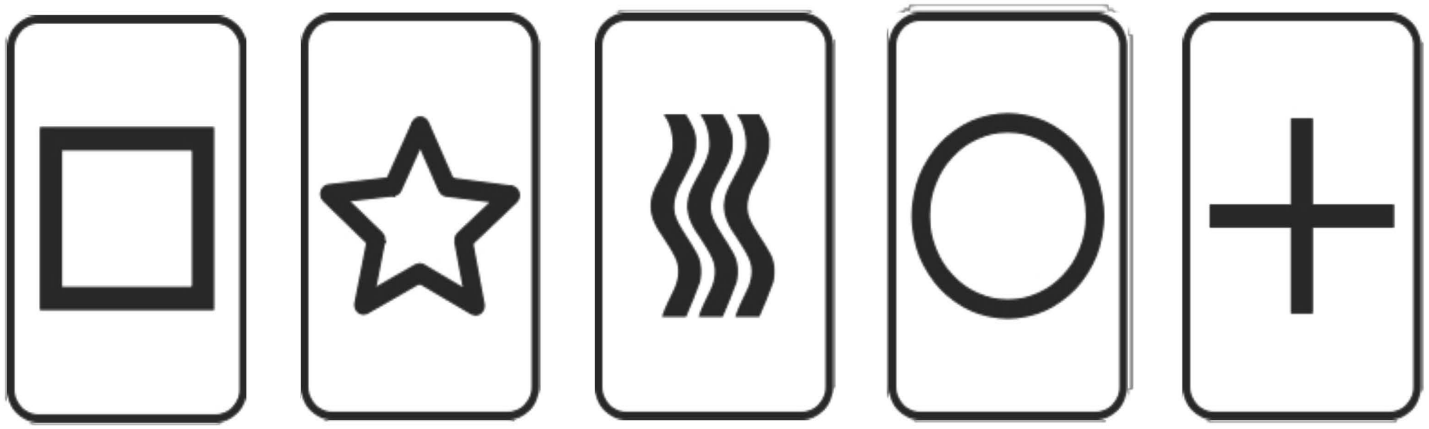

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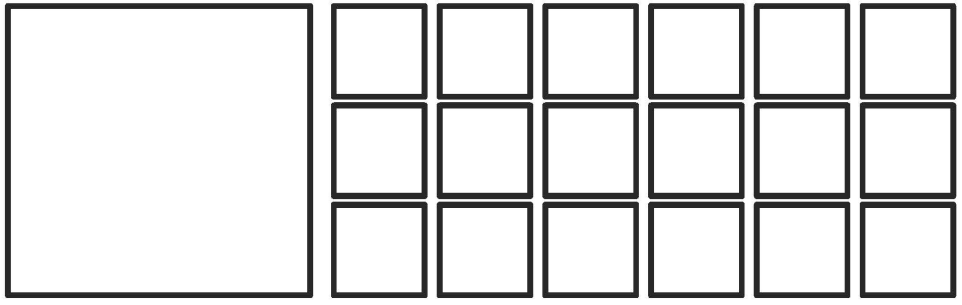

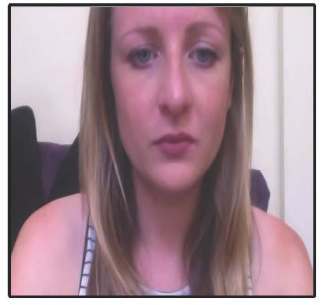

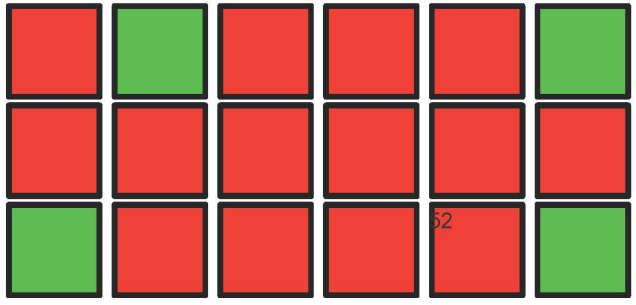

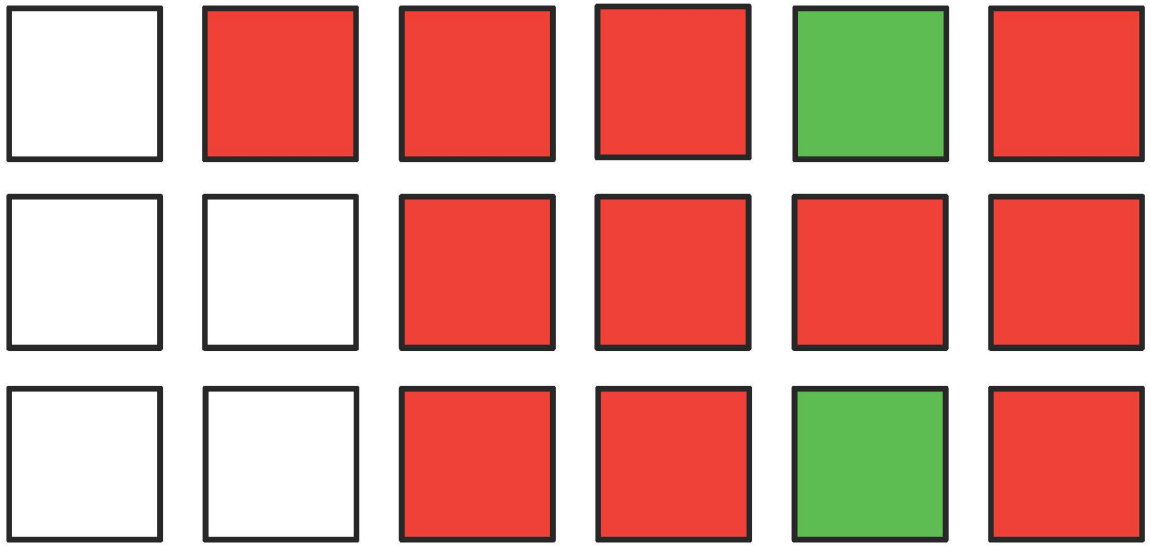

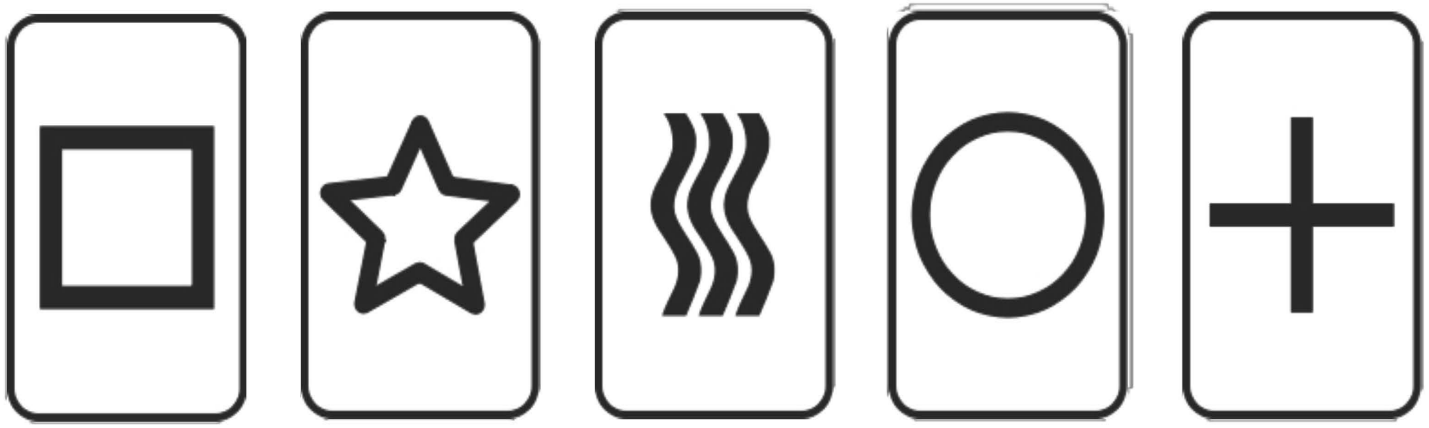

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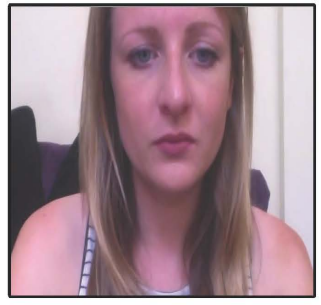

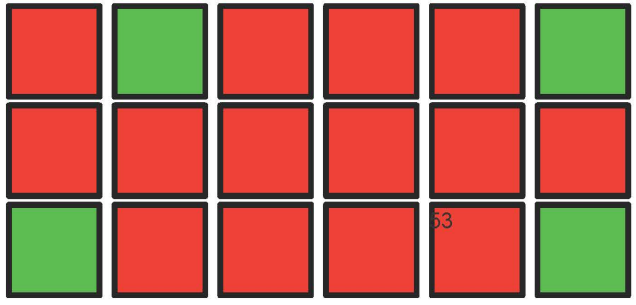

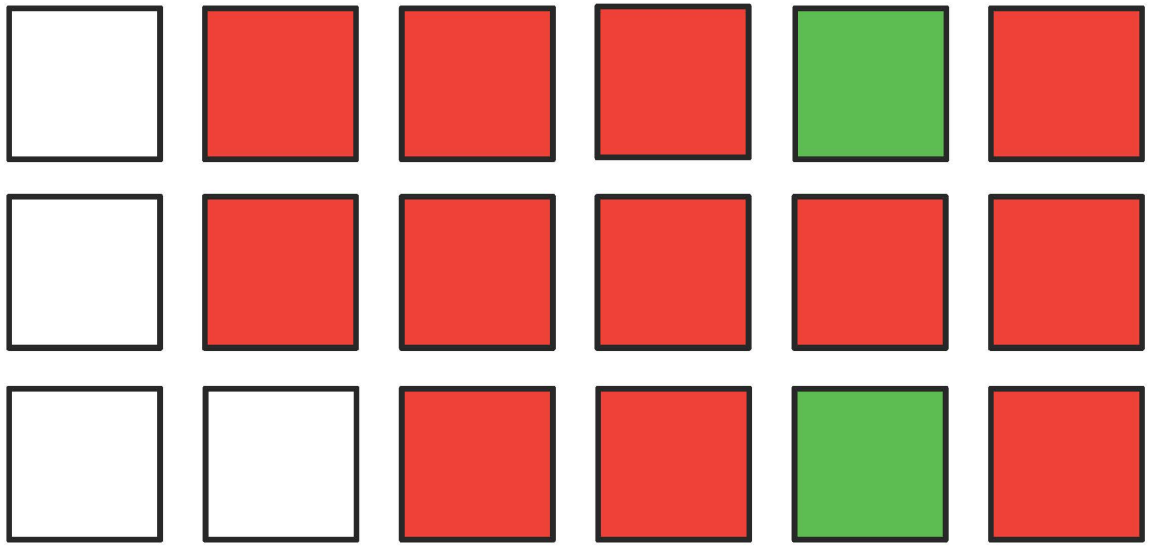

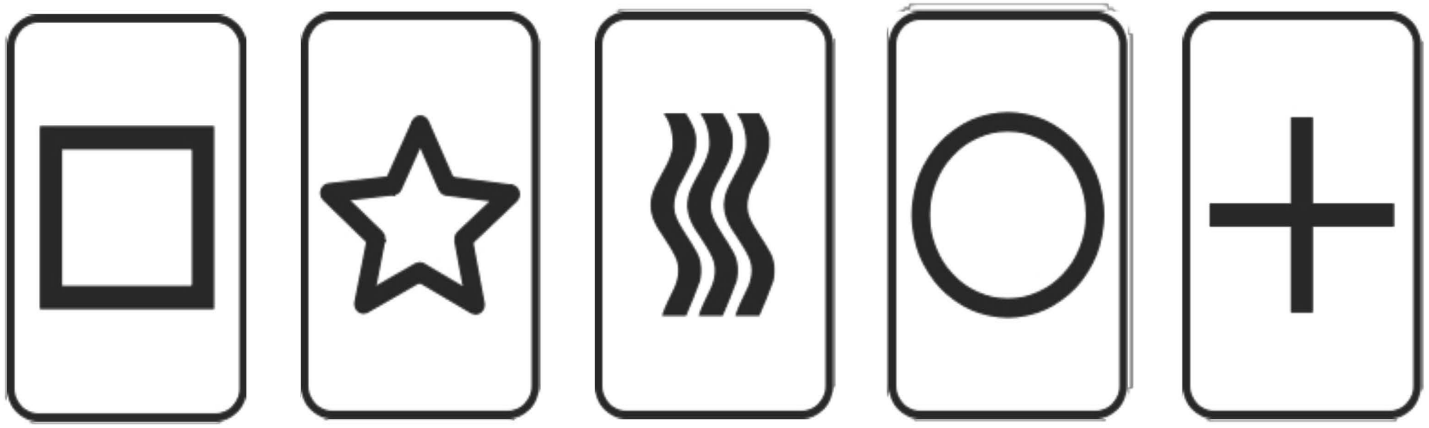

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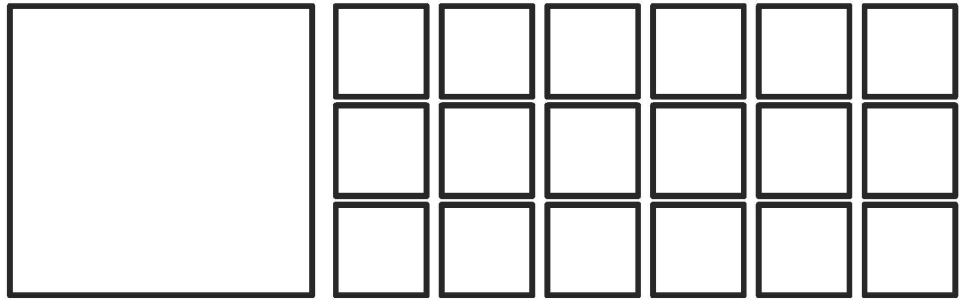

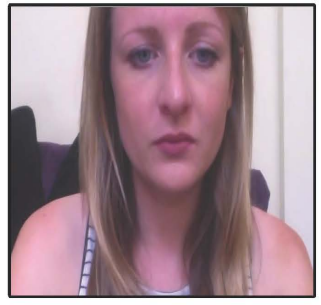

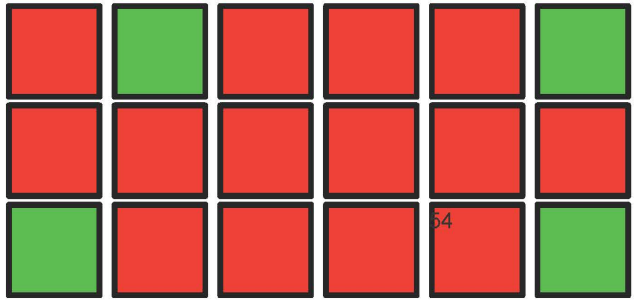

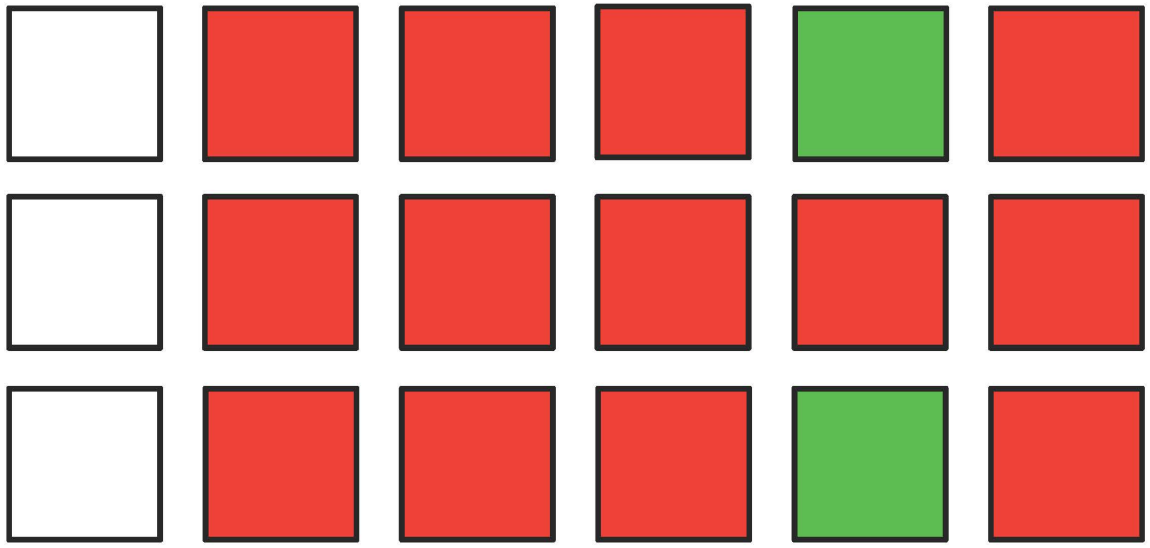

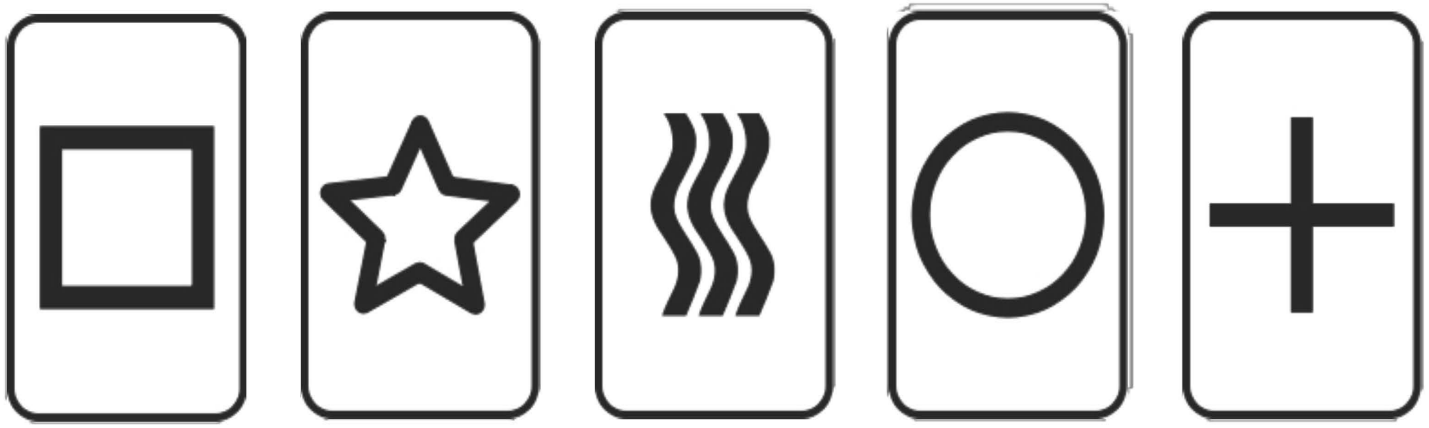

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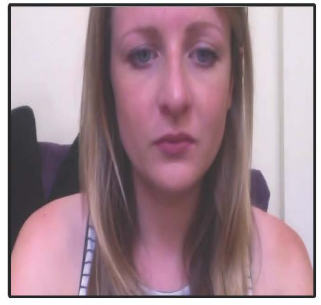

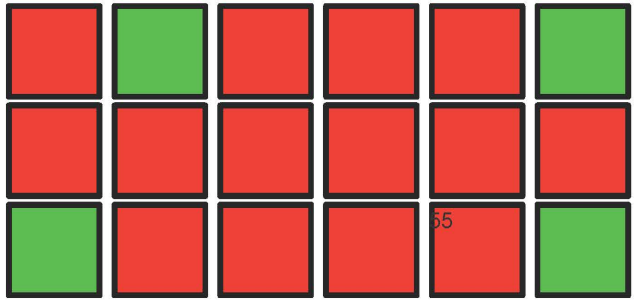

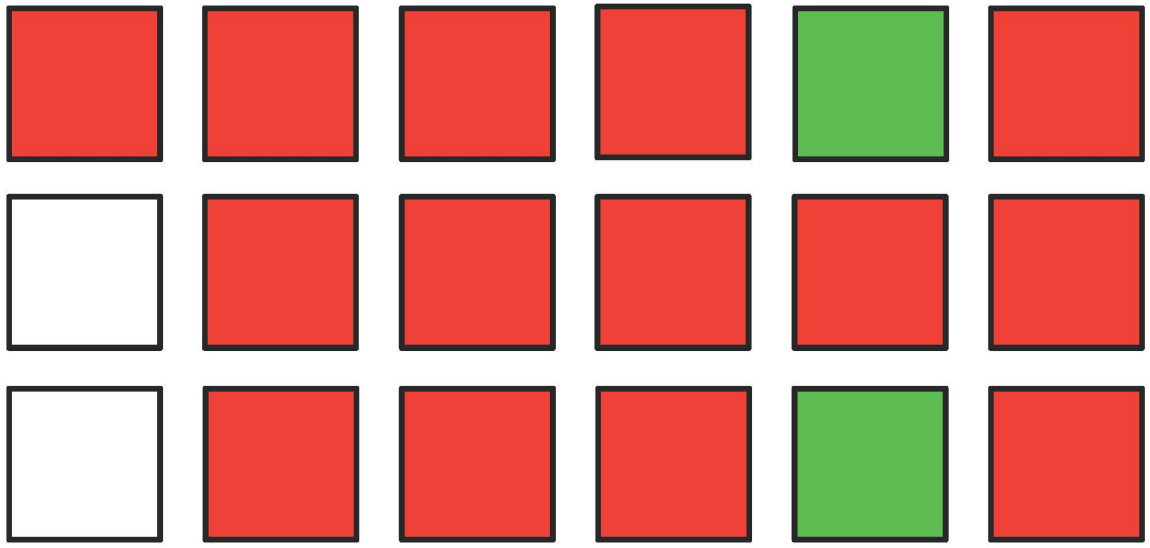

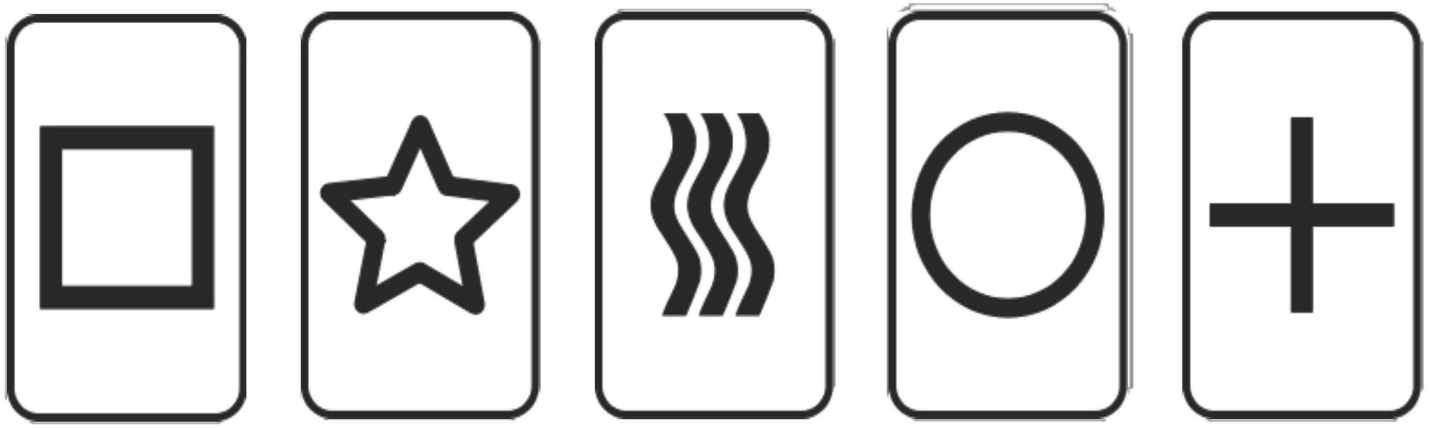

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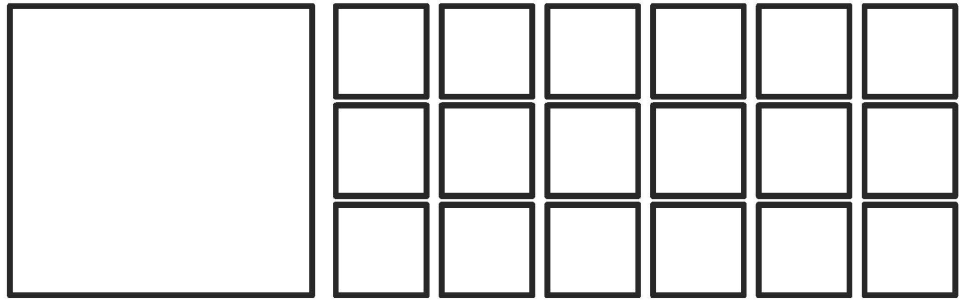

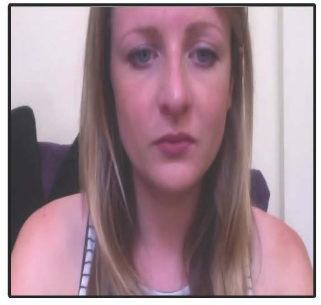

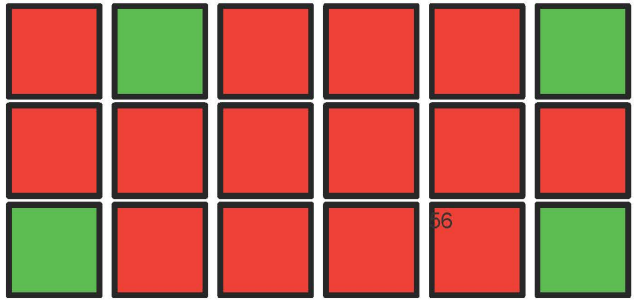

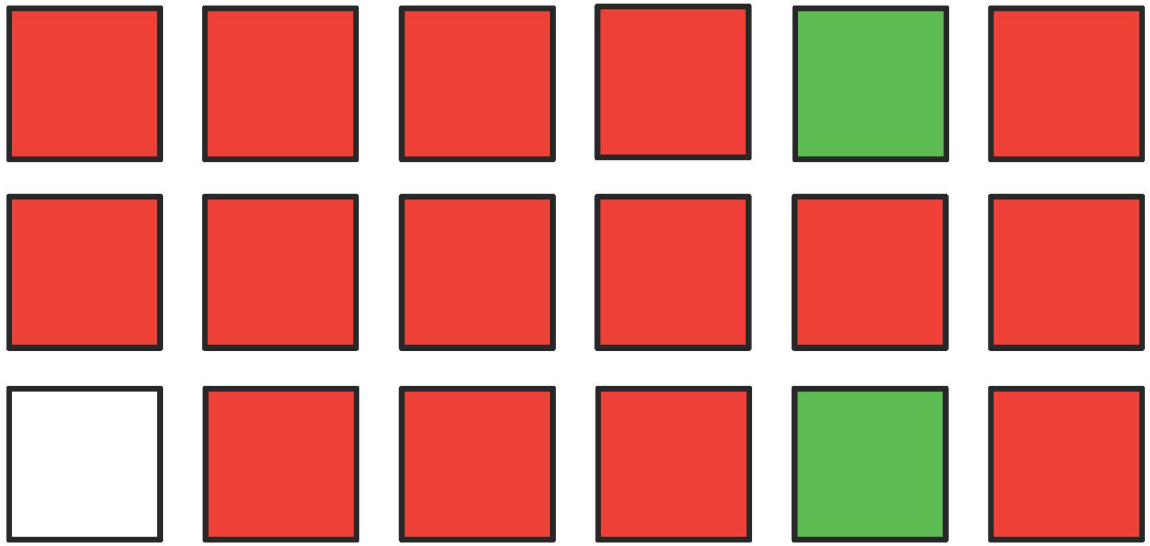

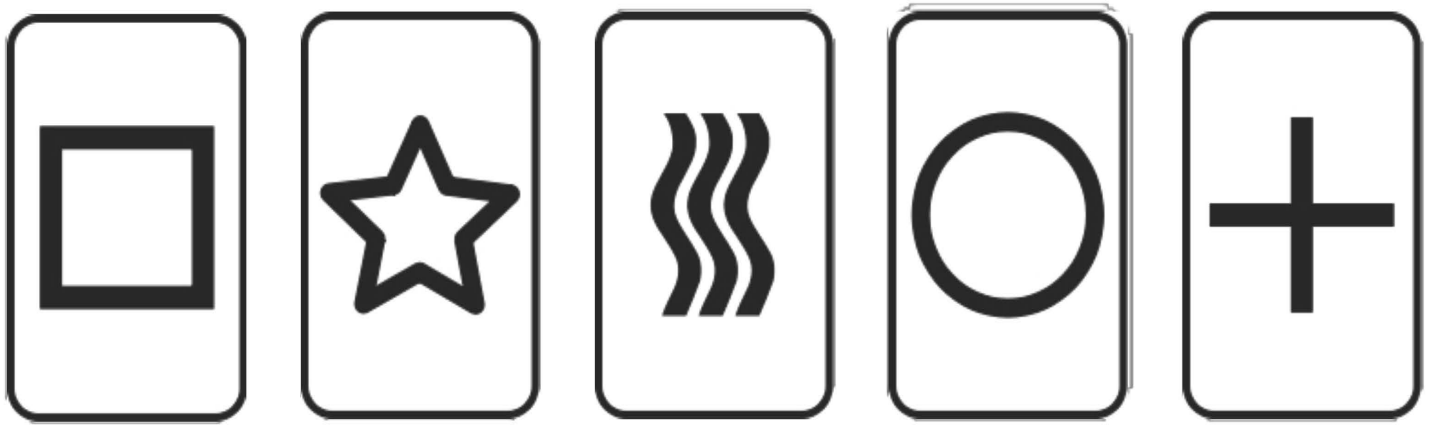

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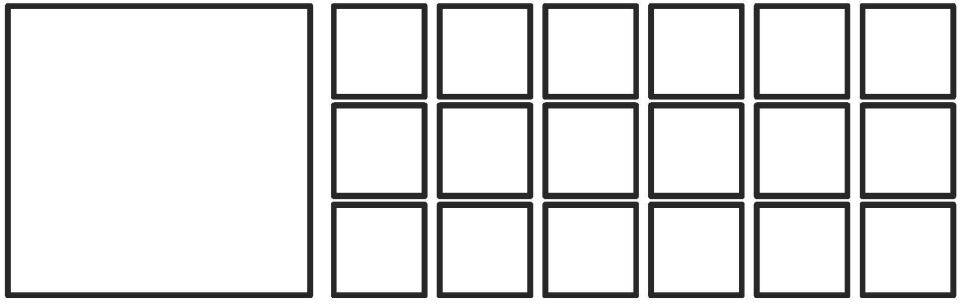

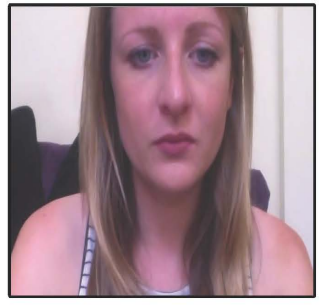

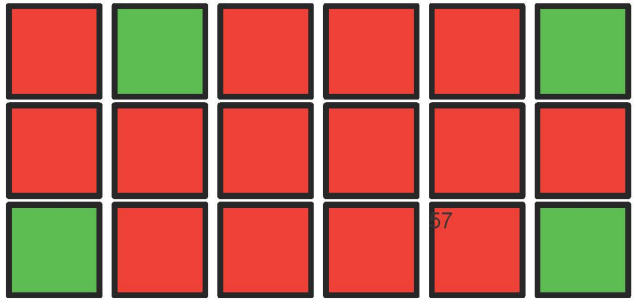

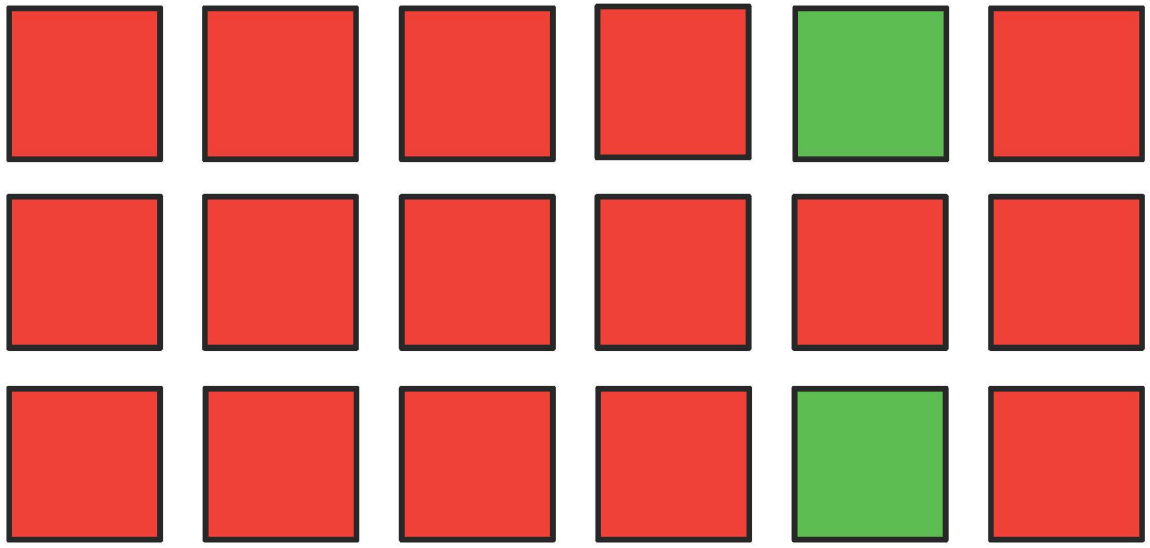

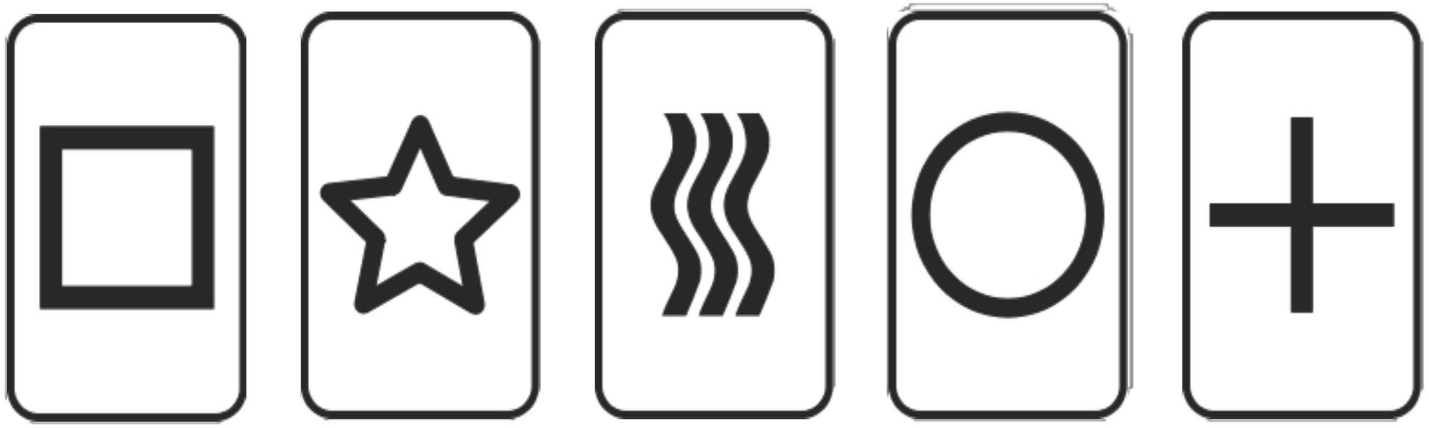

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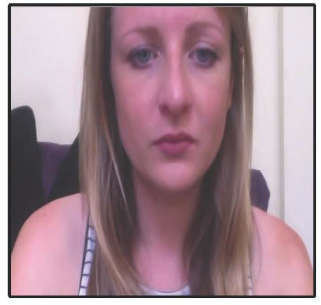
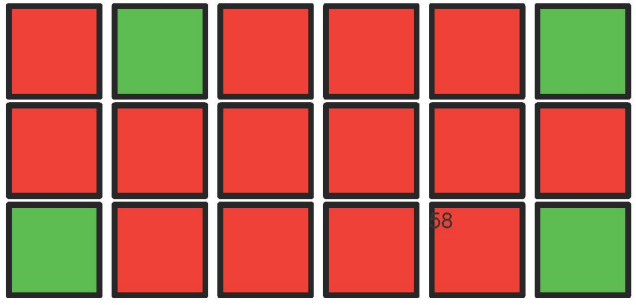
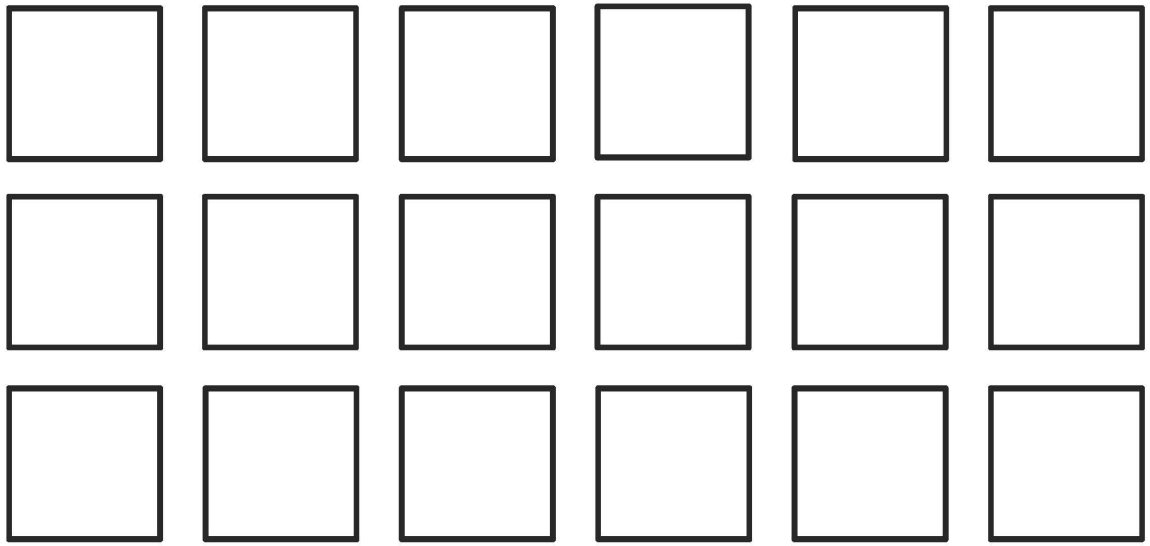
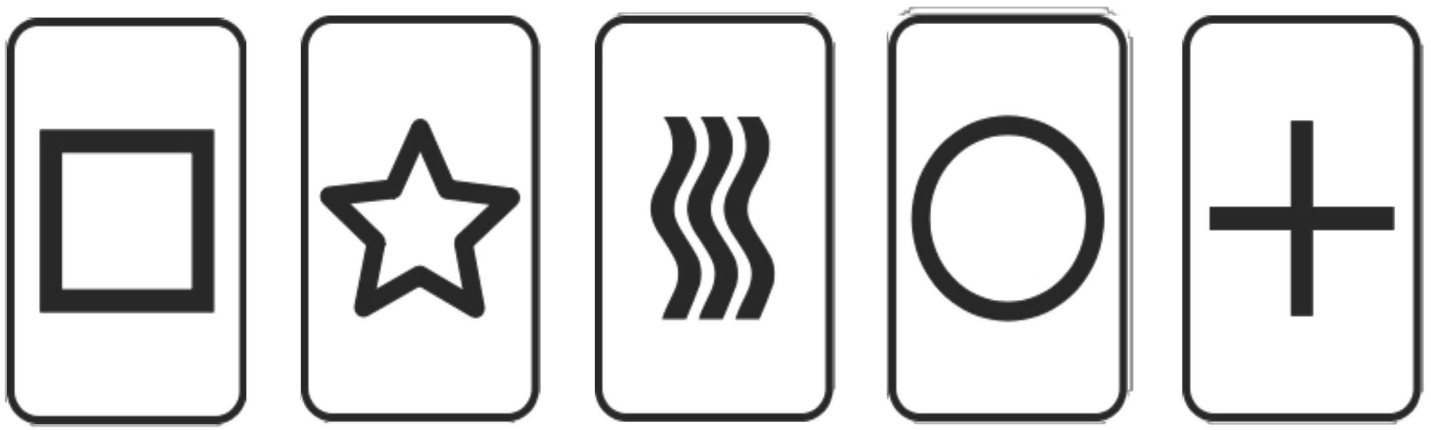




Thank you.
The next player is being selected.
After a short countdown the test will begin again.





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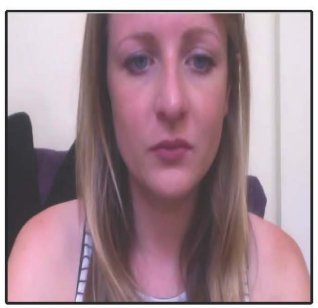
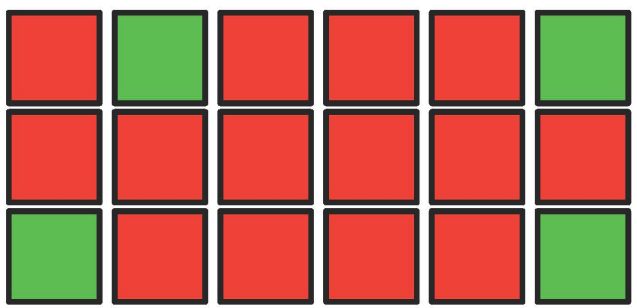
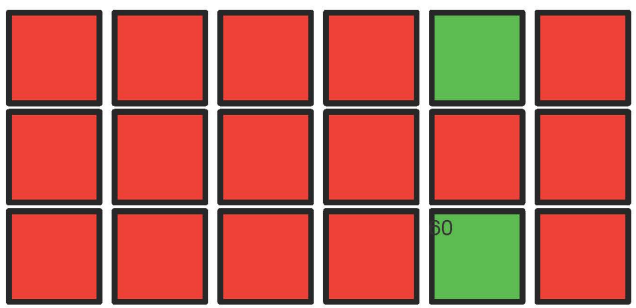
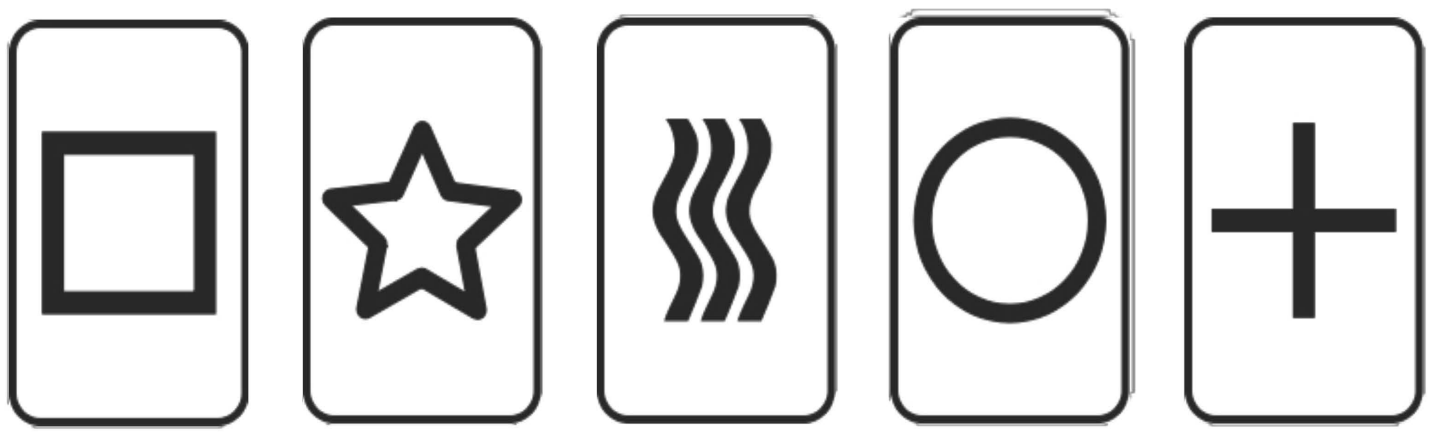






GO!



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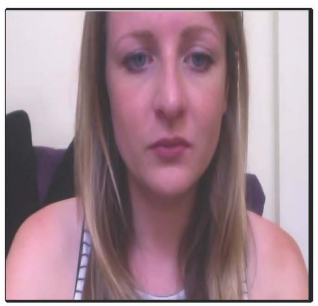

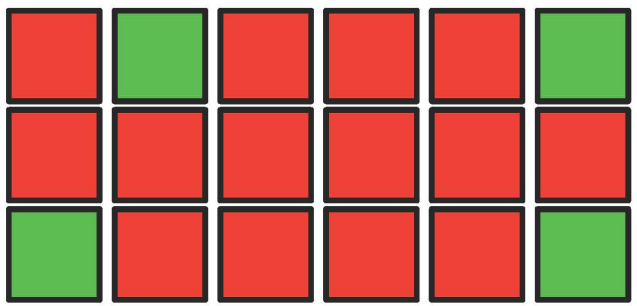

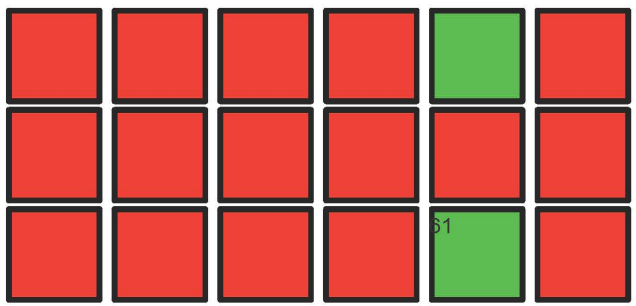

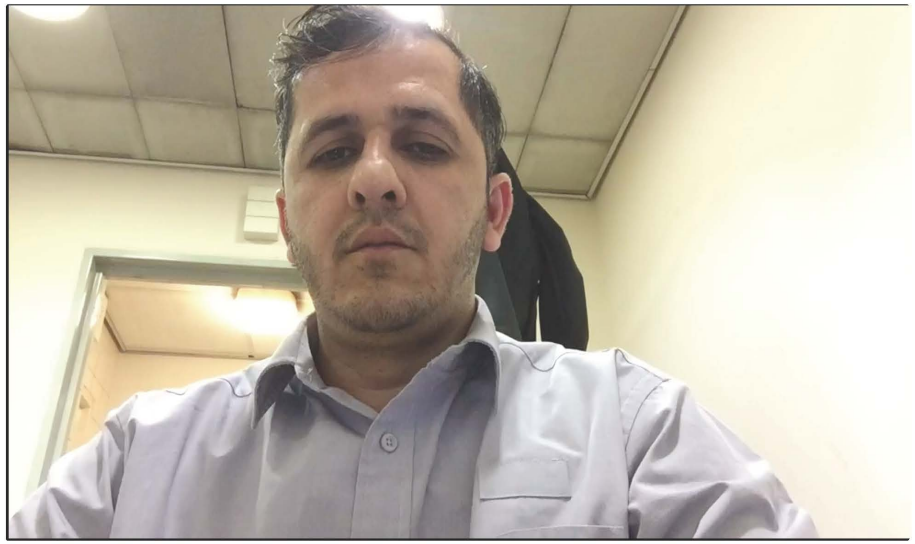

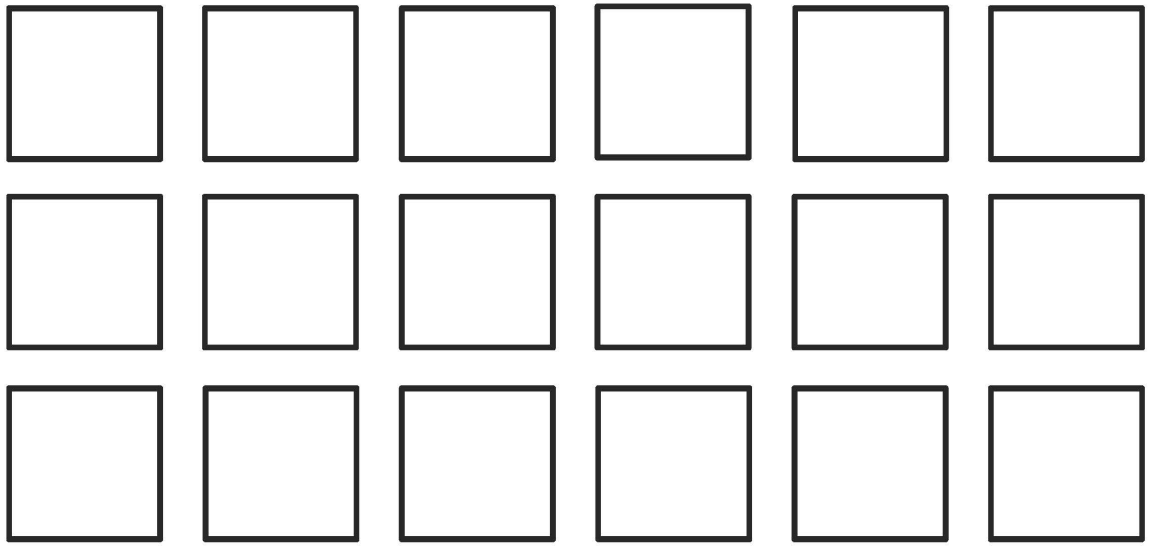

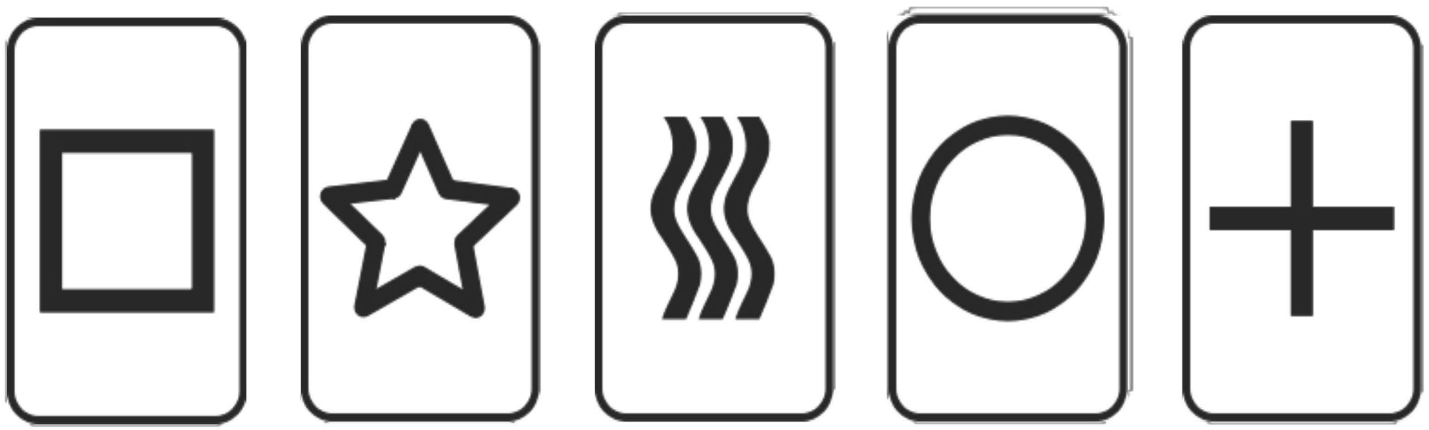

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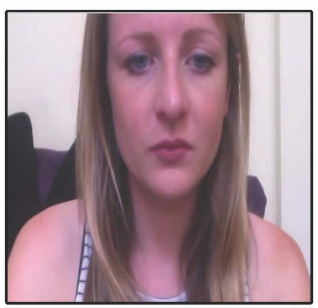

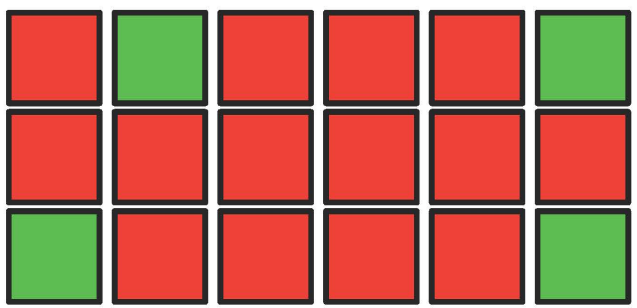

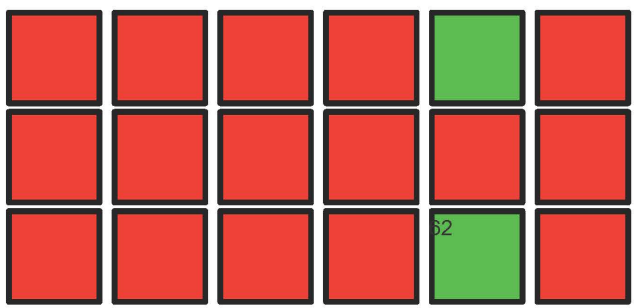

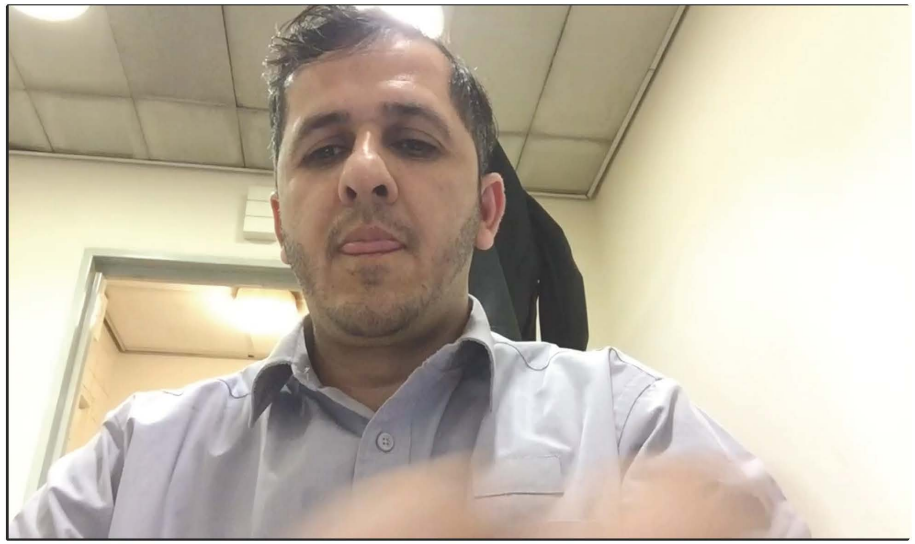

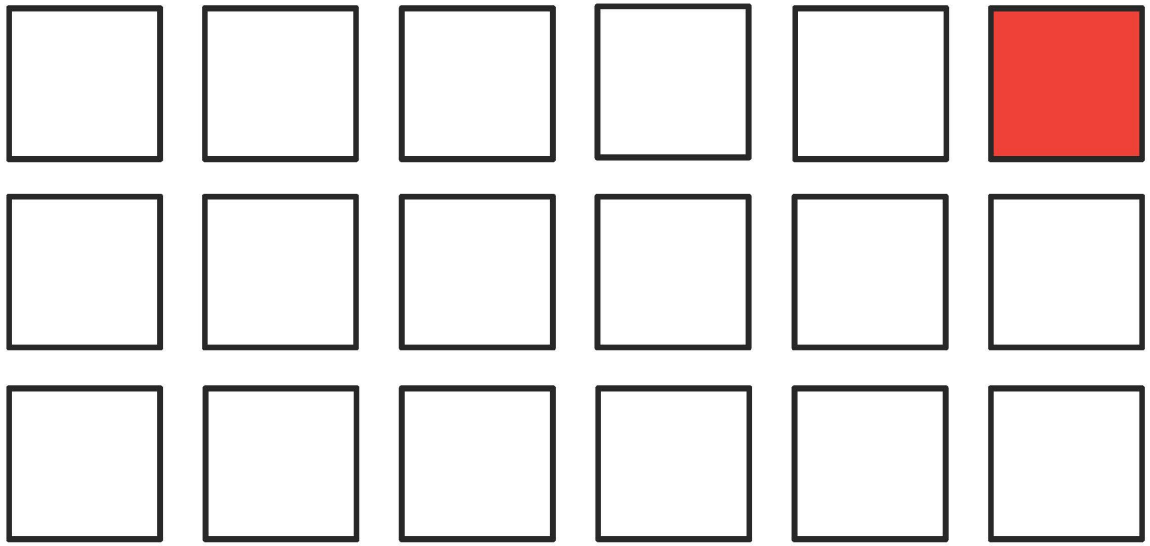

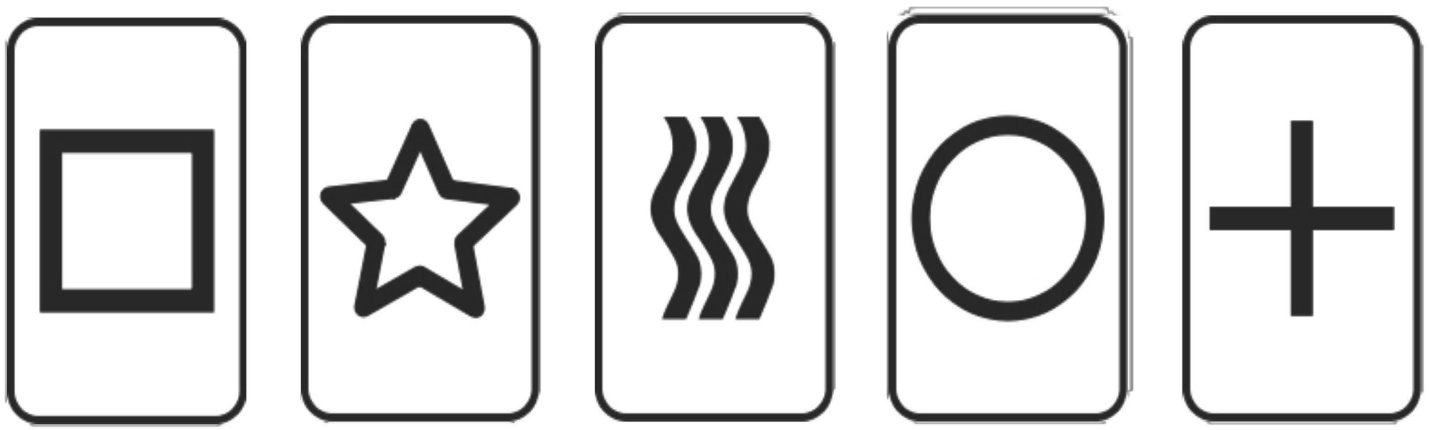

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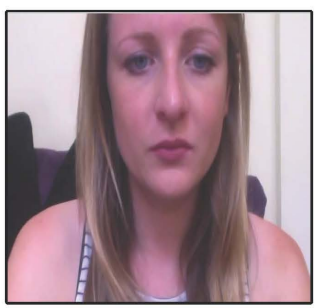

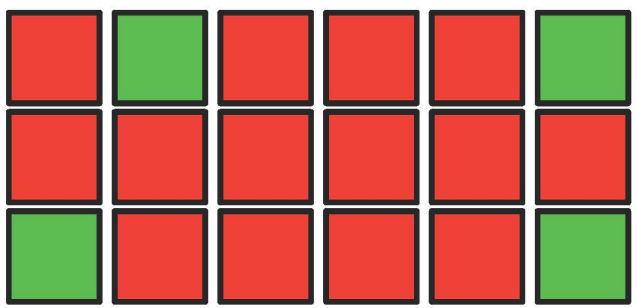

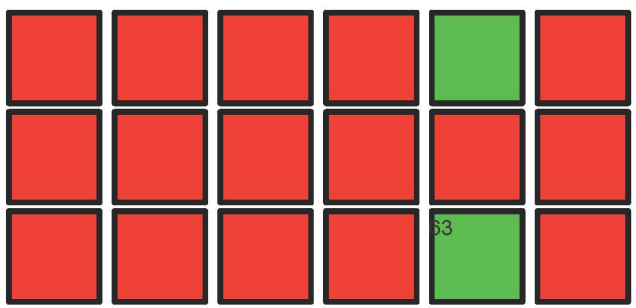

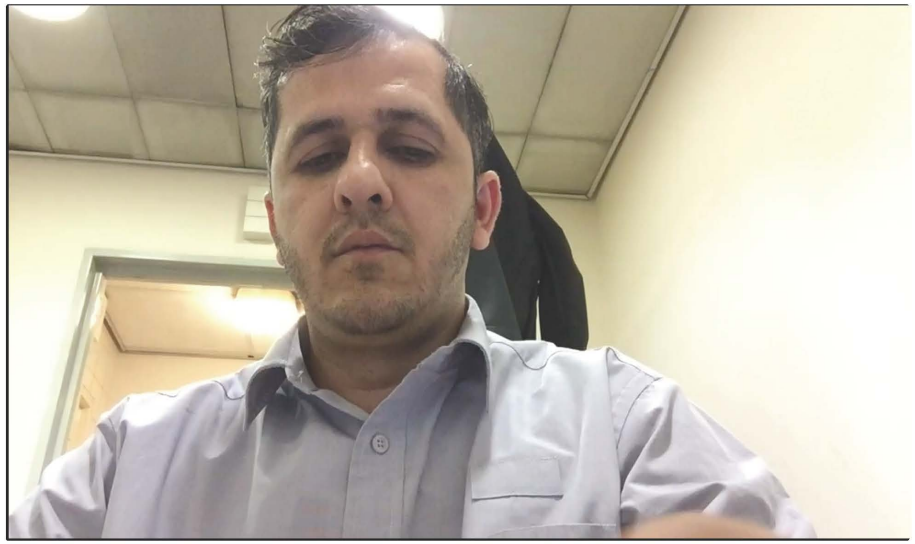

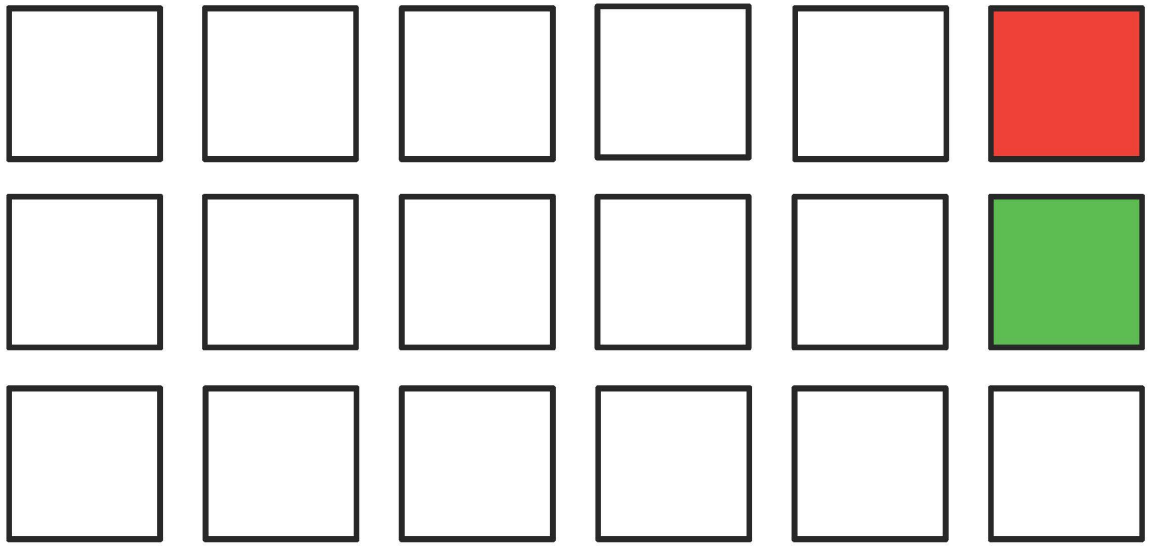

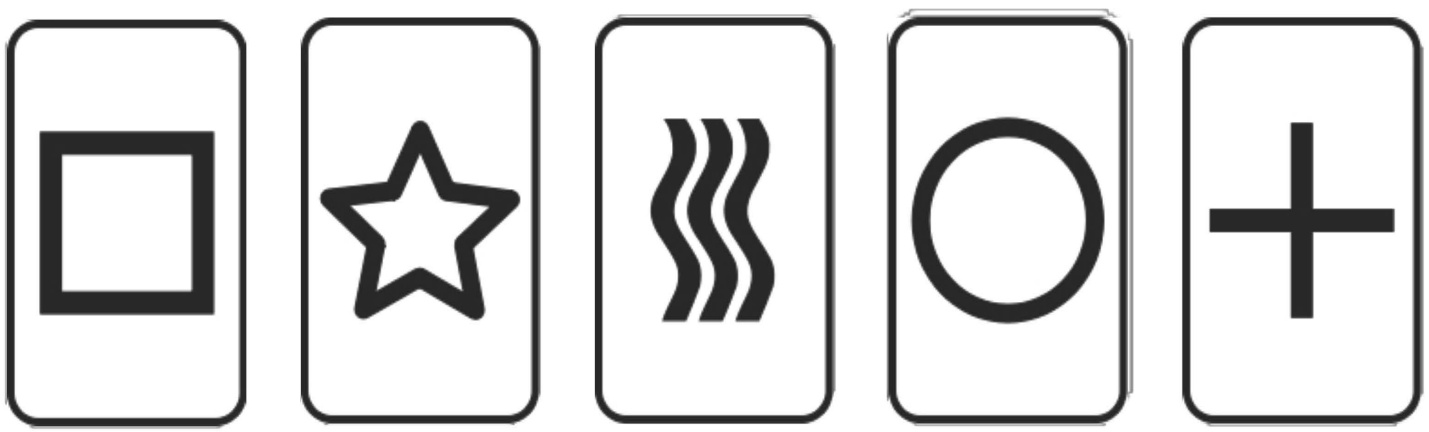

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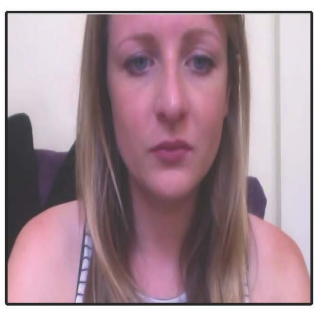

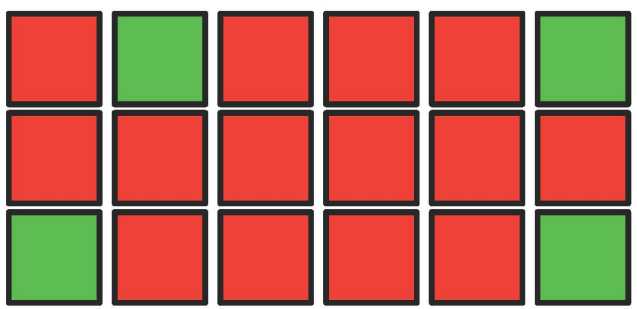

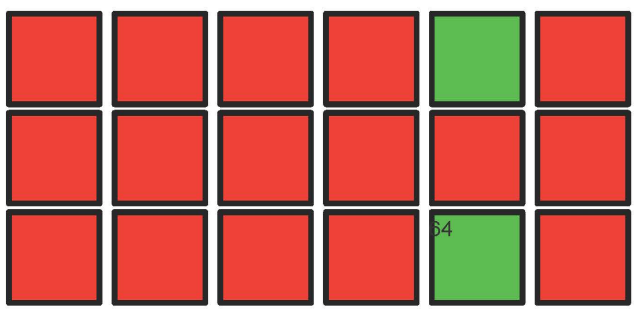

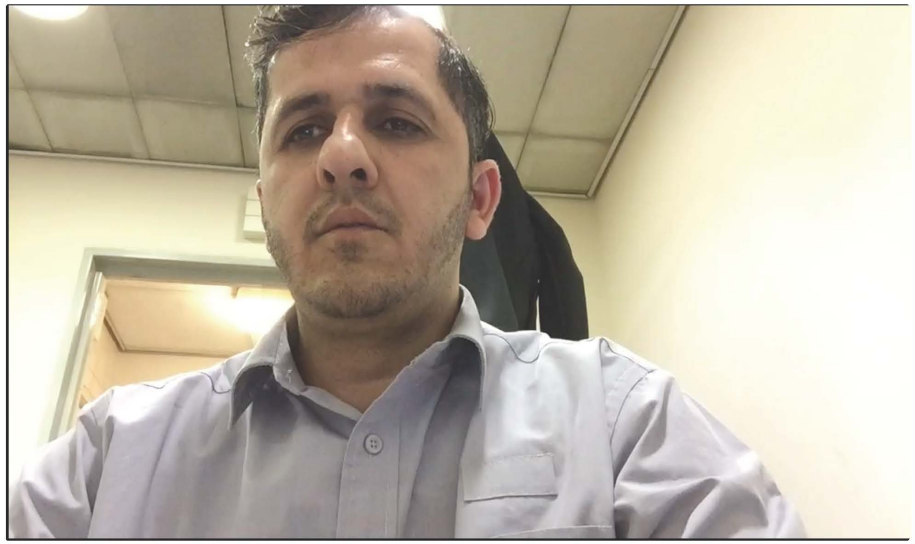

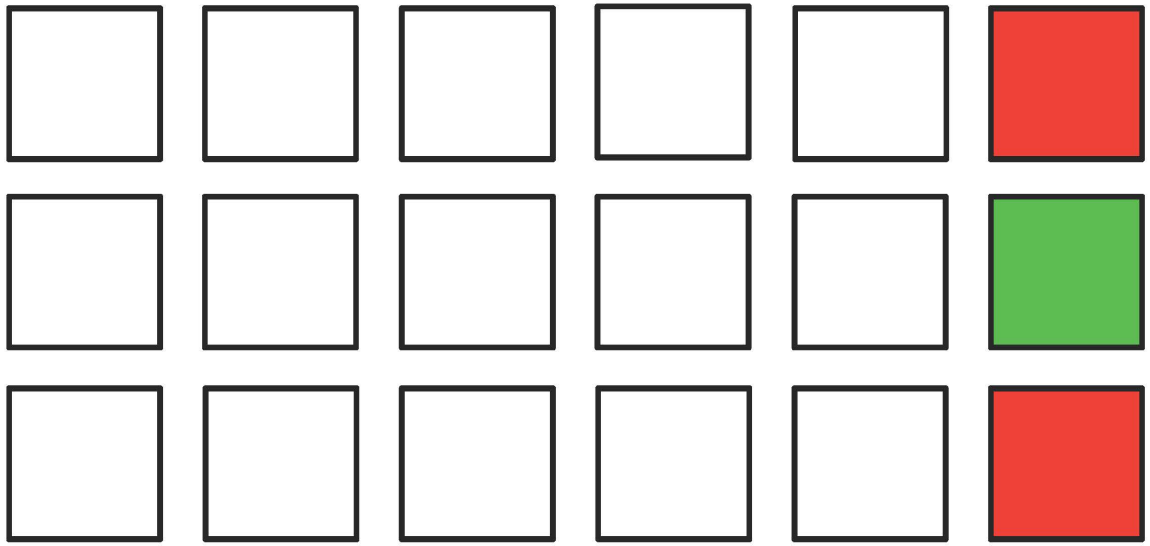

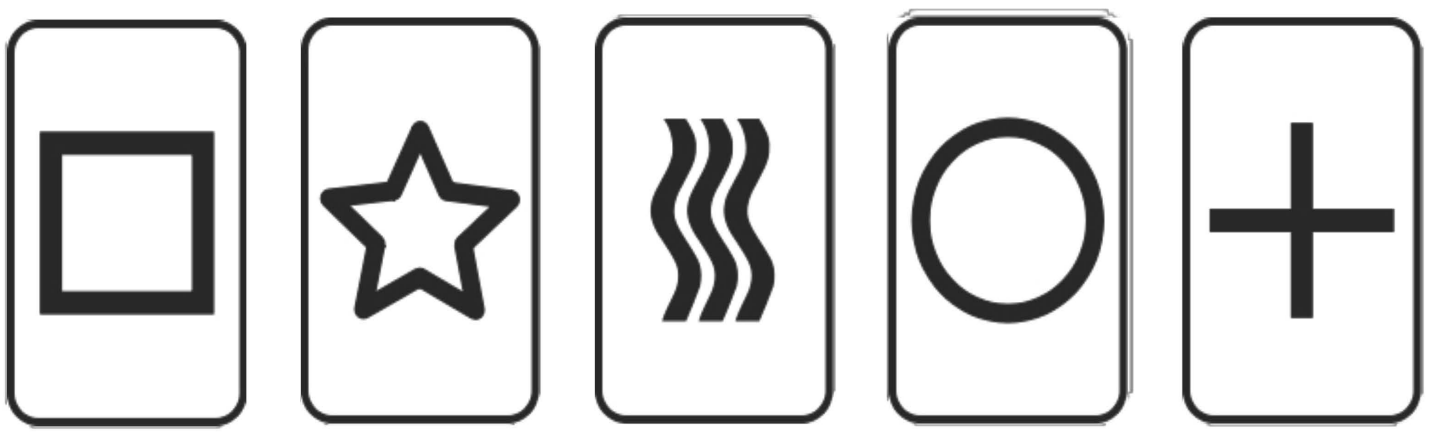

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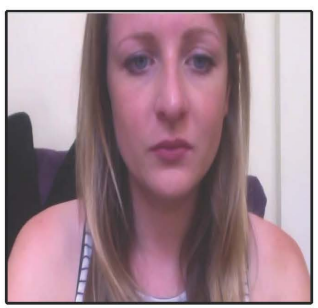

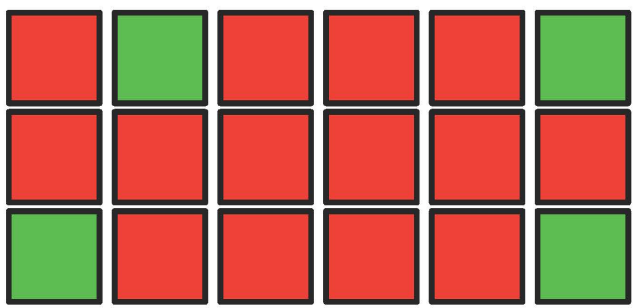

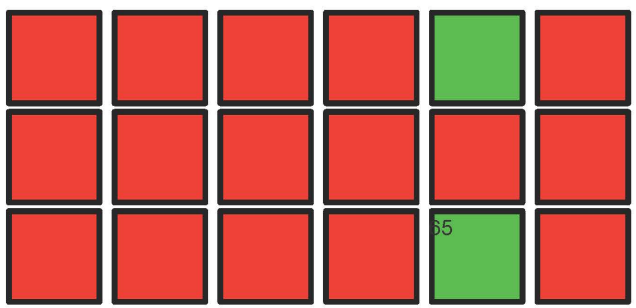

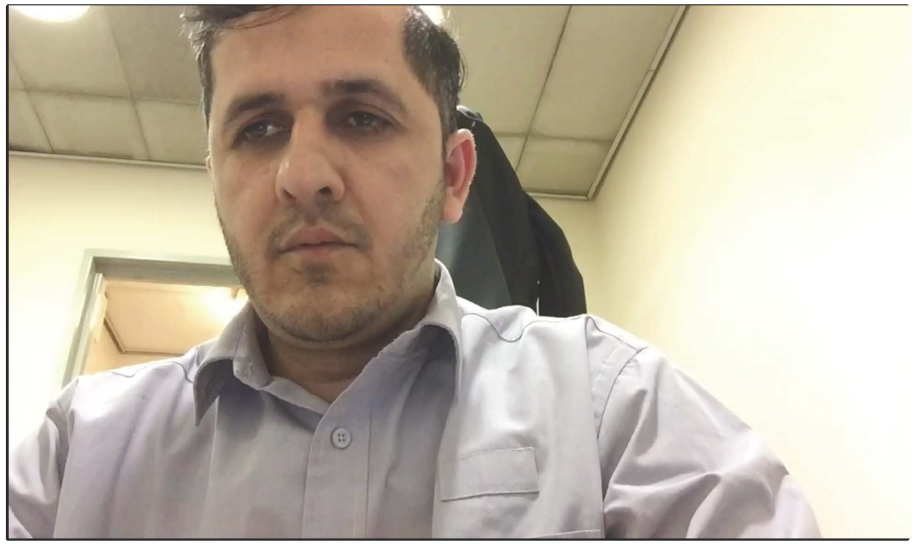

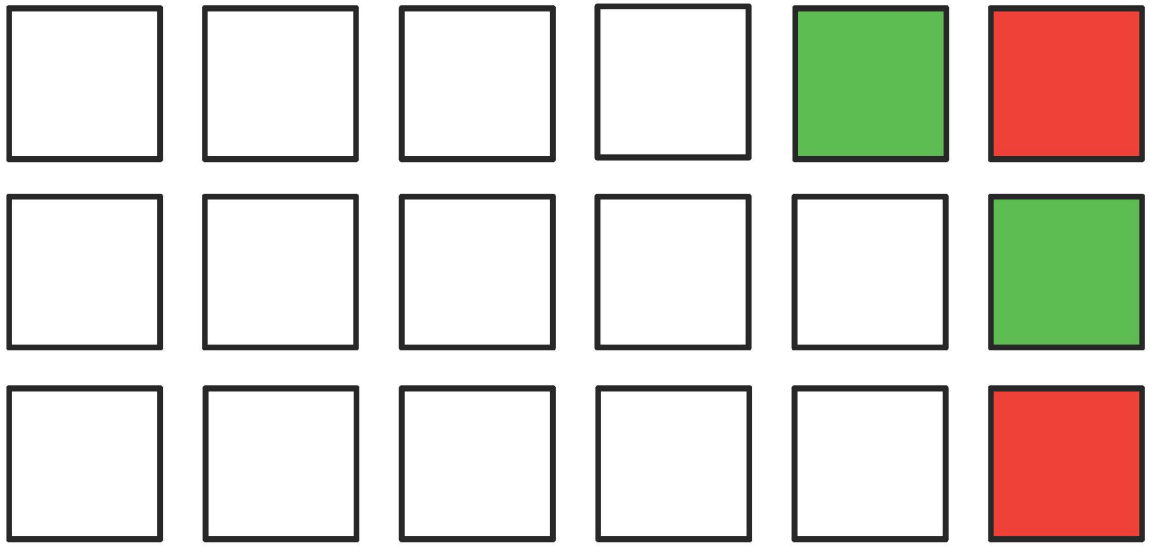

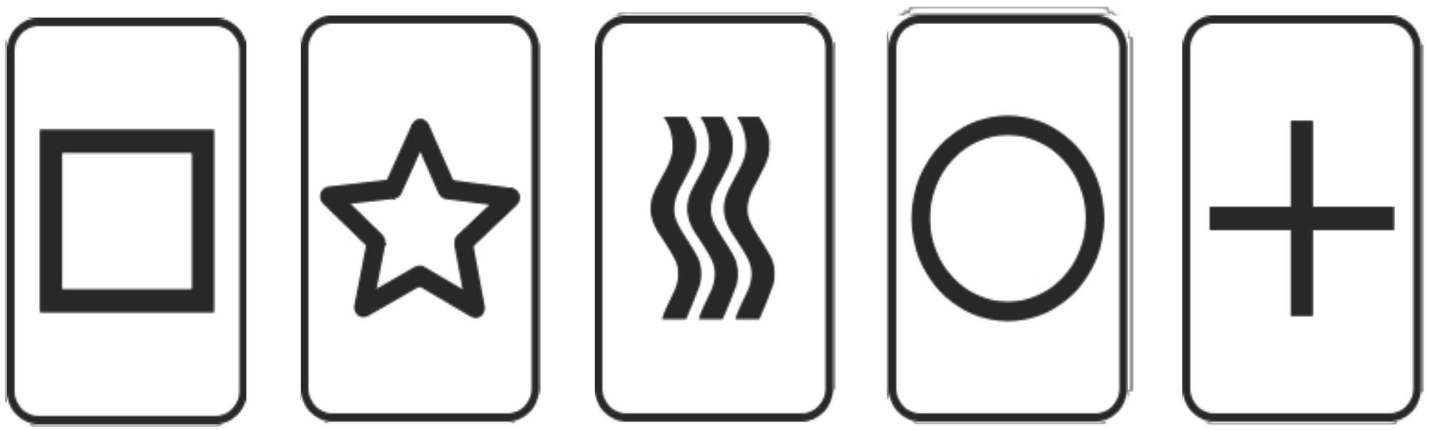

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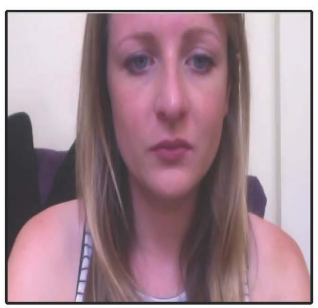

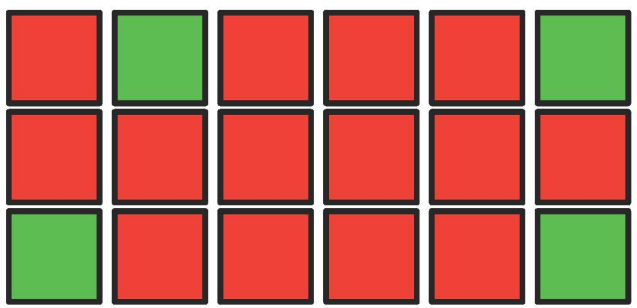

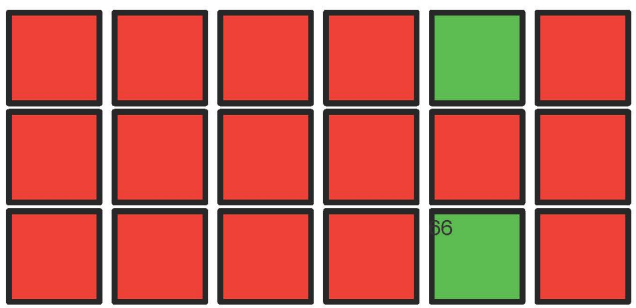

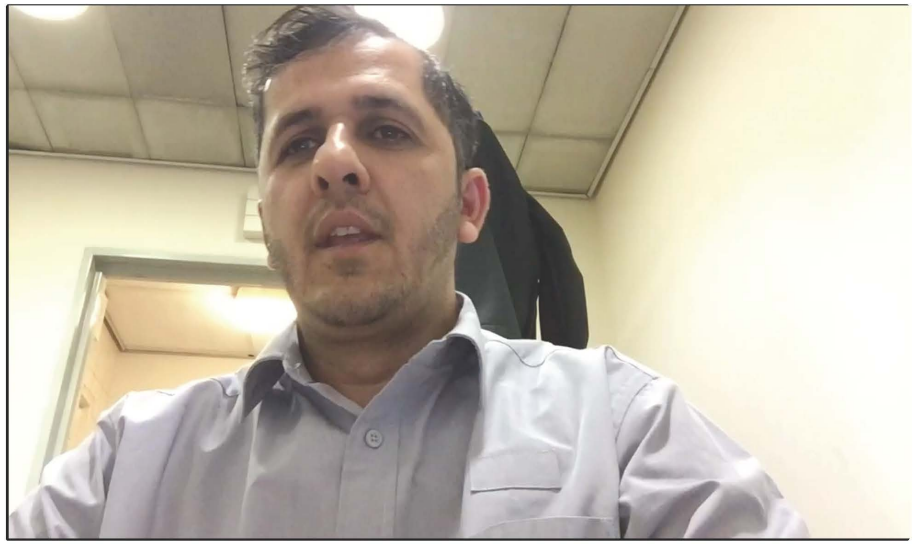

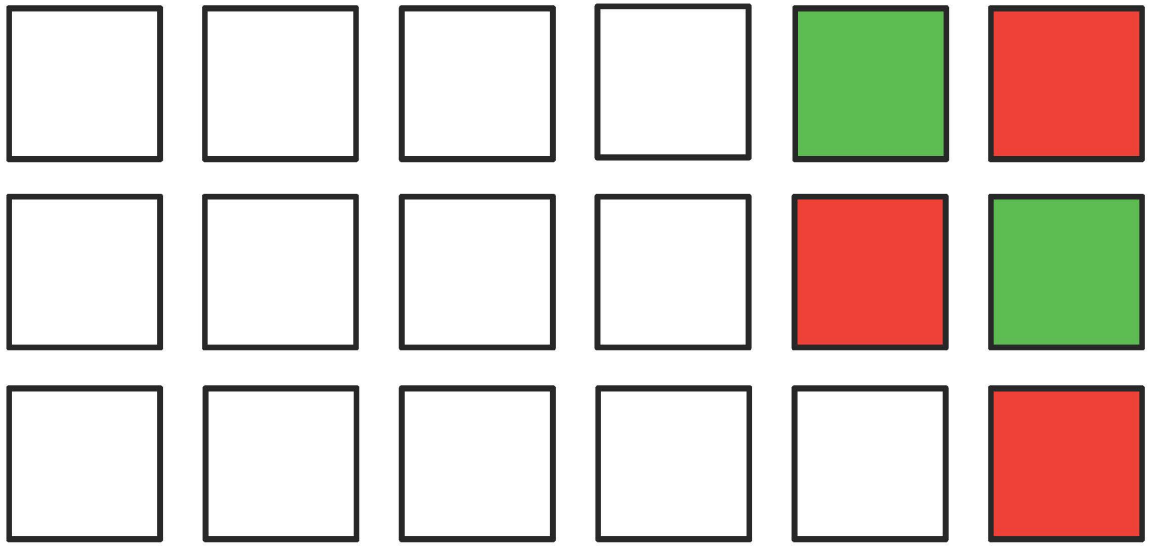

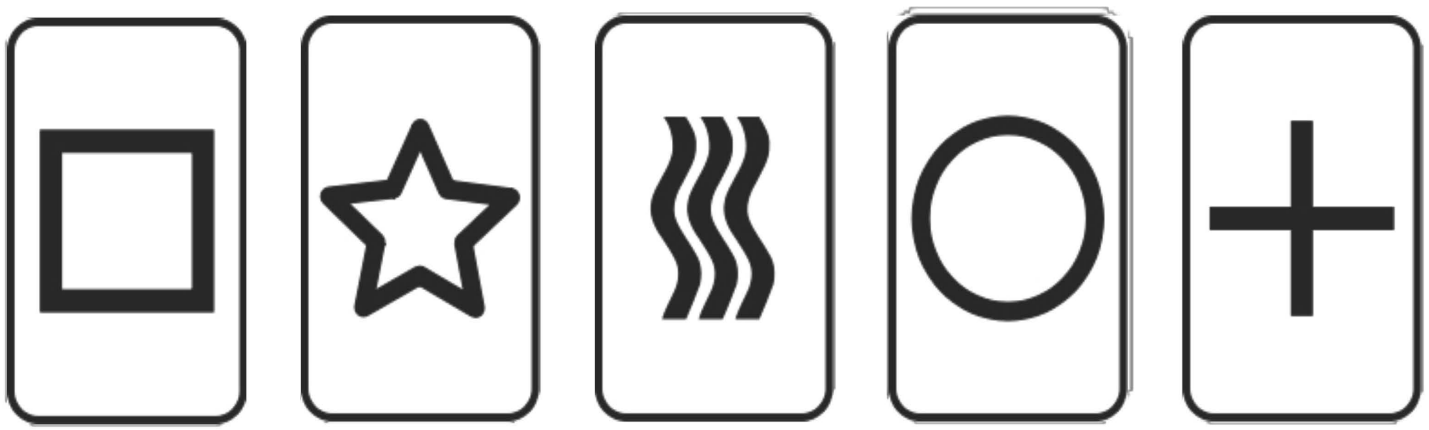

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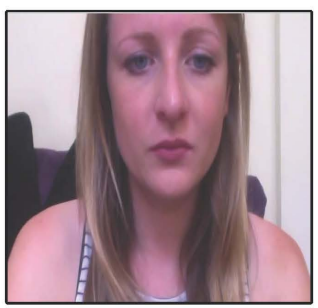

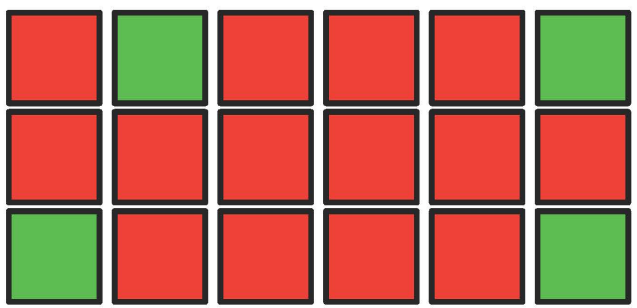

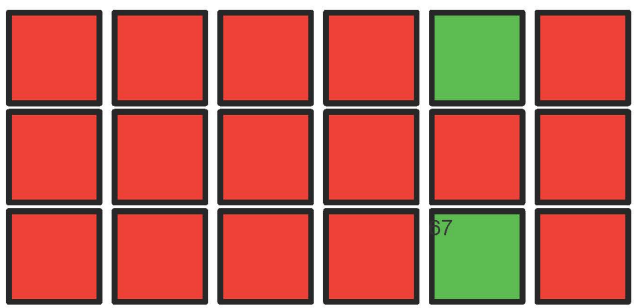

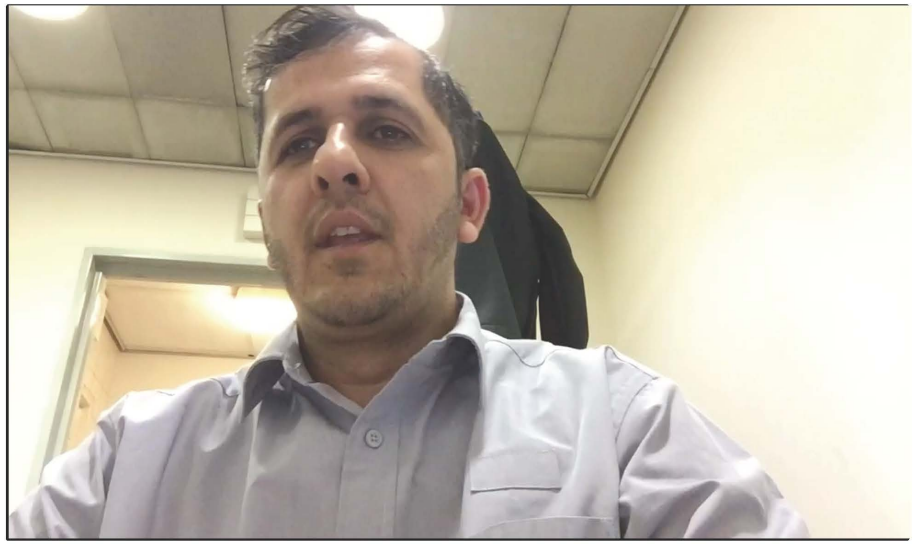

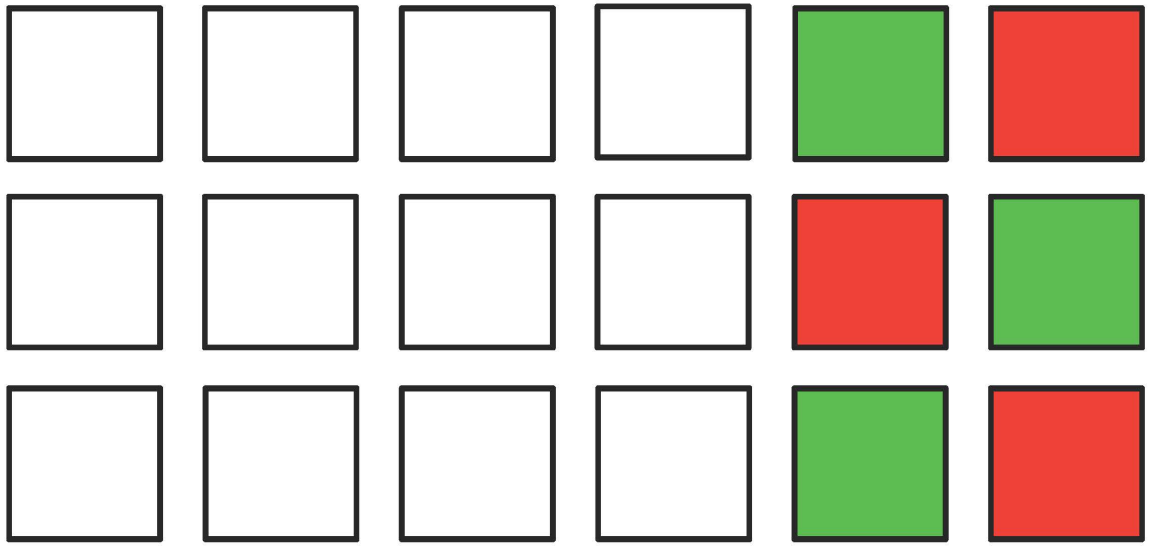

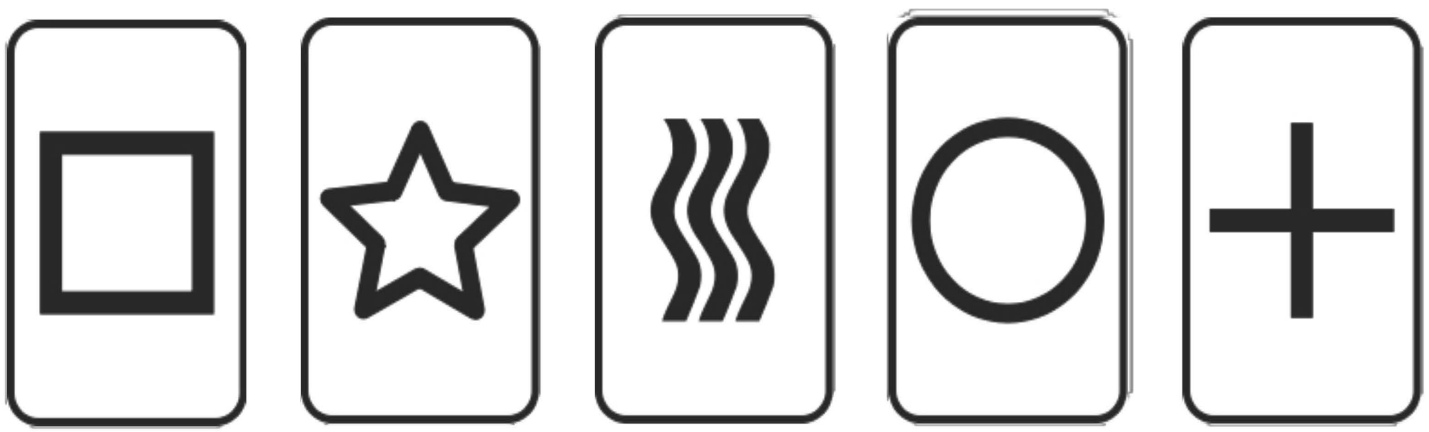

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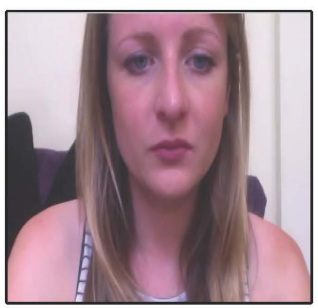

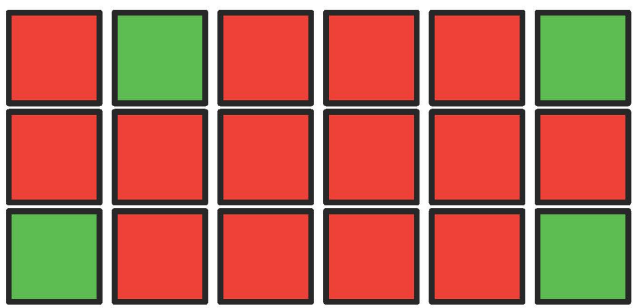

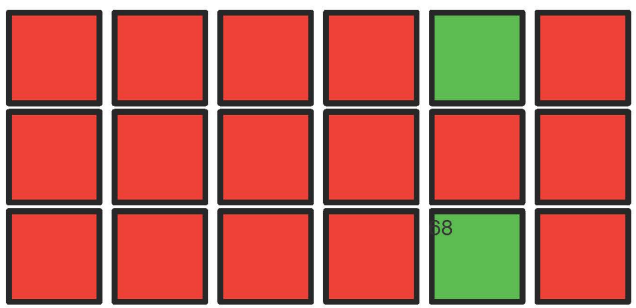

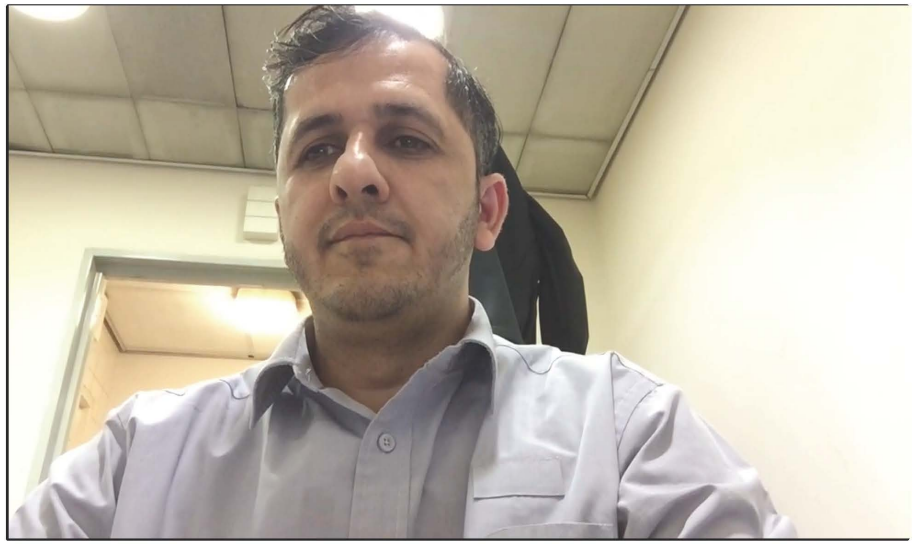

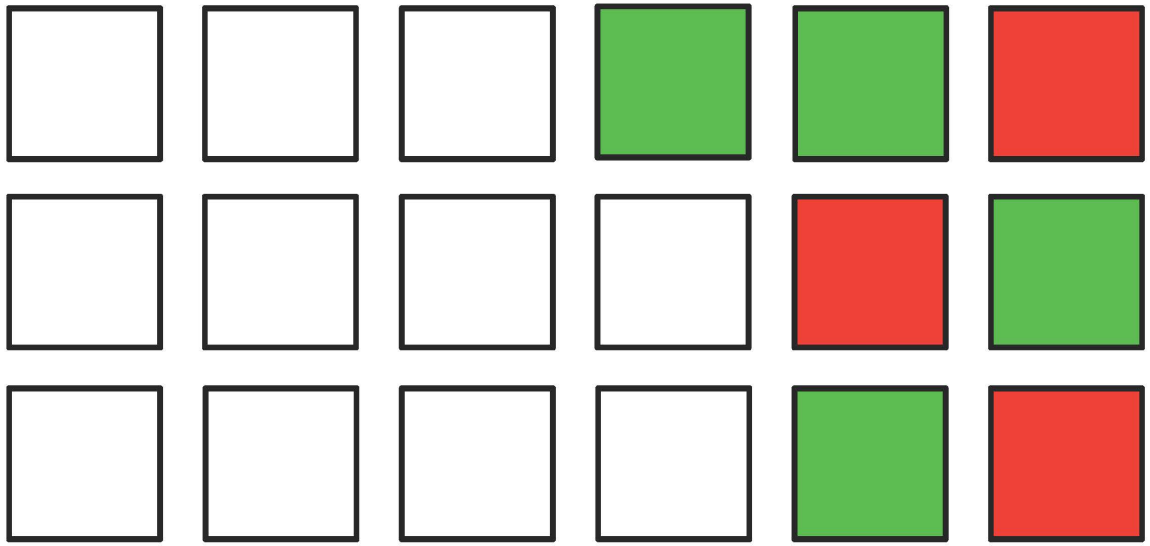

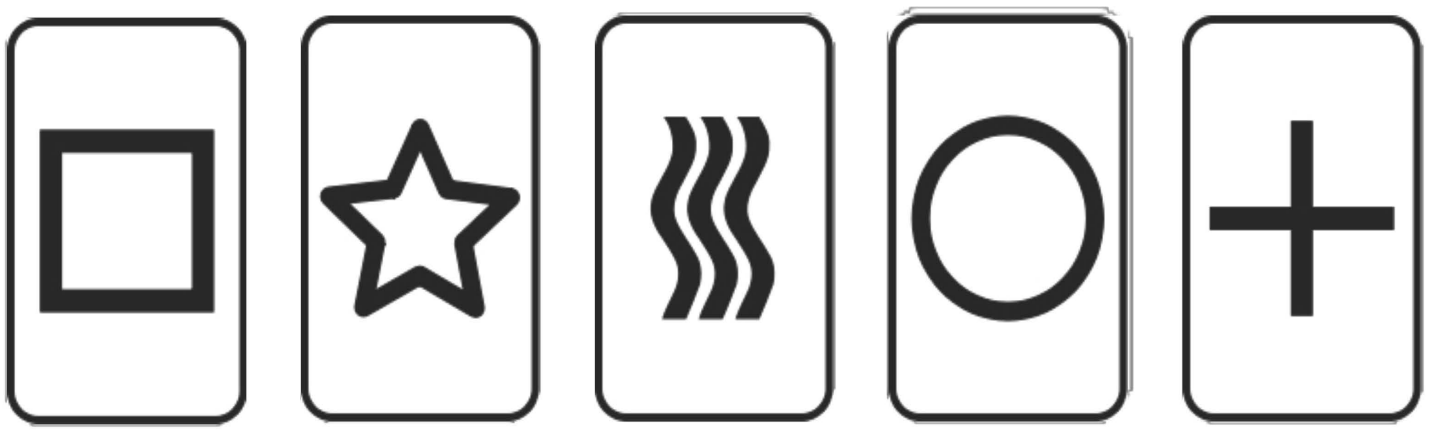

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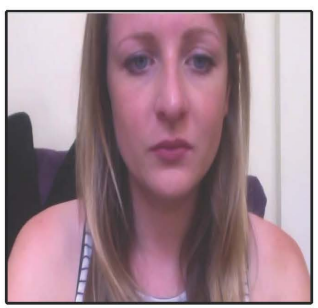

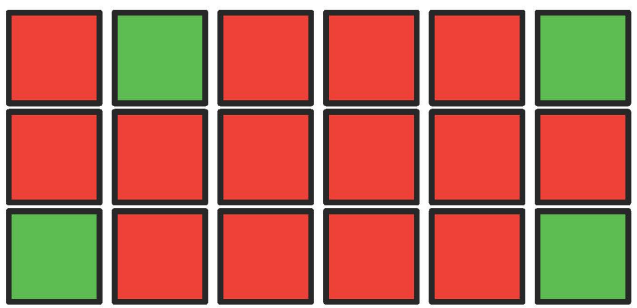

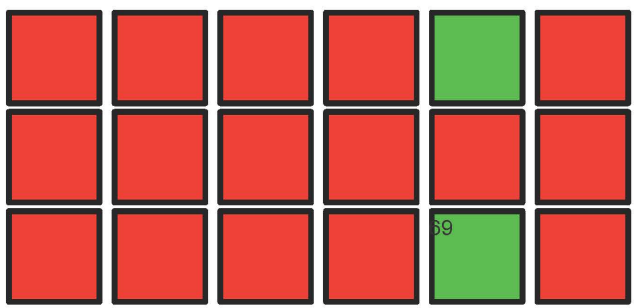

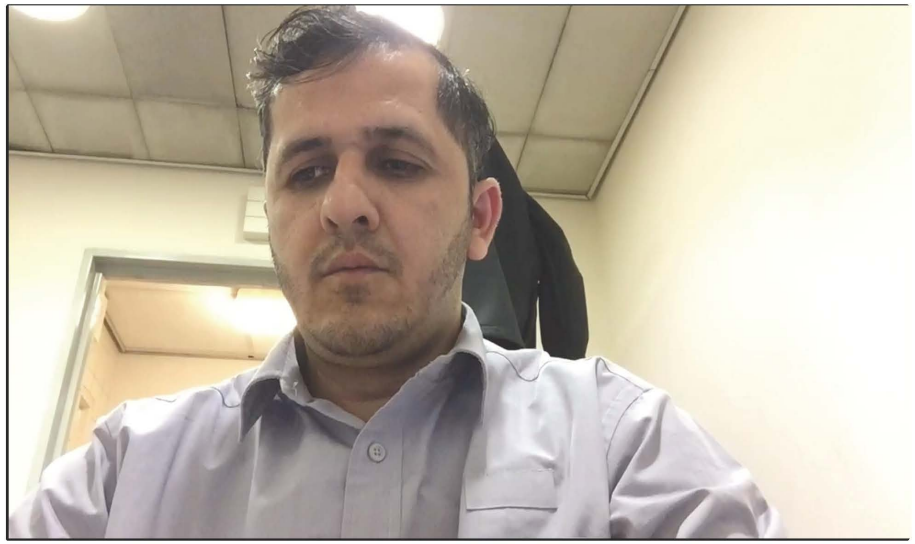

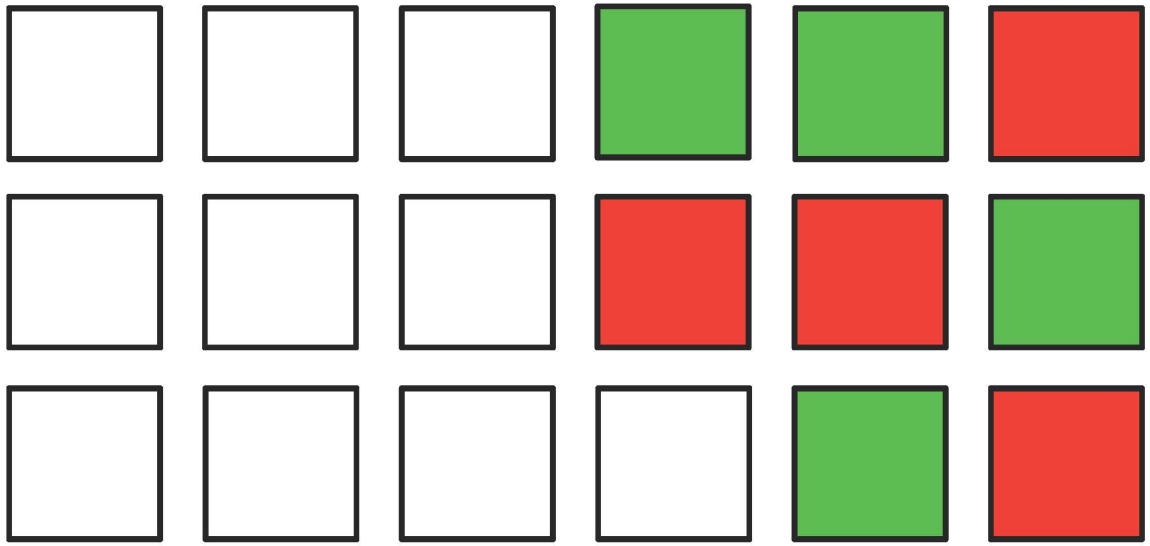

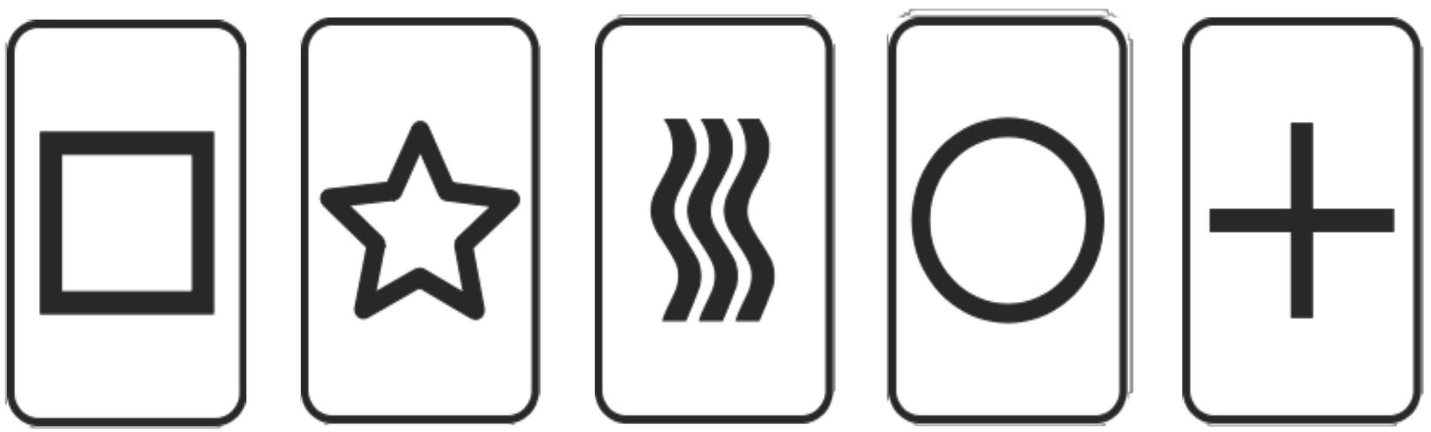

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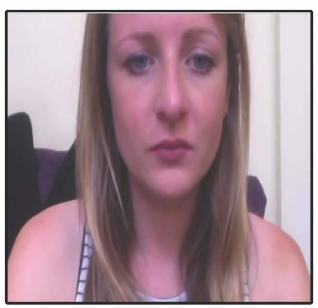

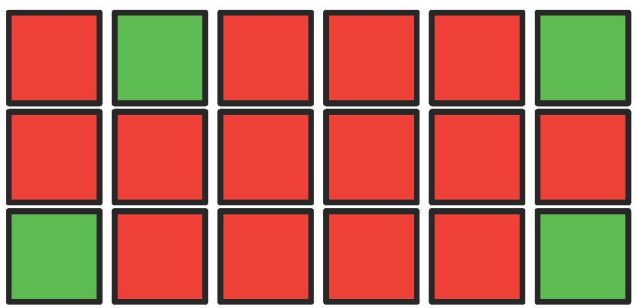

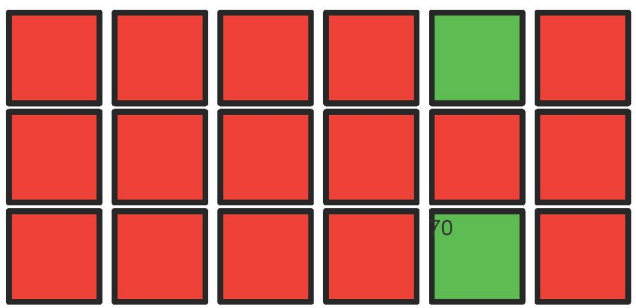

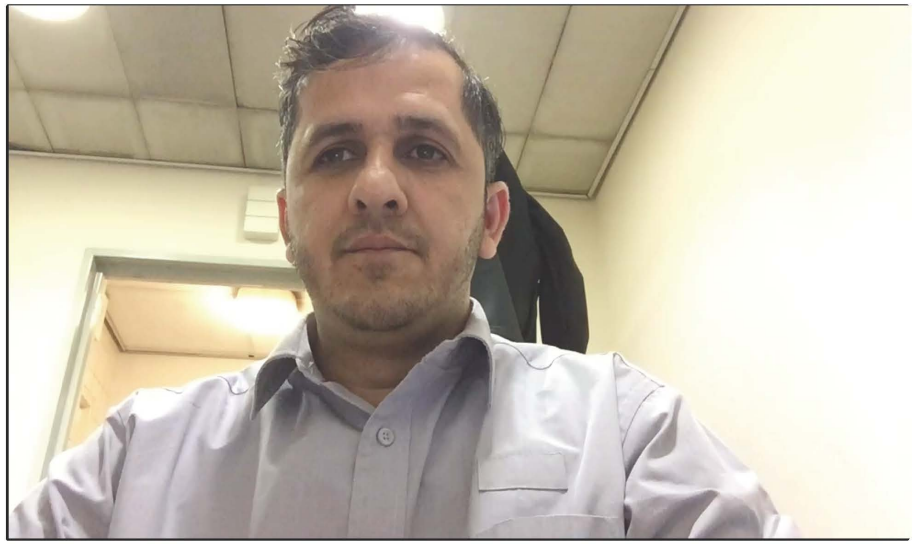

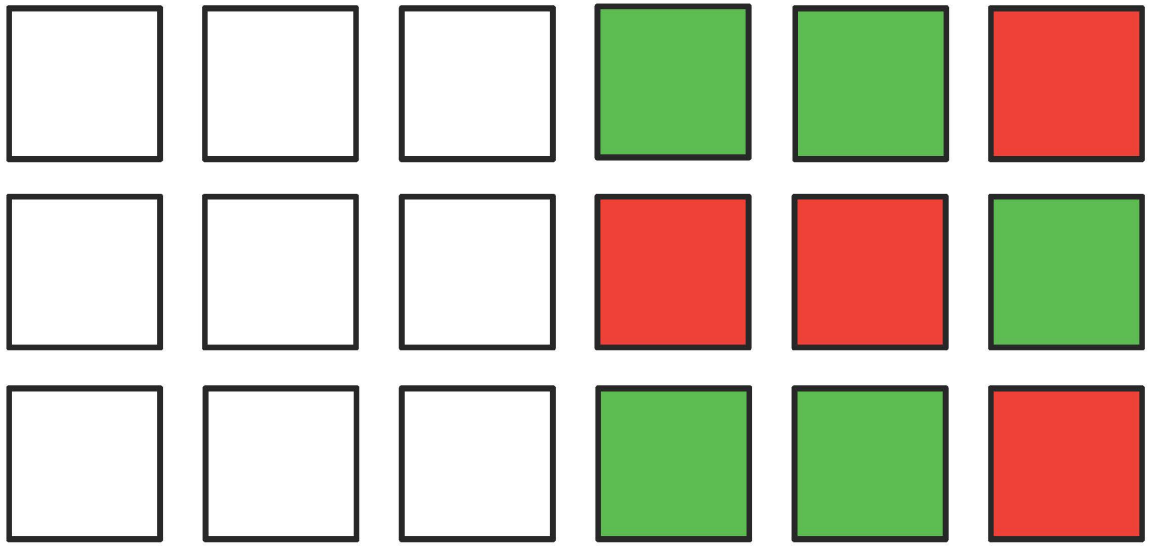

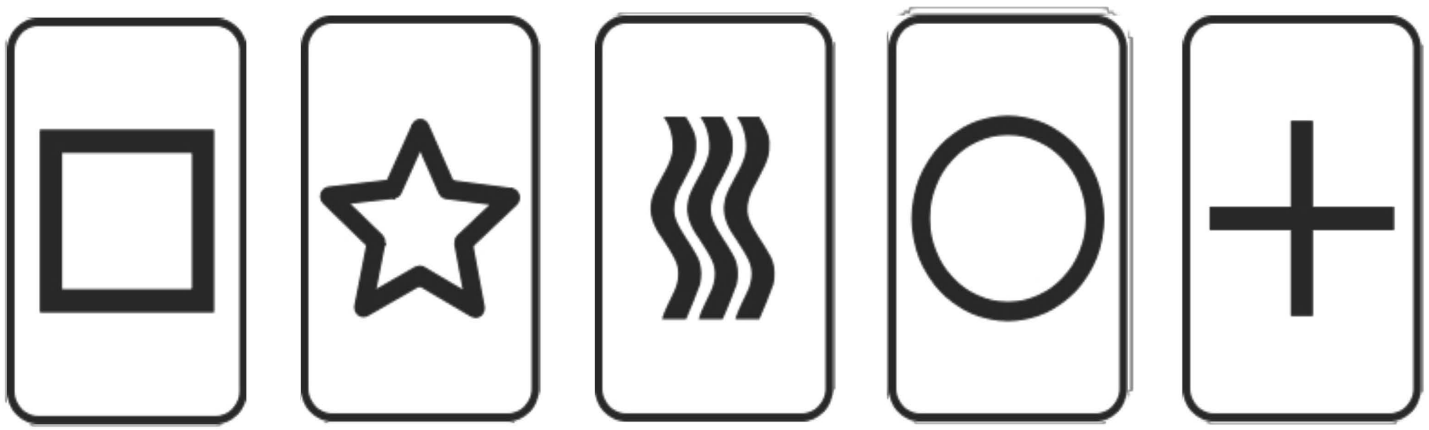

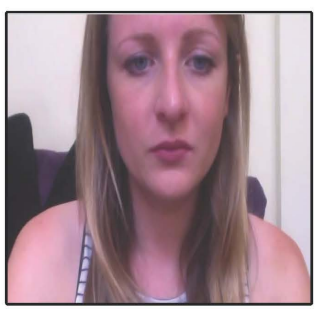

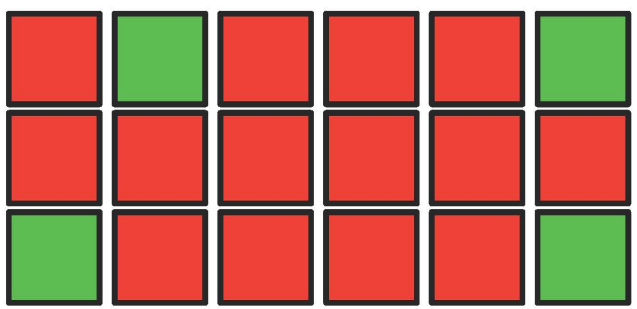

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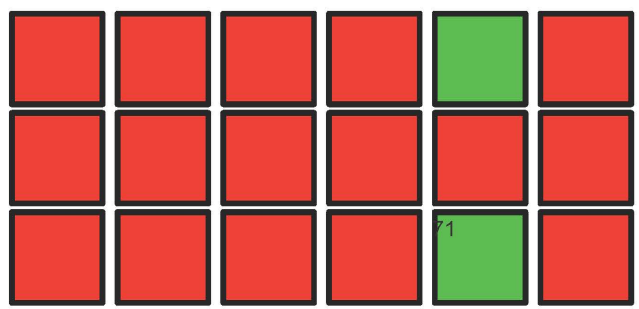

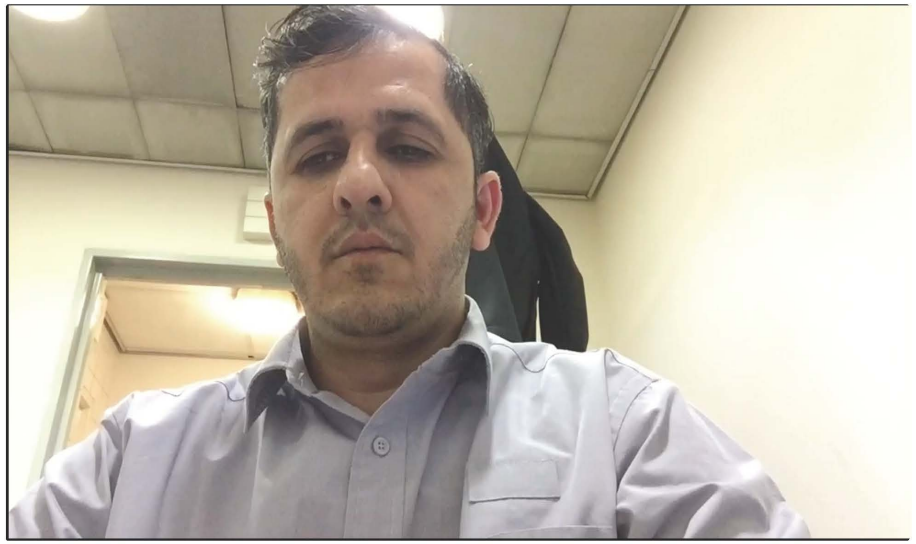

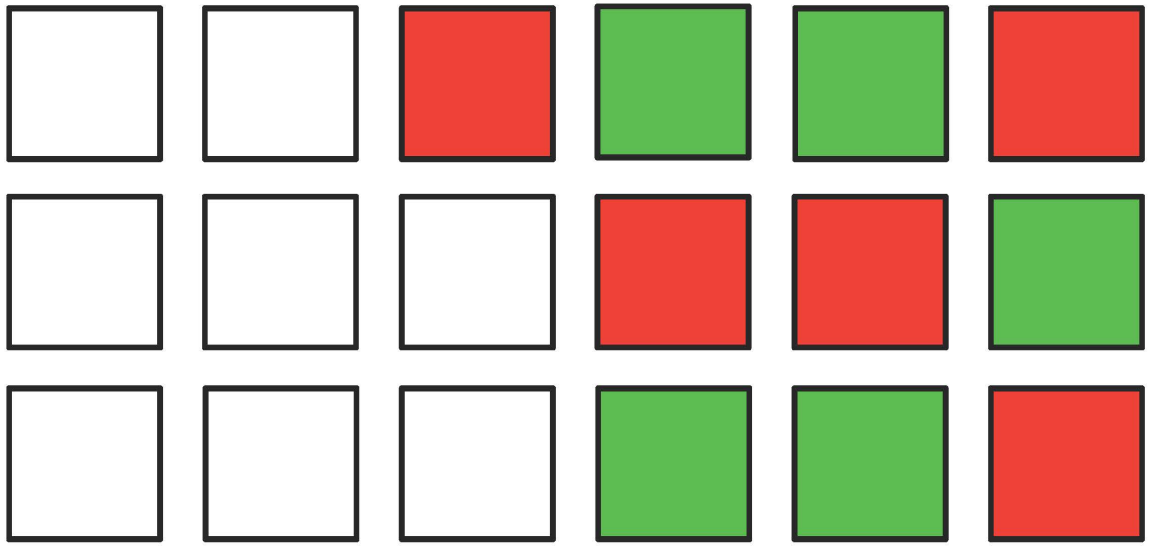

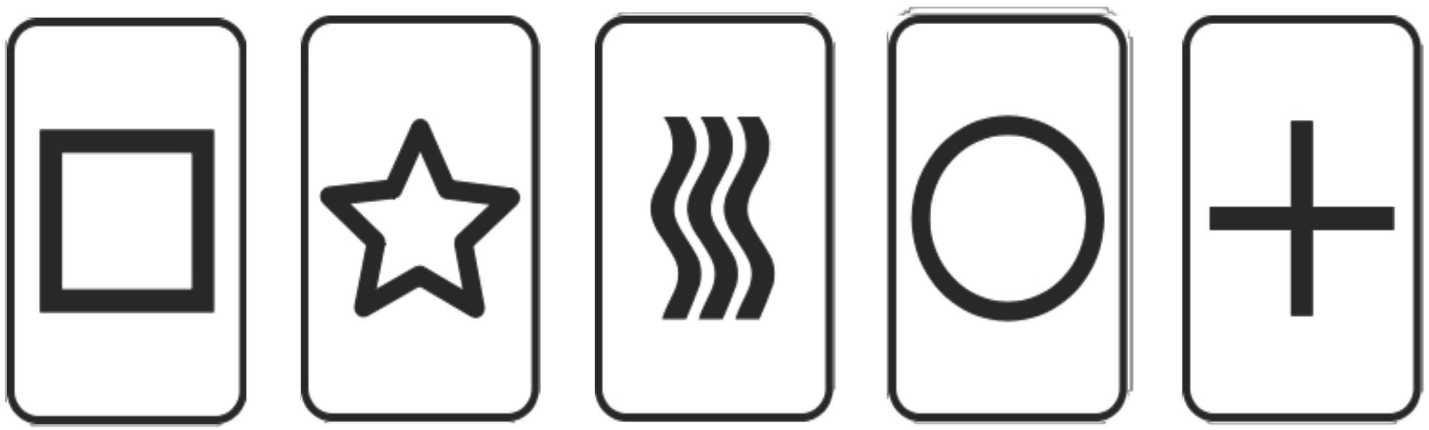

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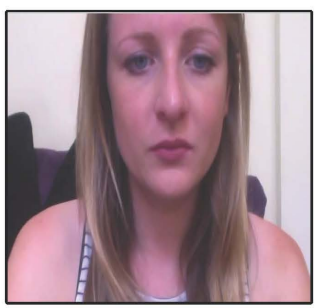

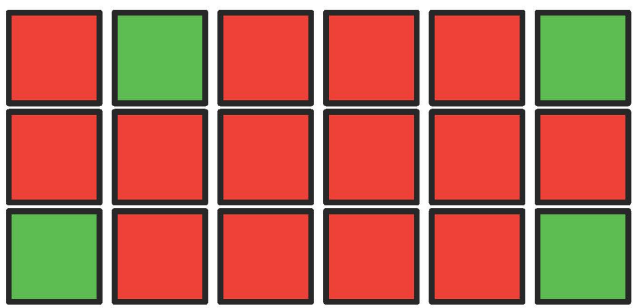

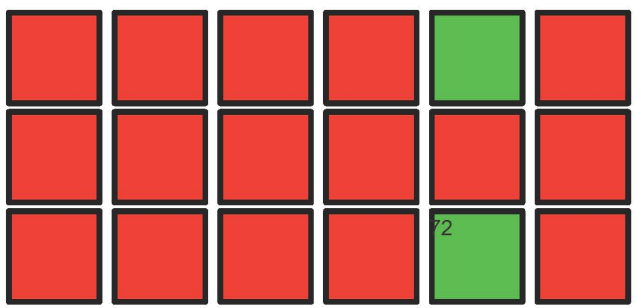

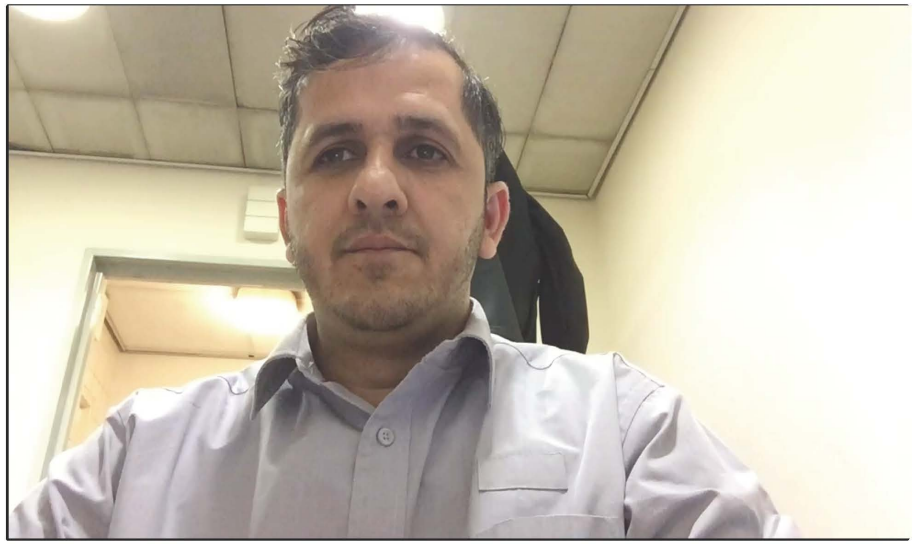

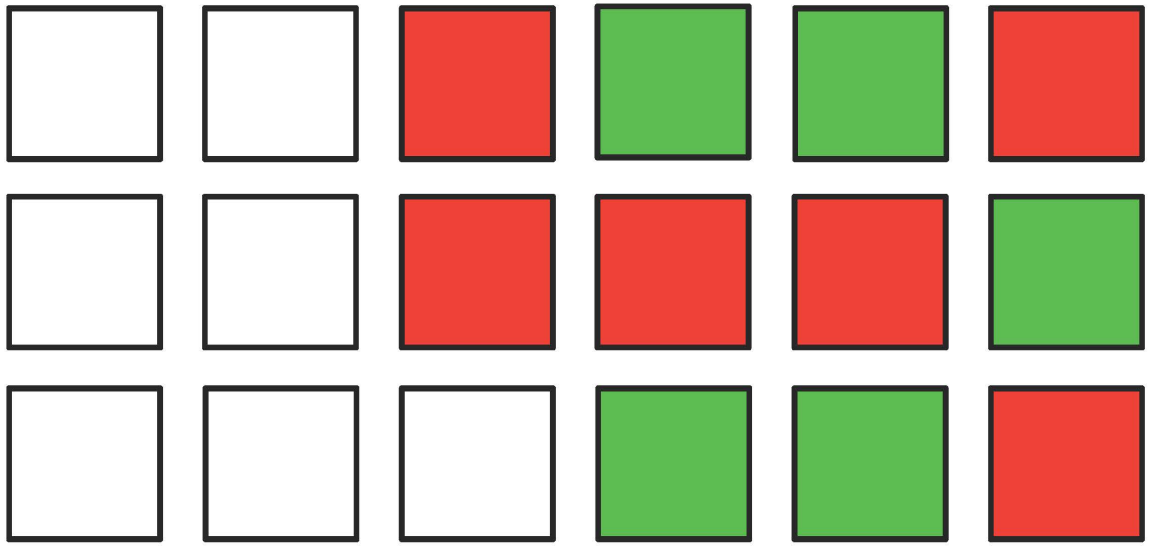

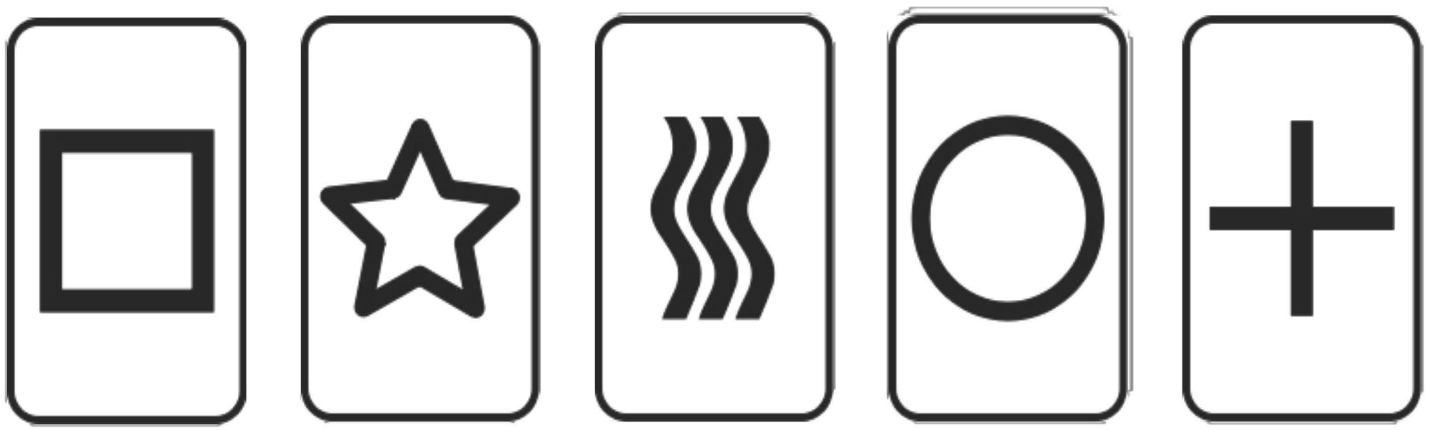

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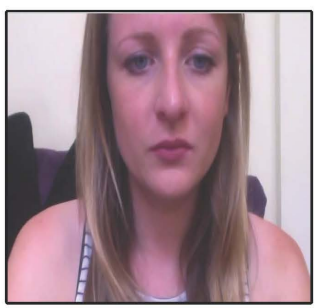

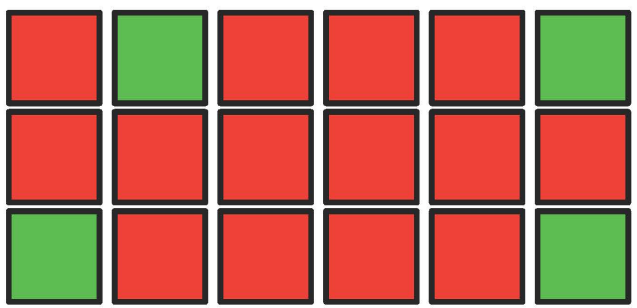

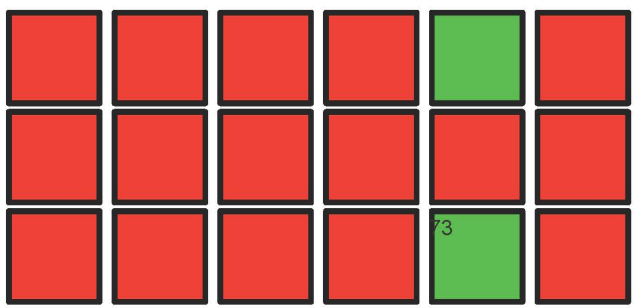

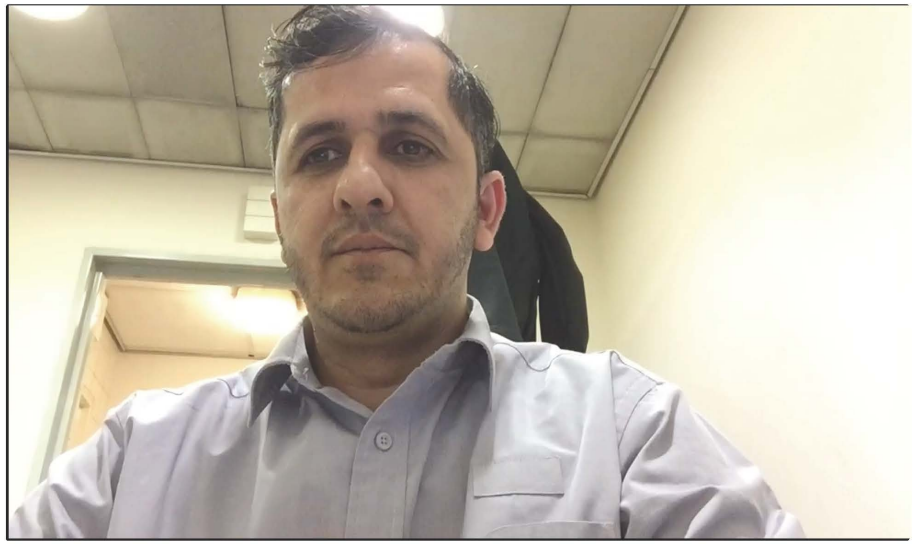

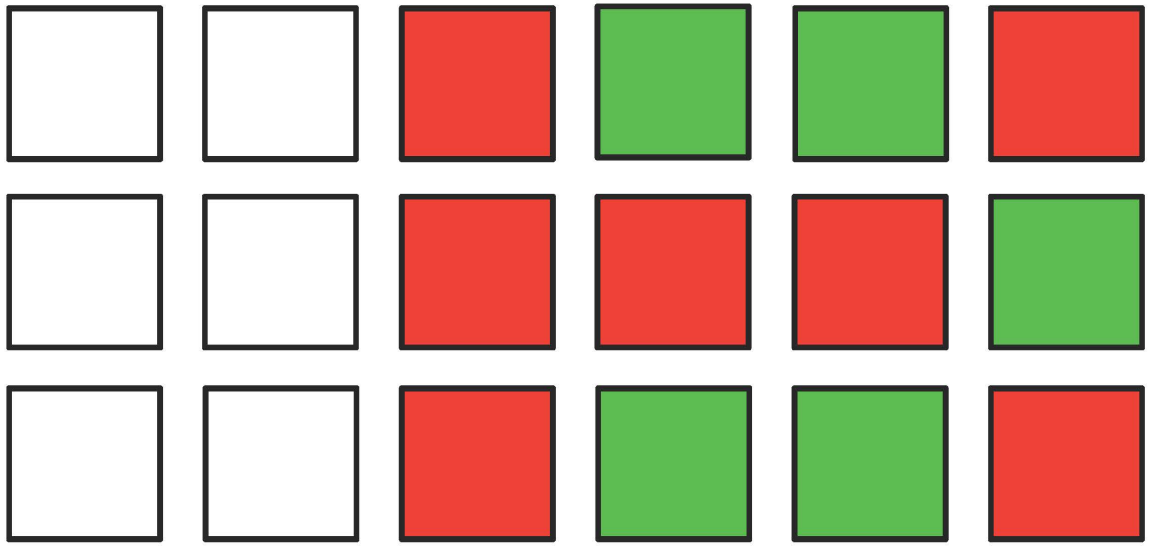

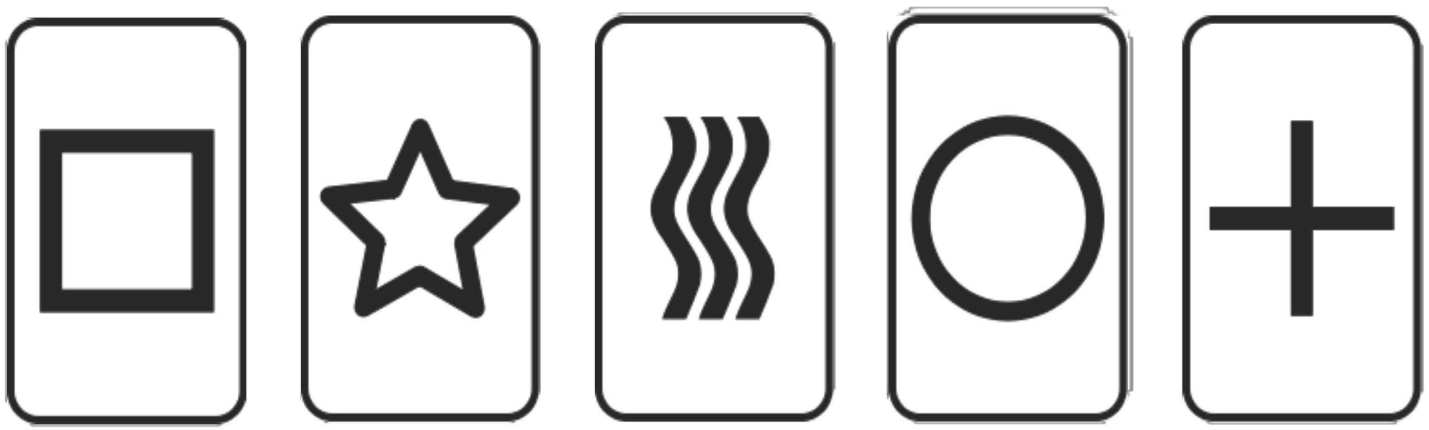

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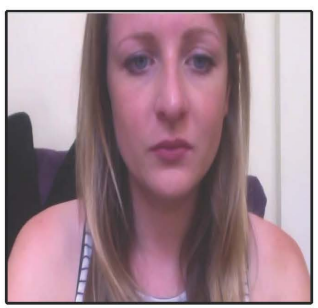

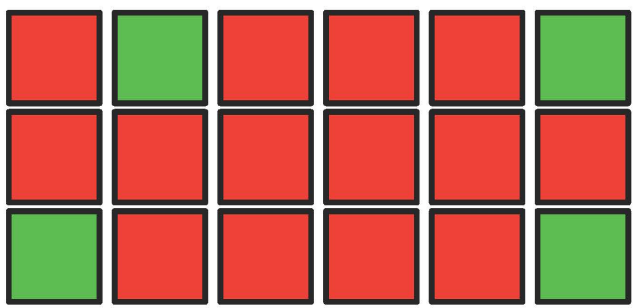

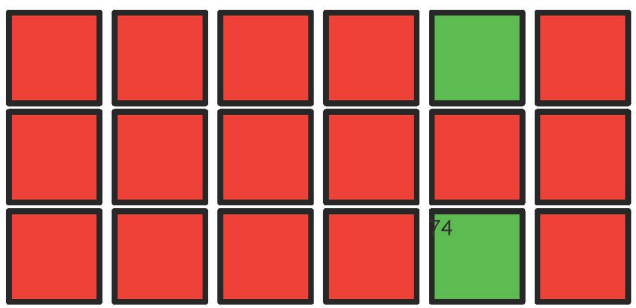

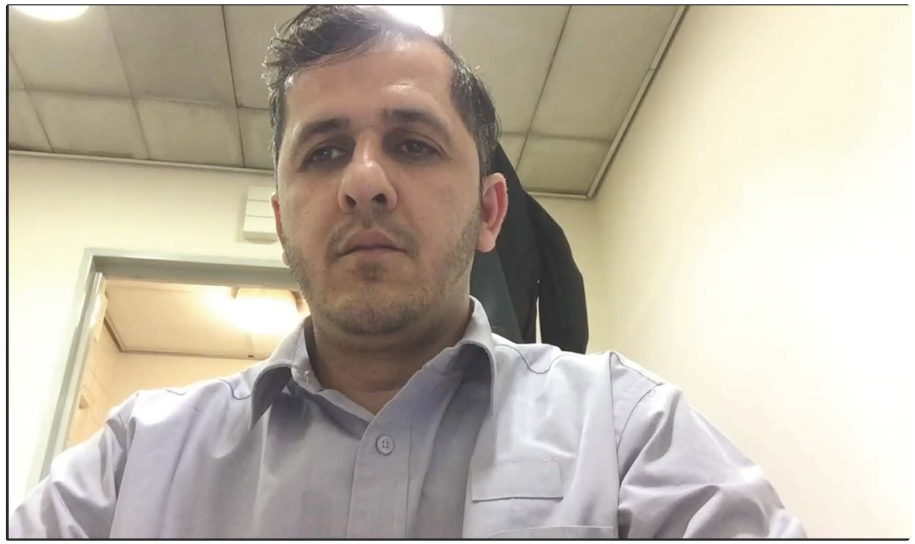

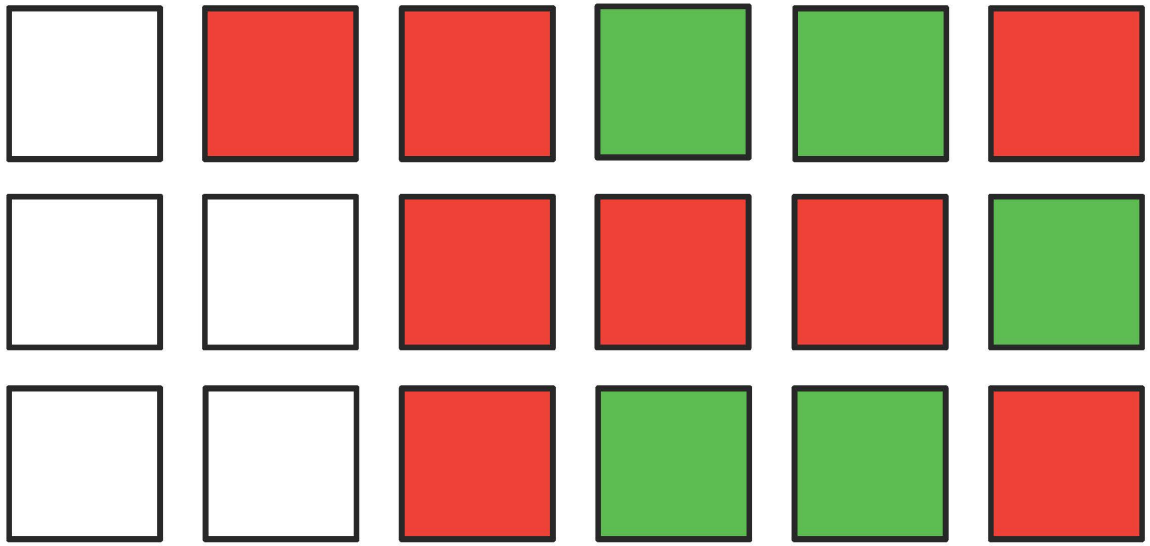

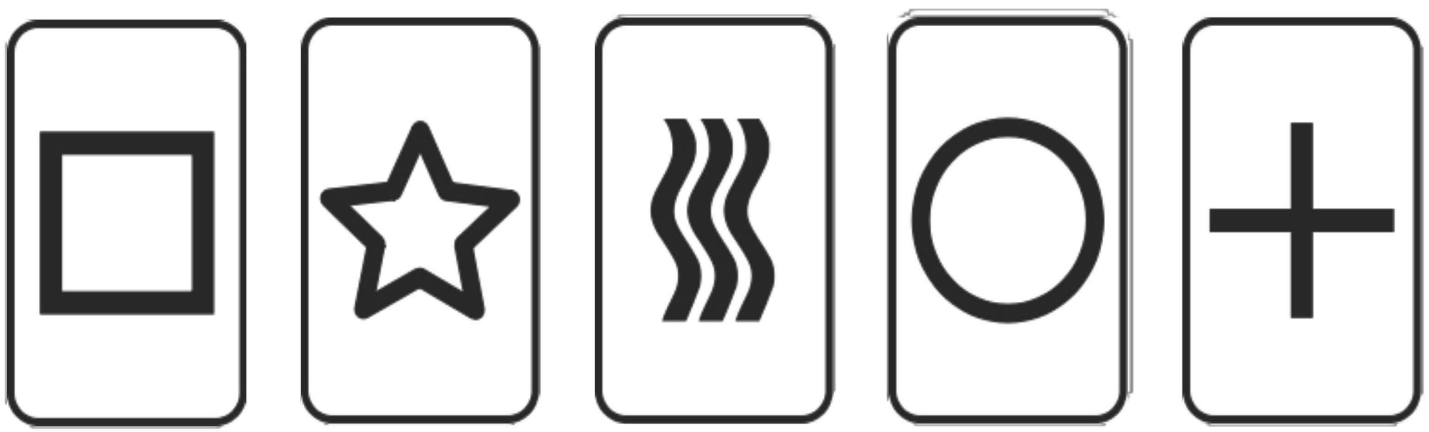

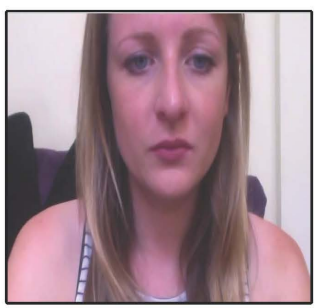

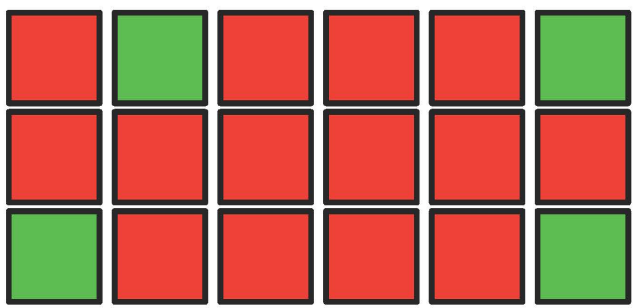

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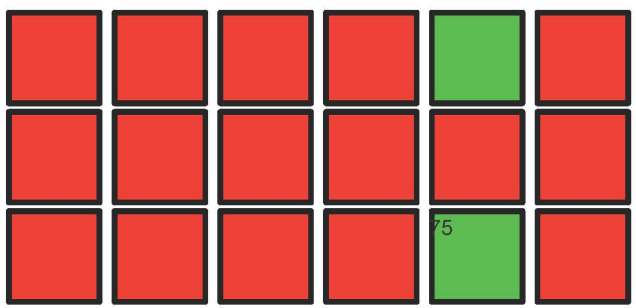

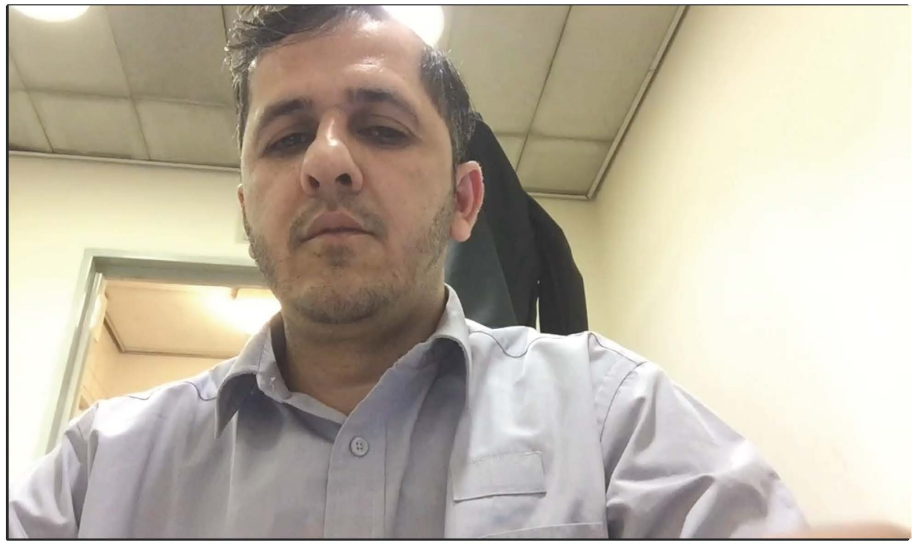

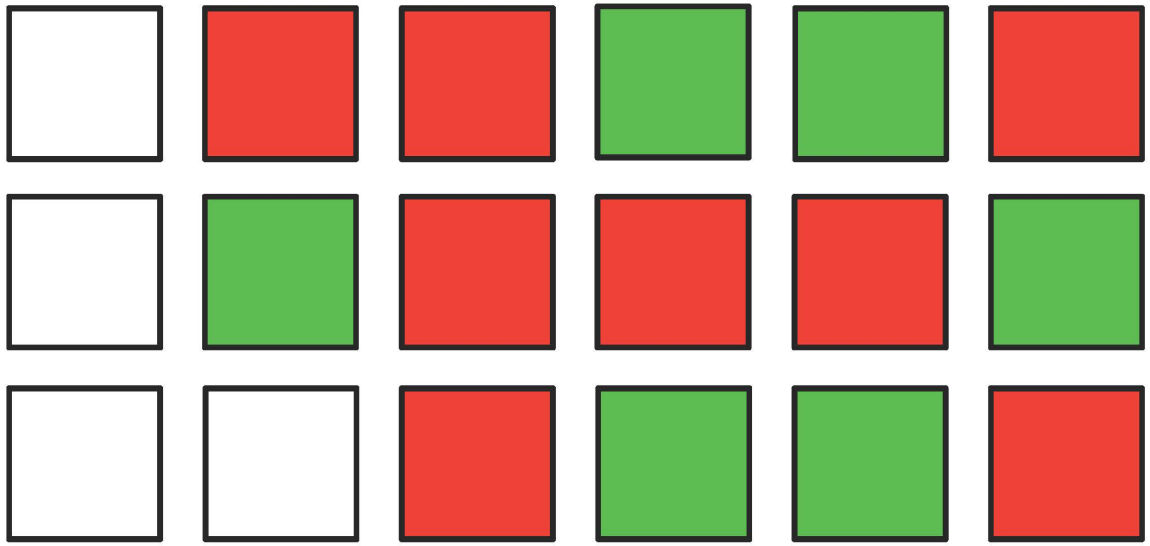

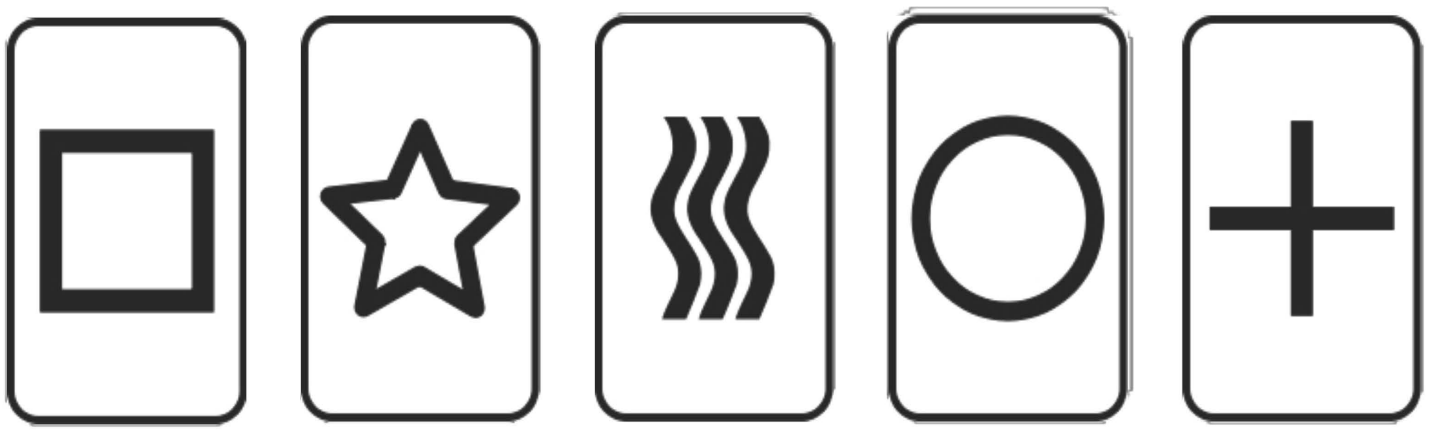

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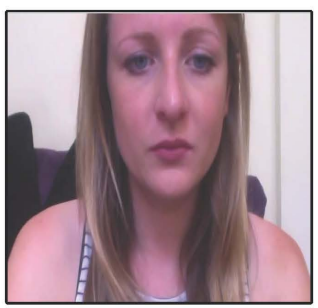

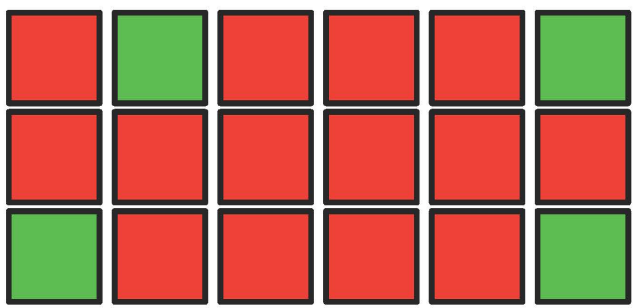

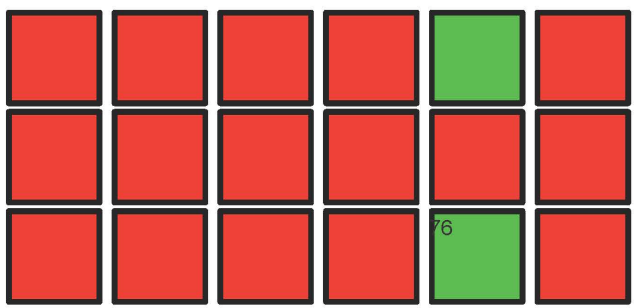

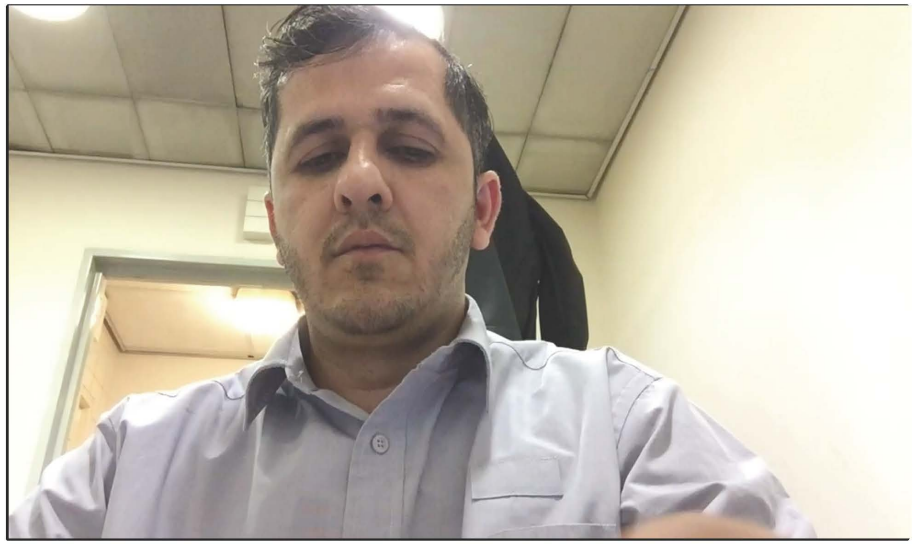

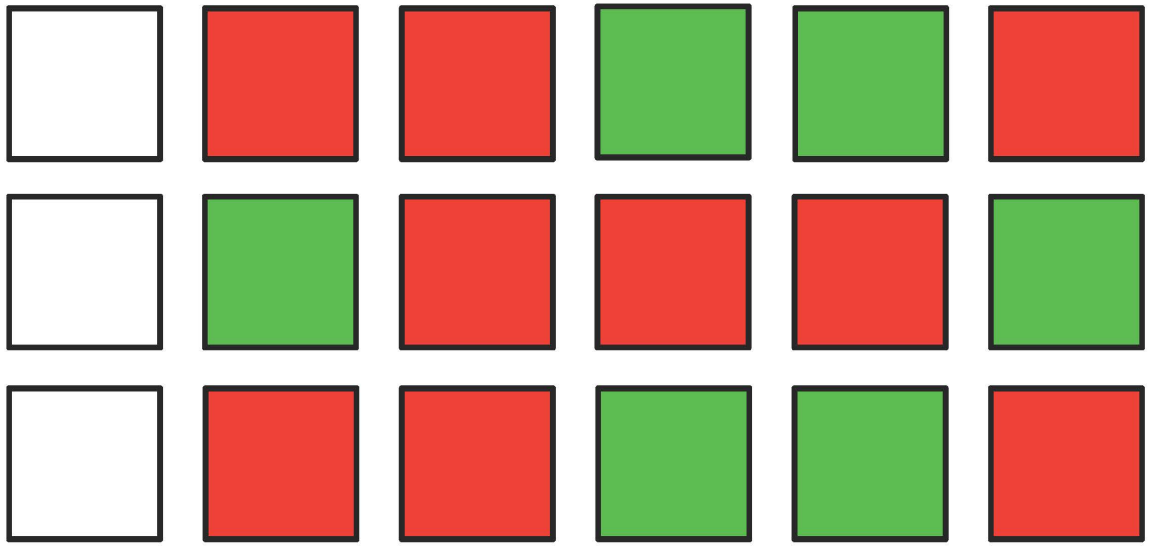

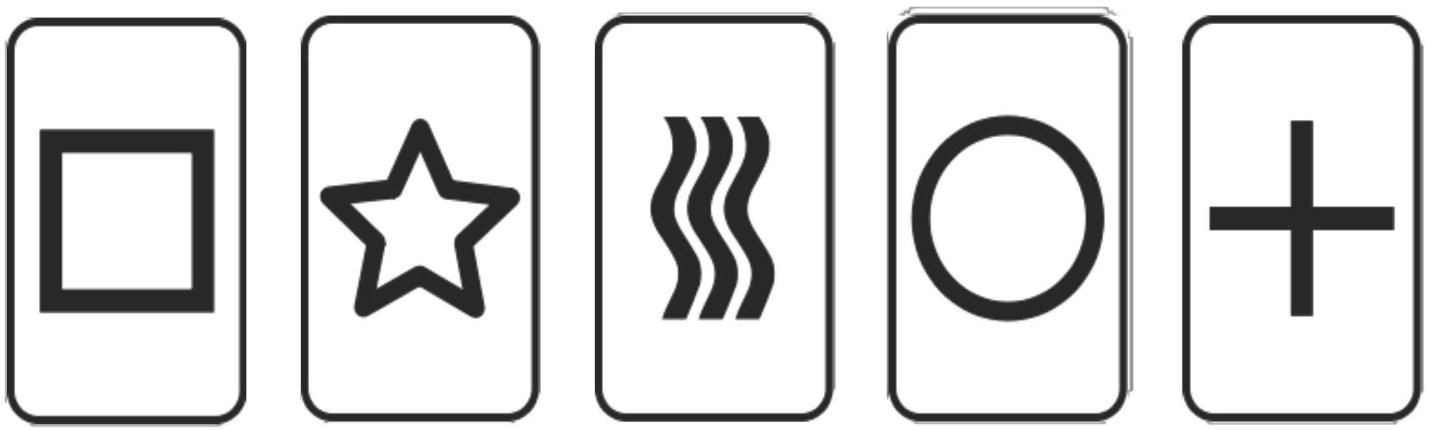

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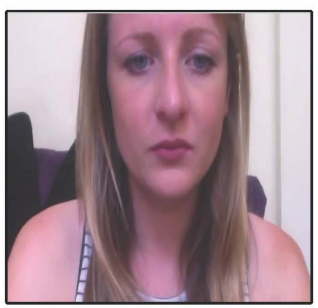

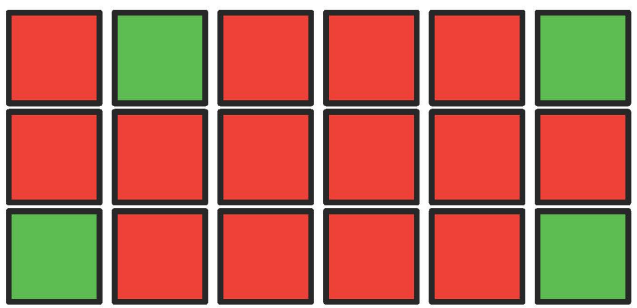

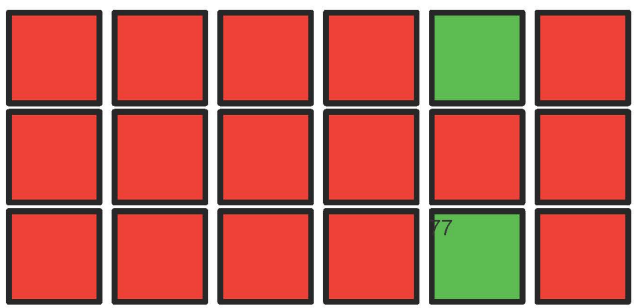

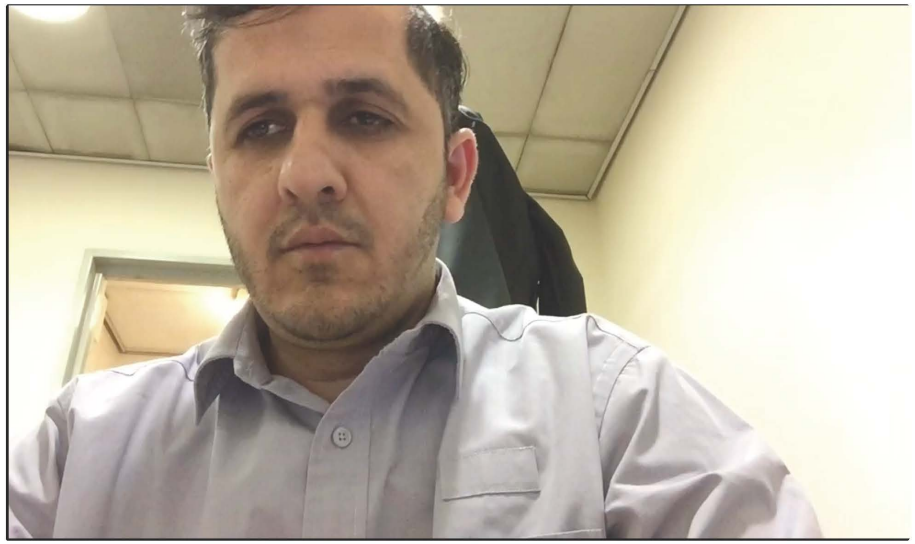

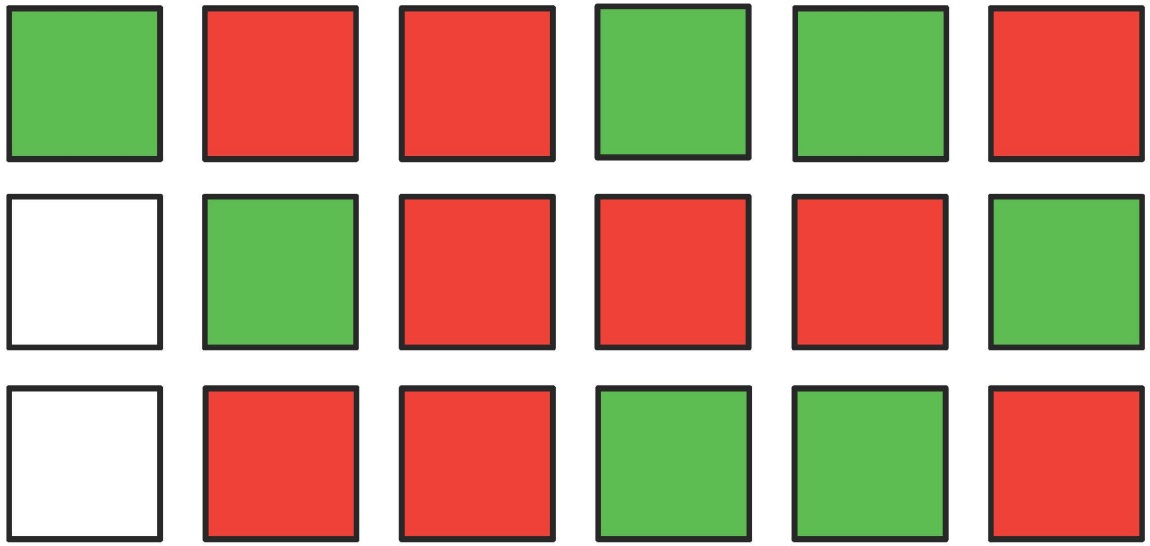

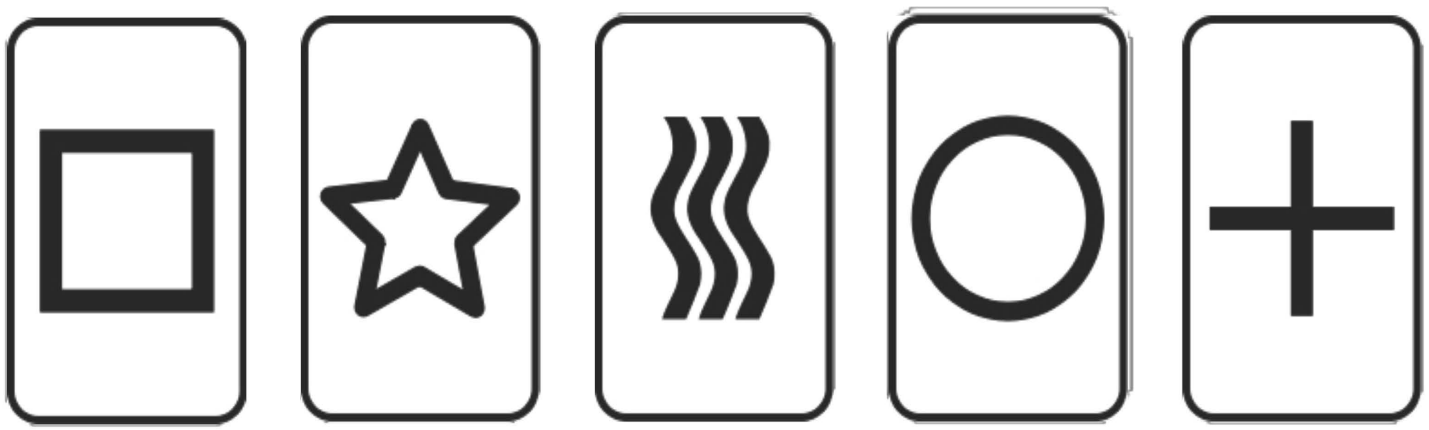

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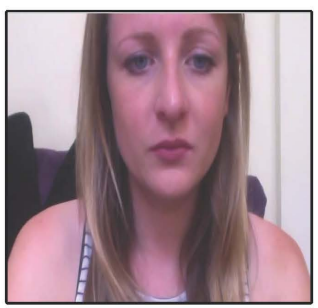

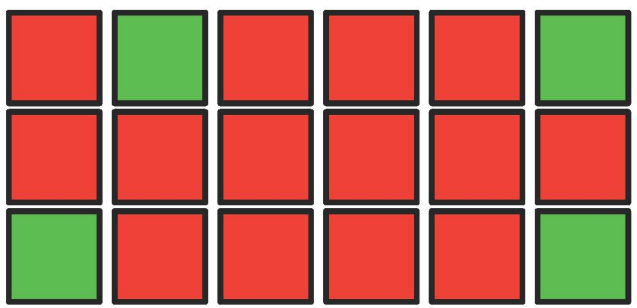

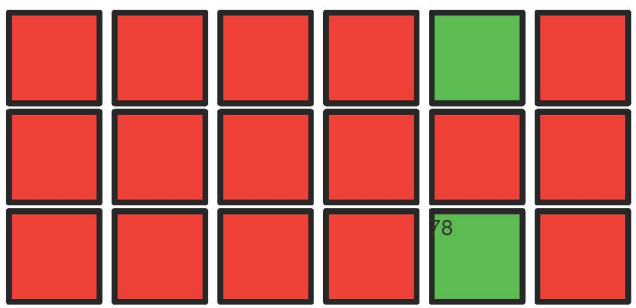

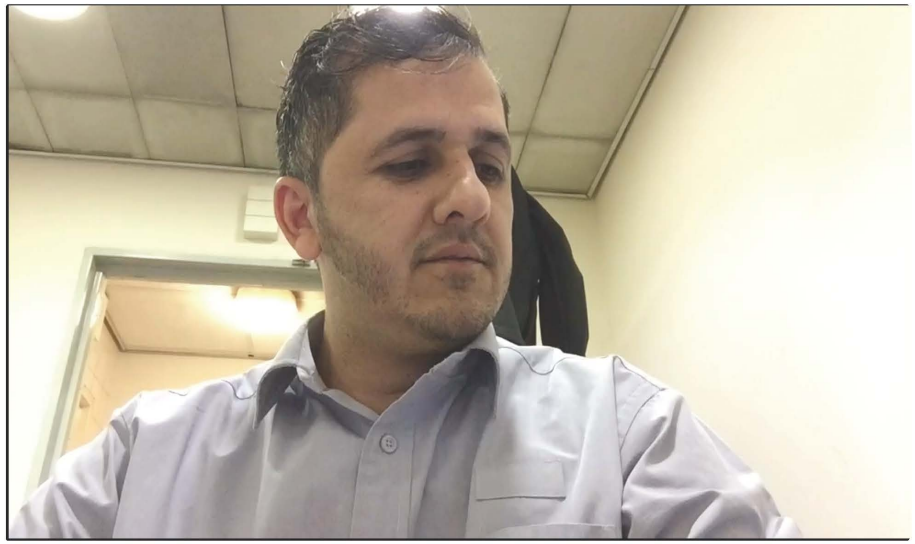

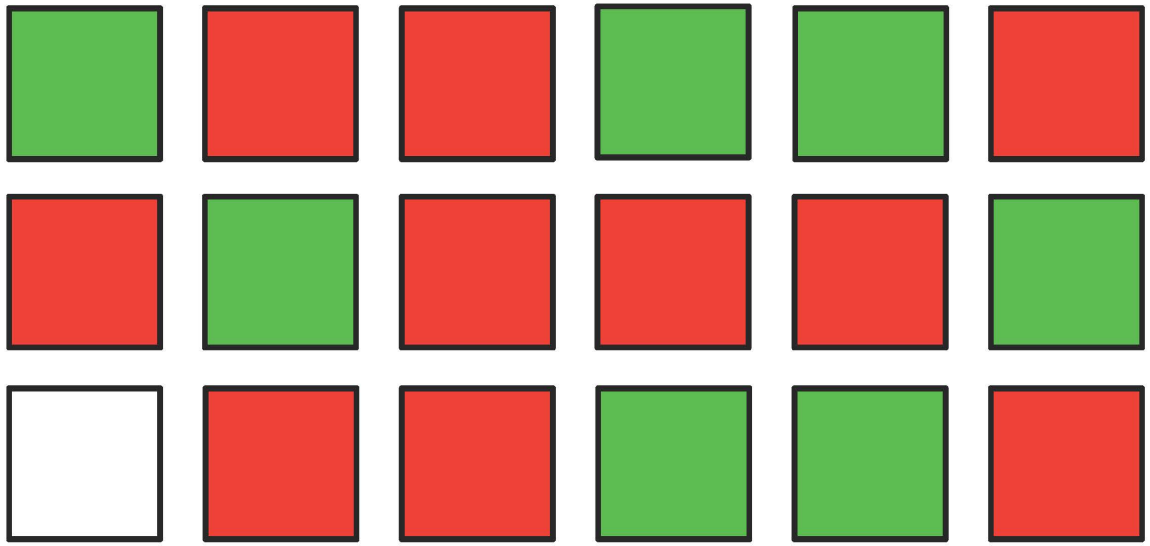

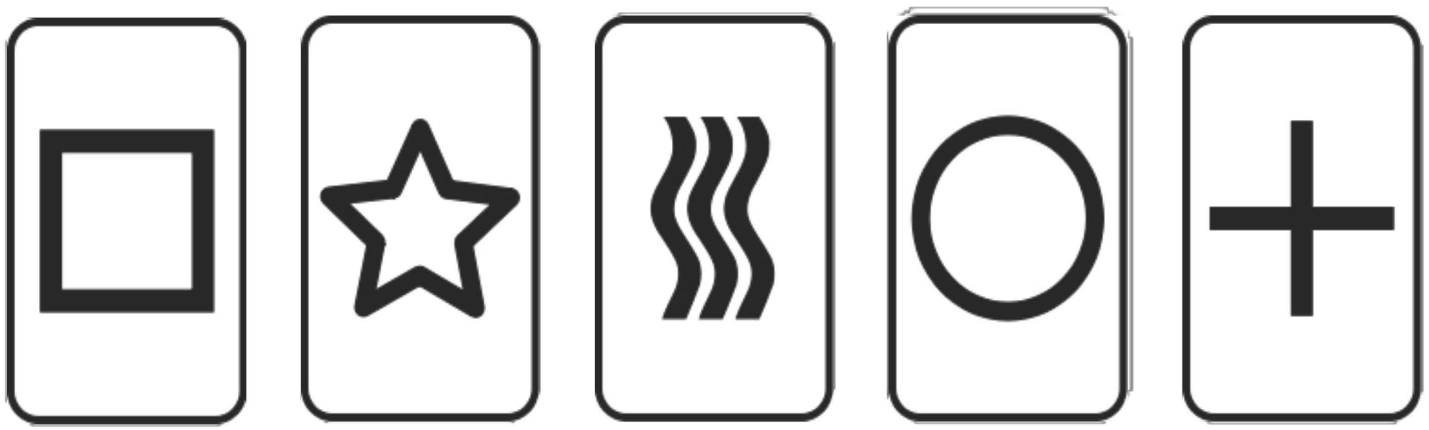

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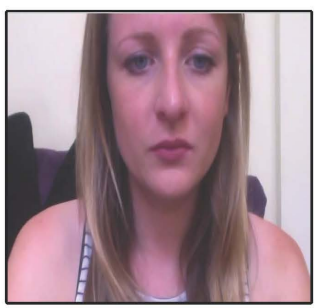

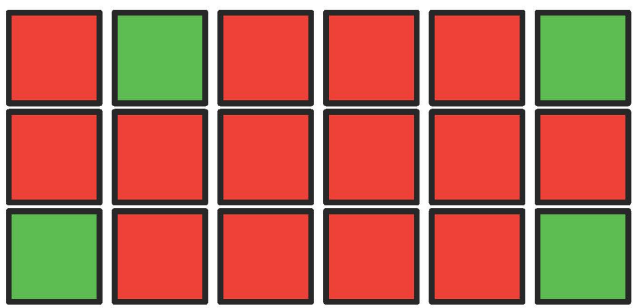

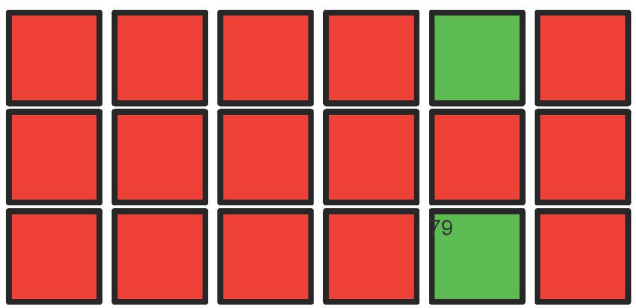

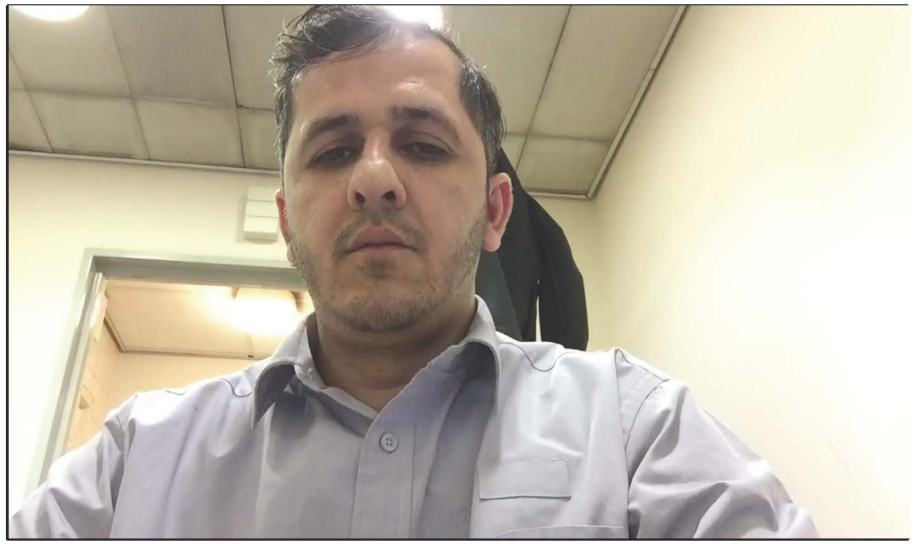

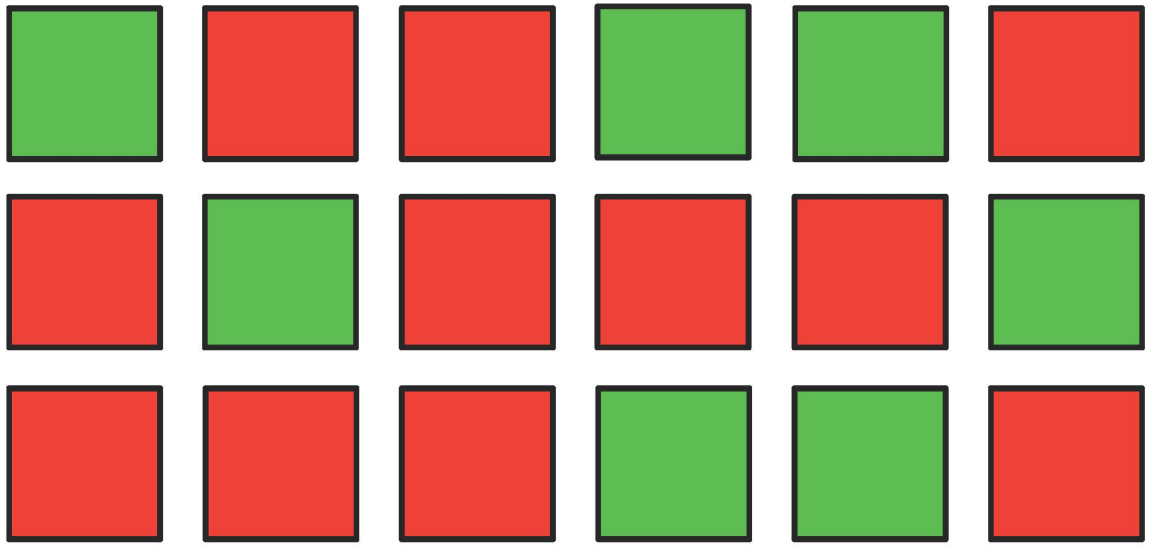

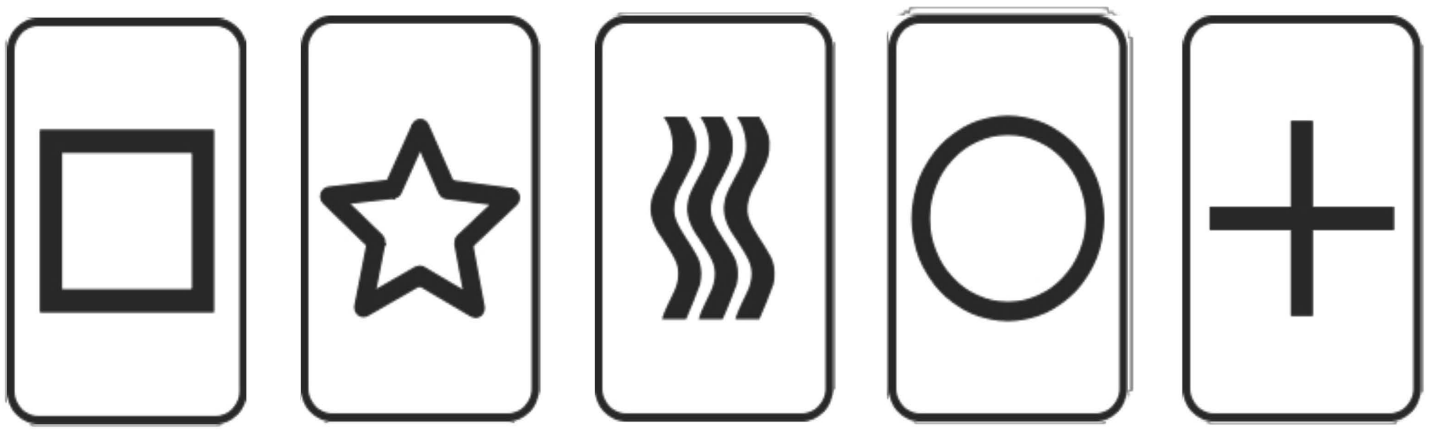

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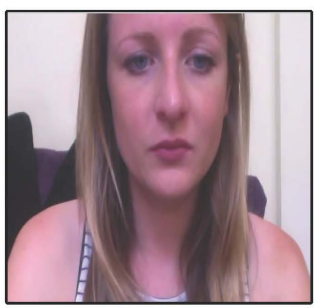
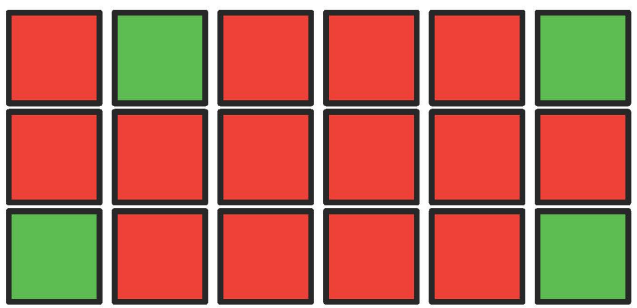
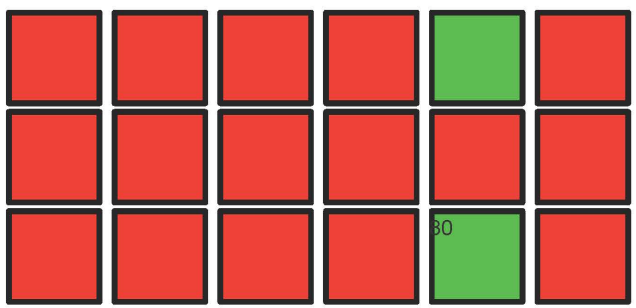
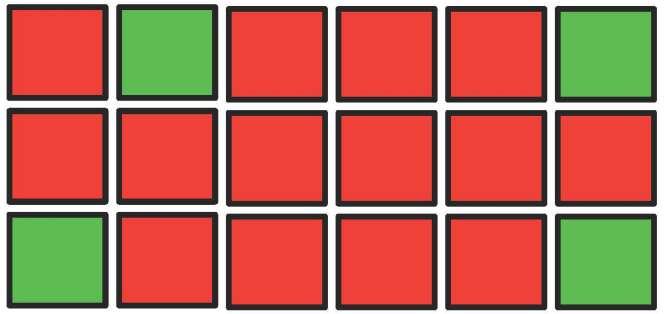


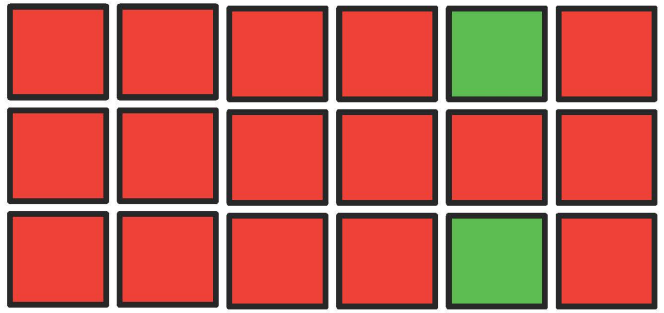


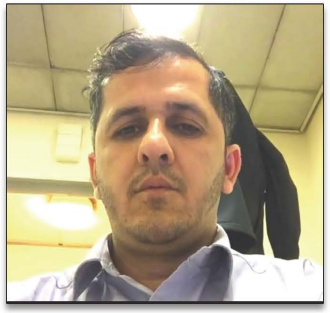


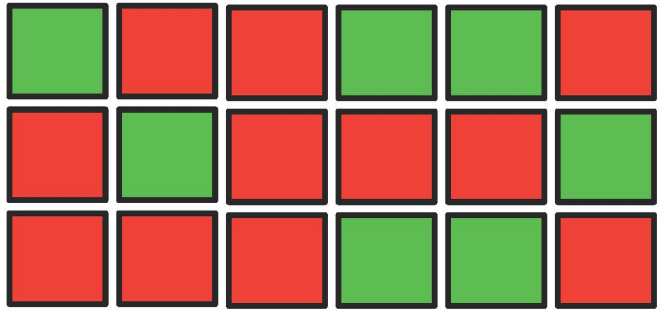
The next screen will display all of the players results.

Continue







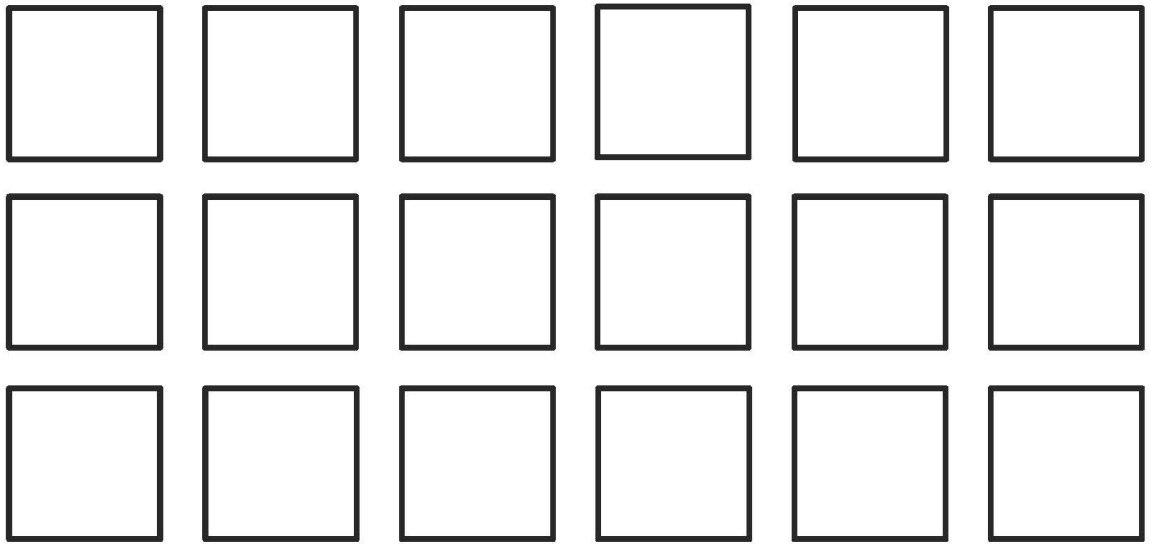


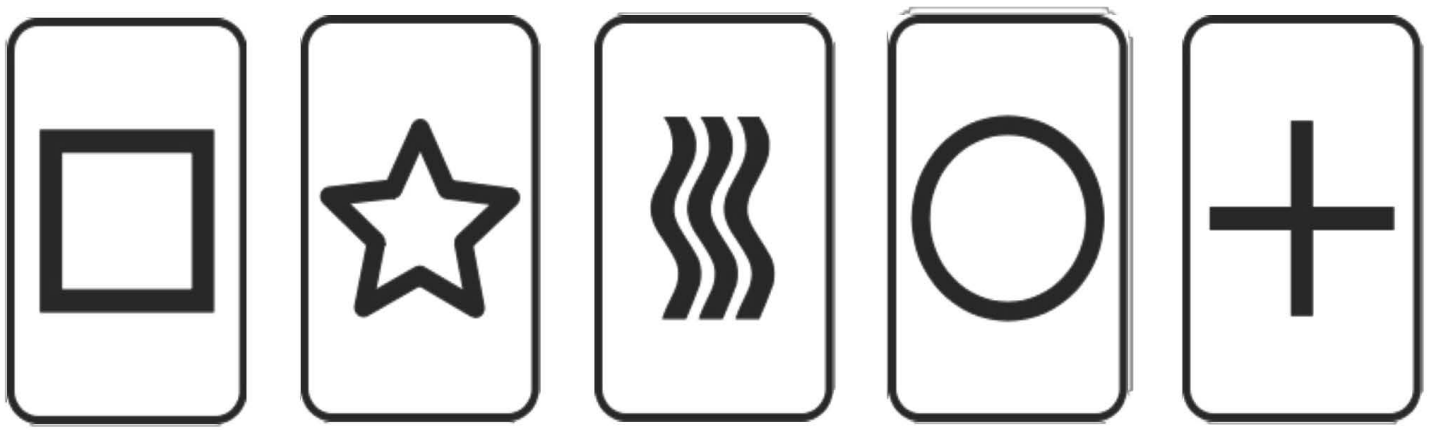
Please complete the questionnaire labeled *01.

Take time to consider your answers and press continue when you have finished.

Continue

Thank you.
The next player is being selected.
After a short countdown the test will begin again.





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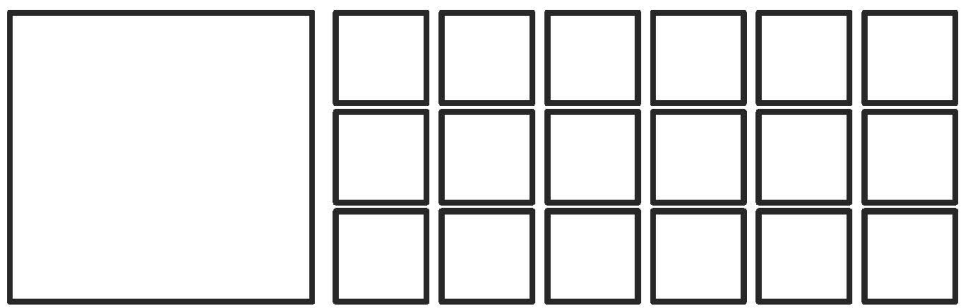
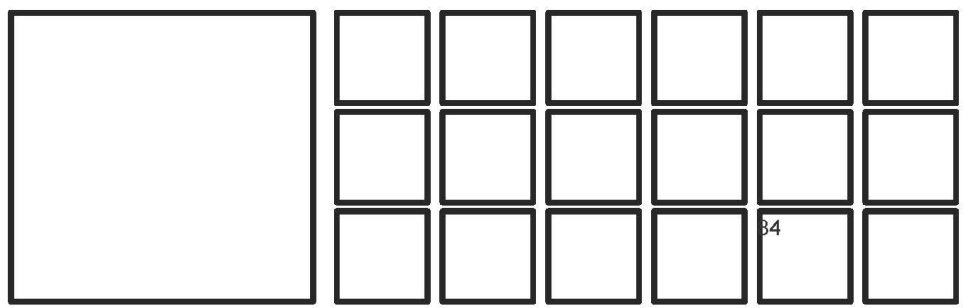
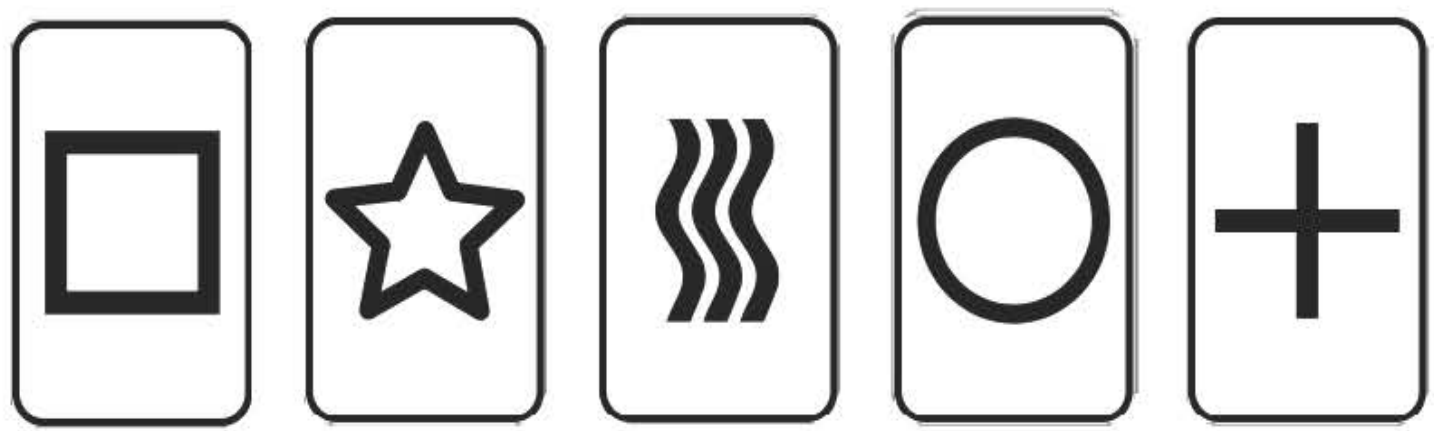




GO!



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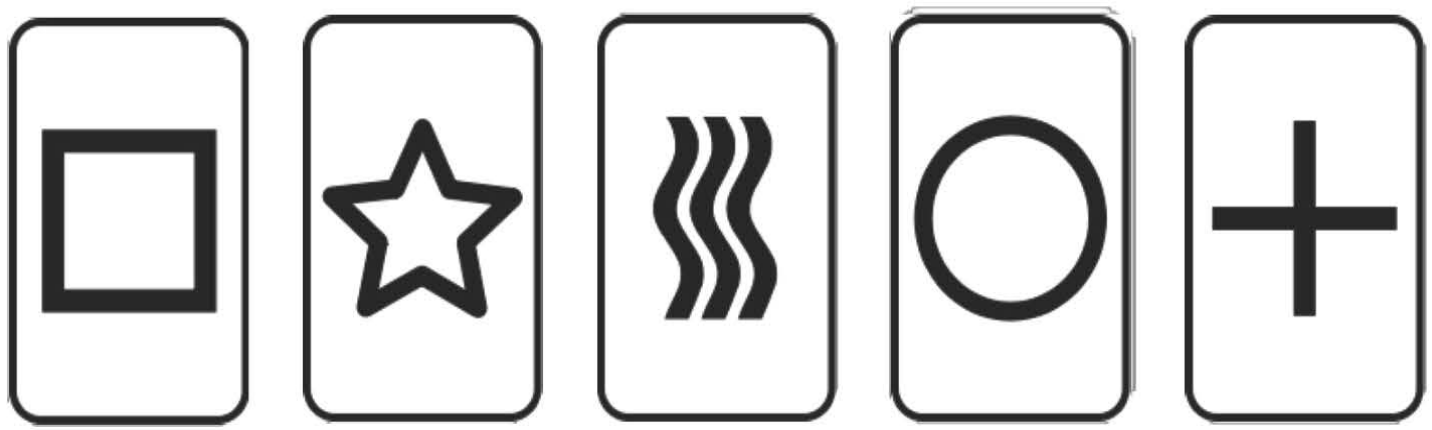

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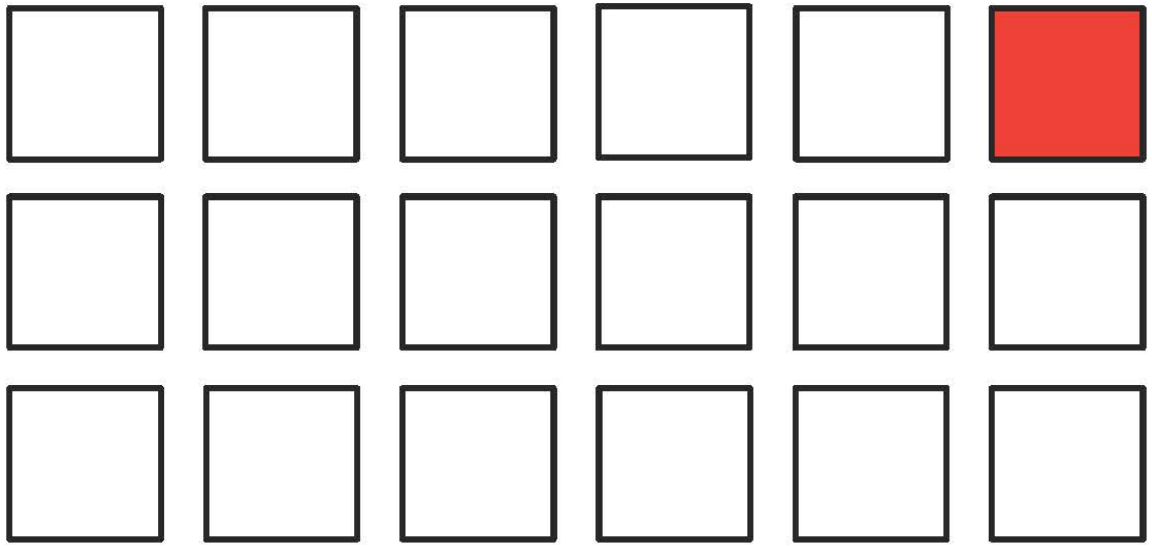

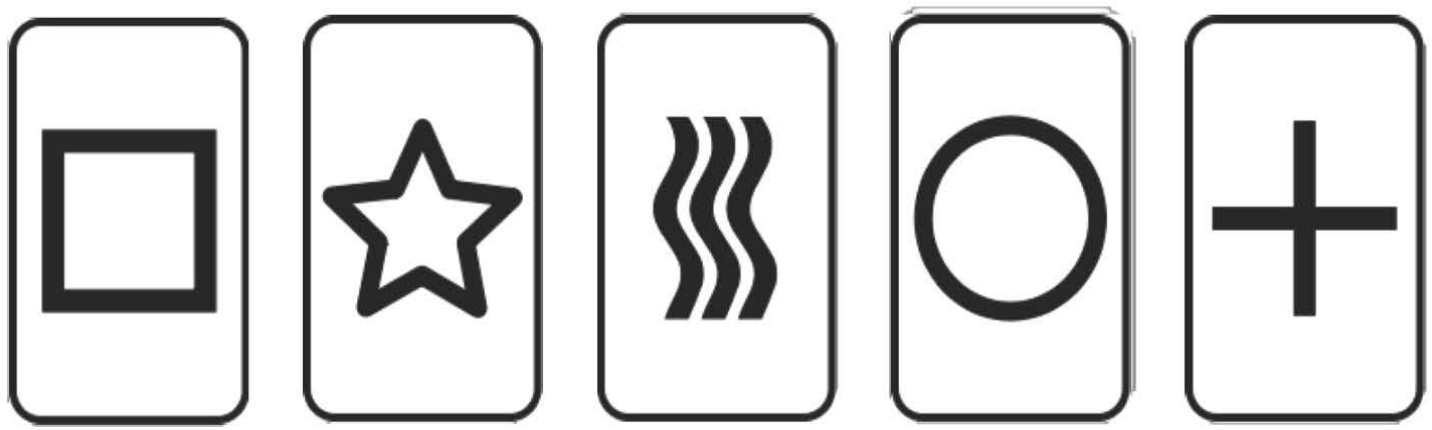

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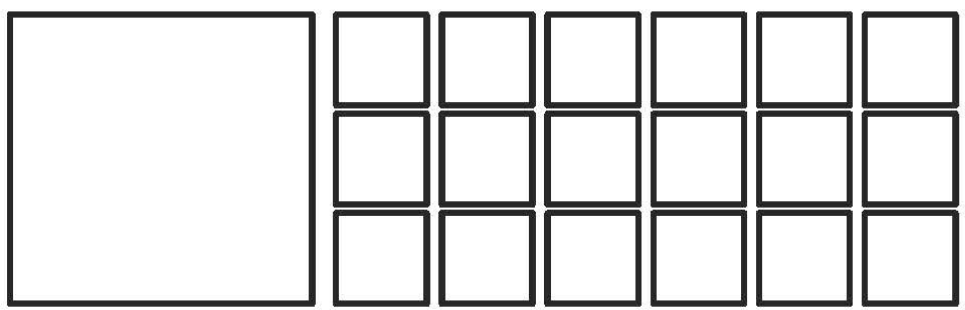

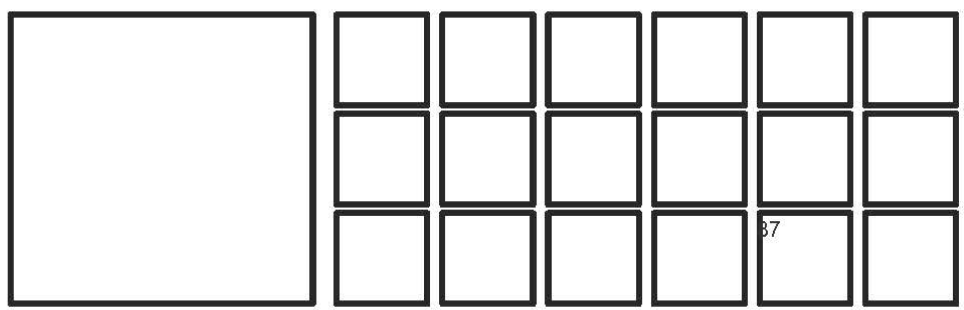

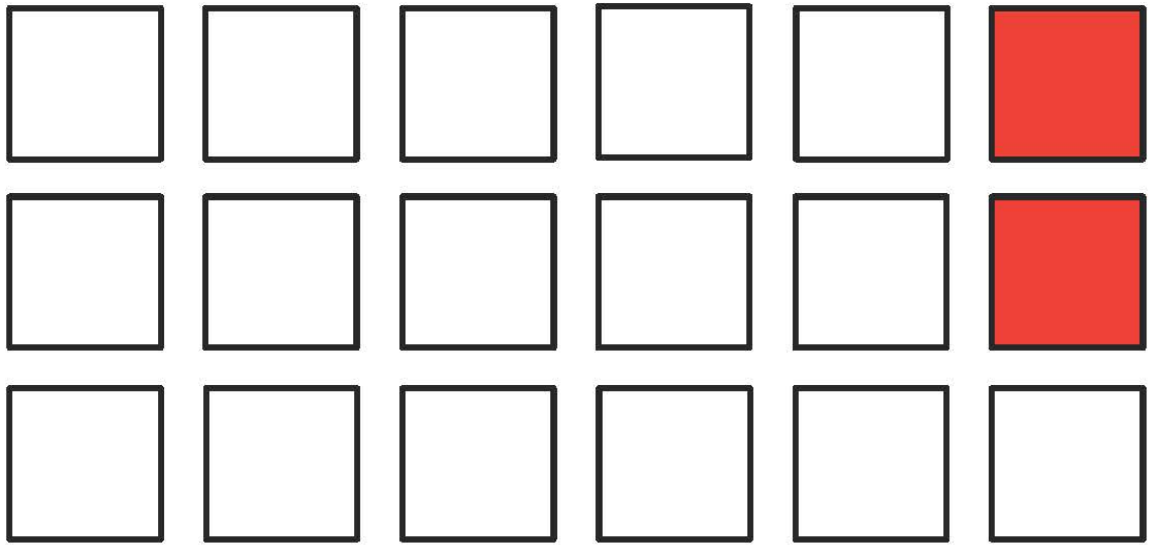

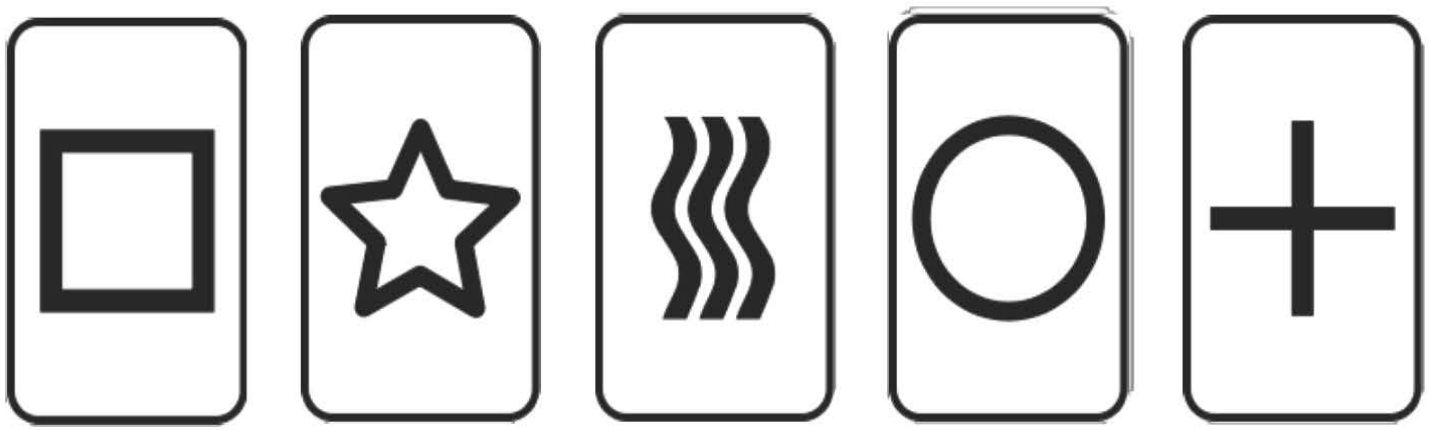

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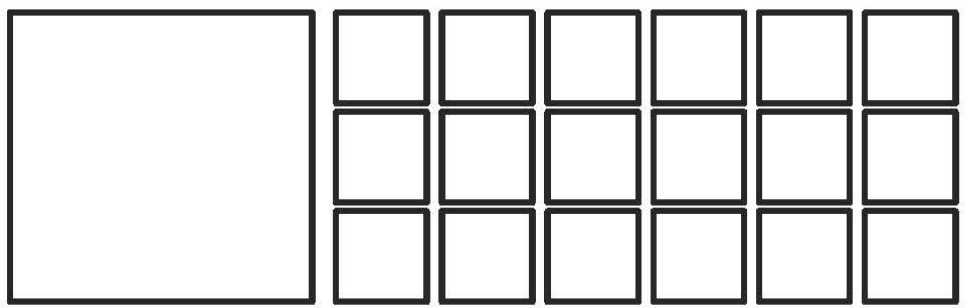

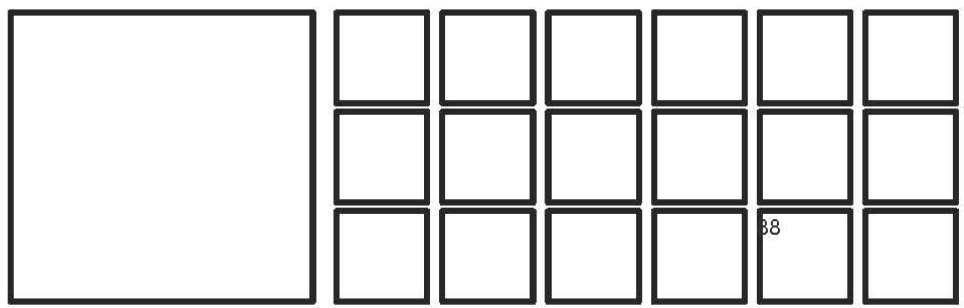

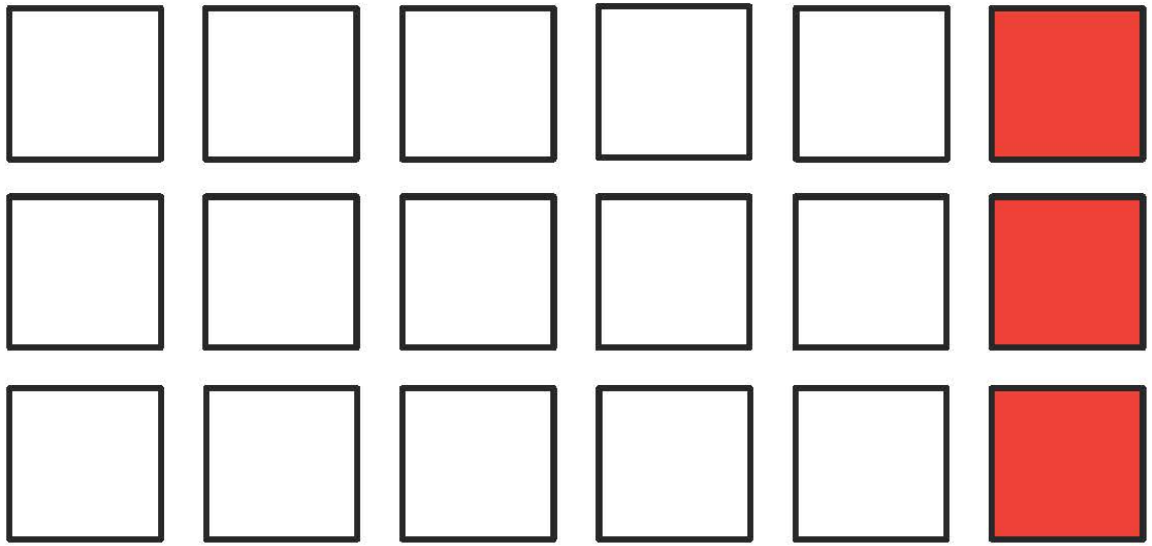

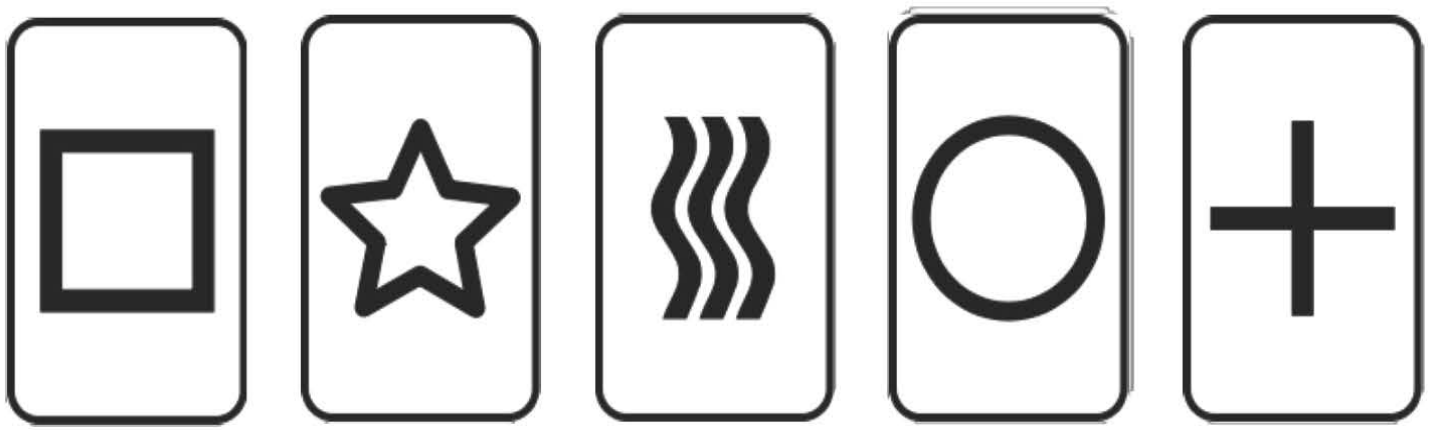

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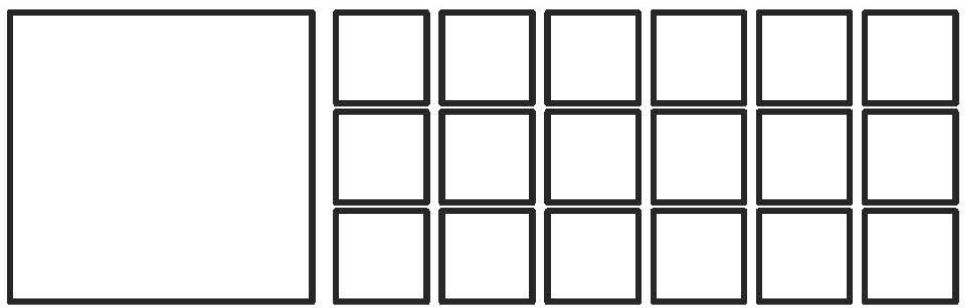

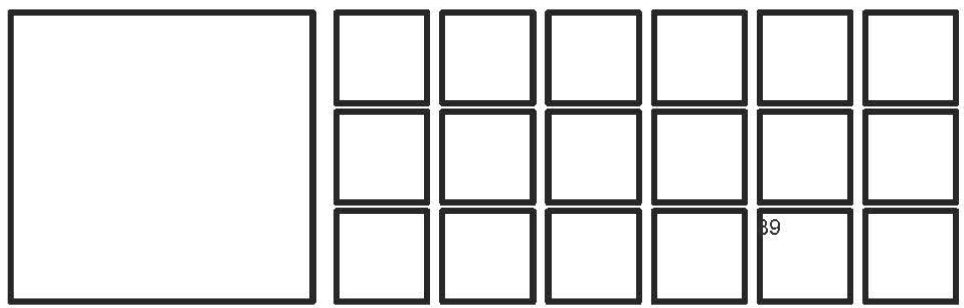

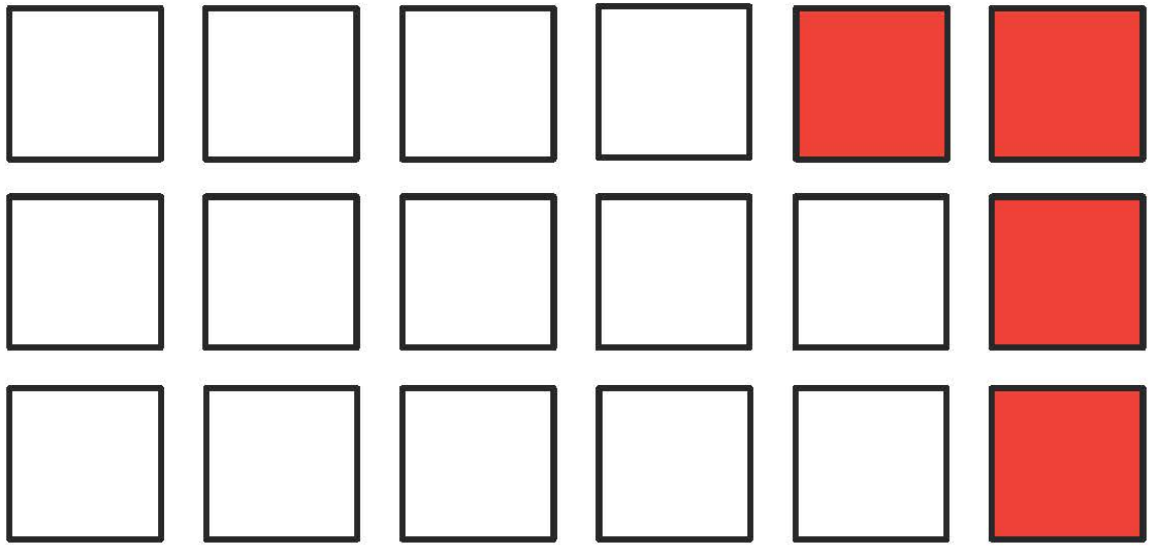

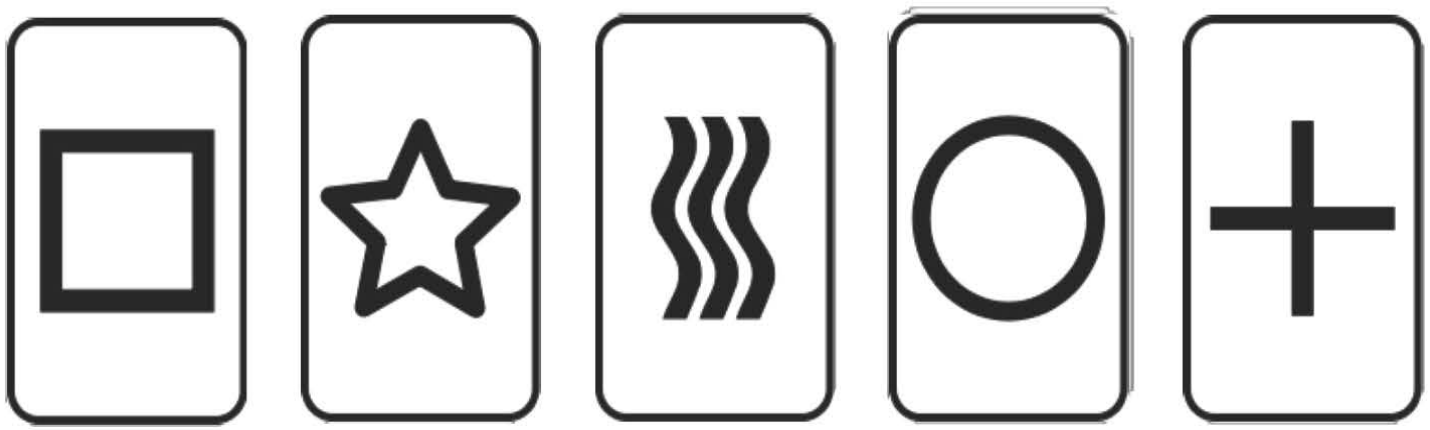

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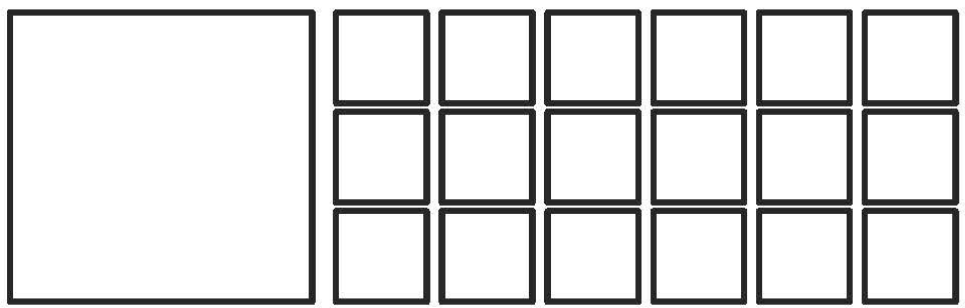

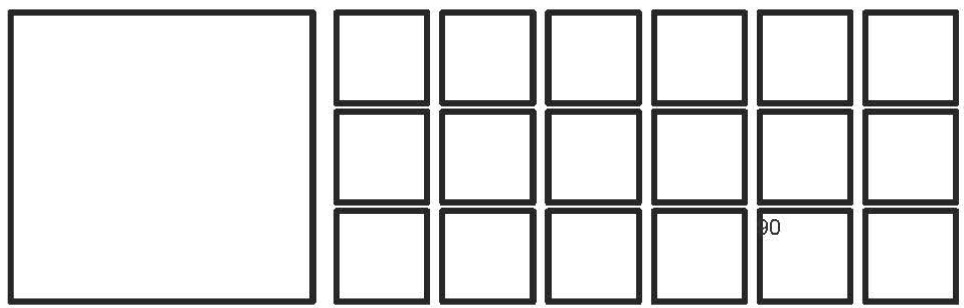

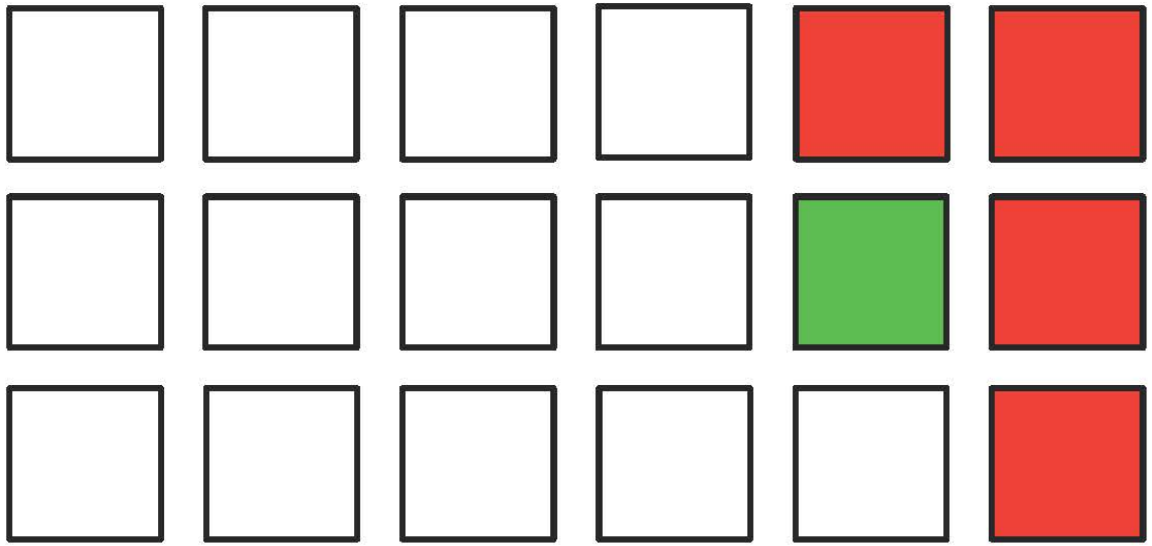

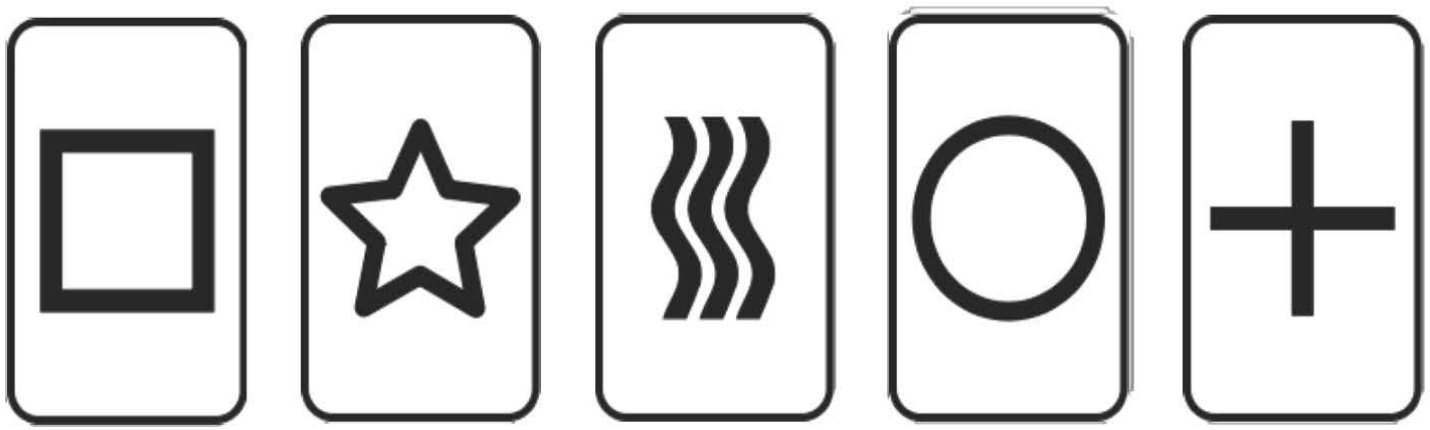

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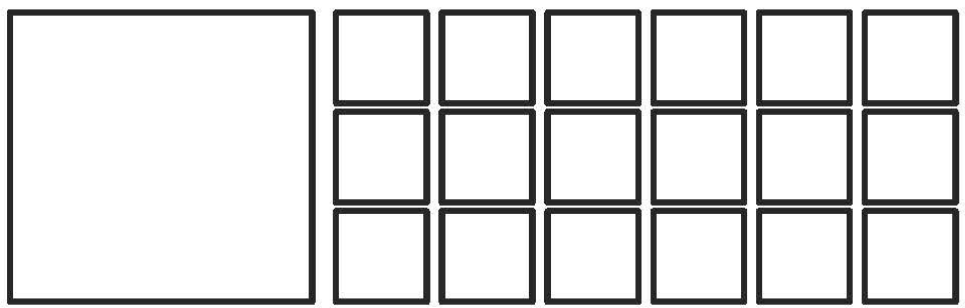

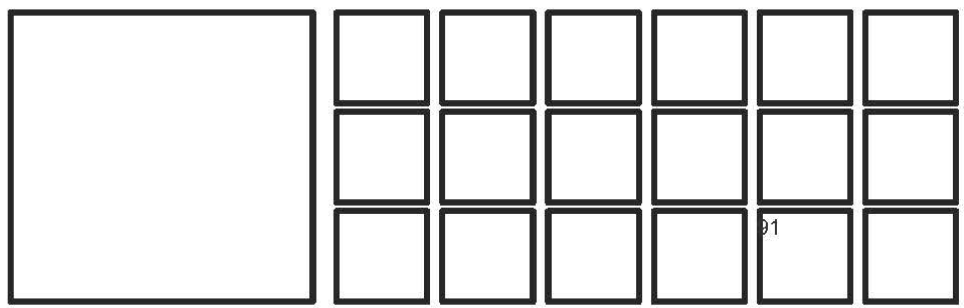

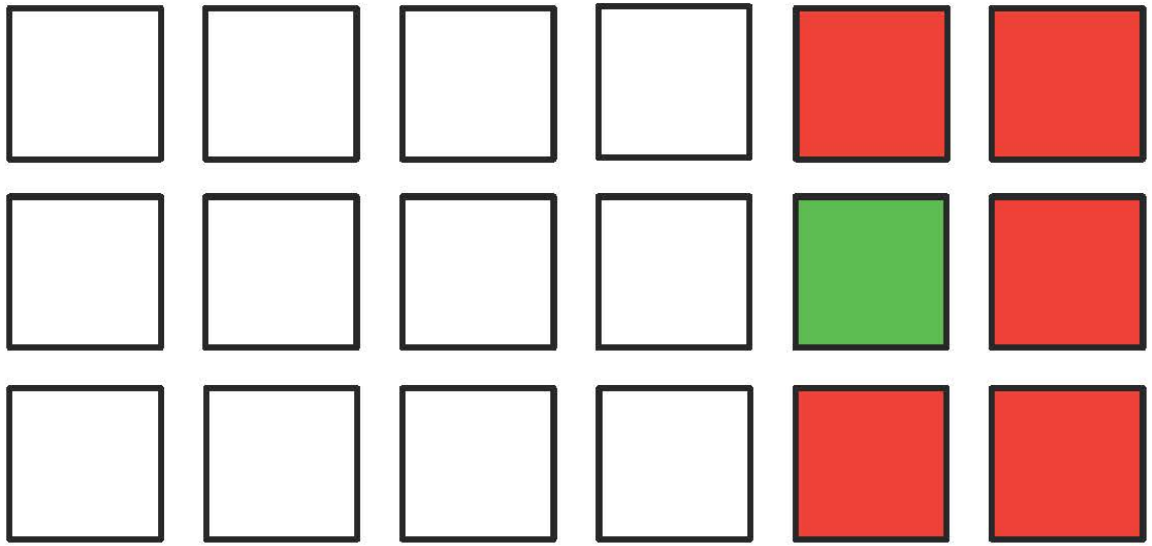

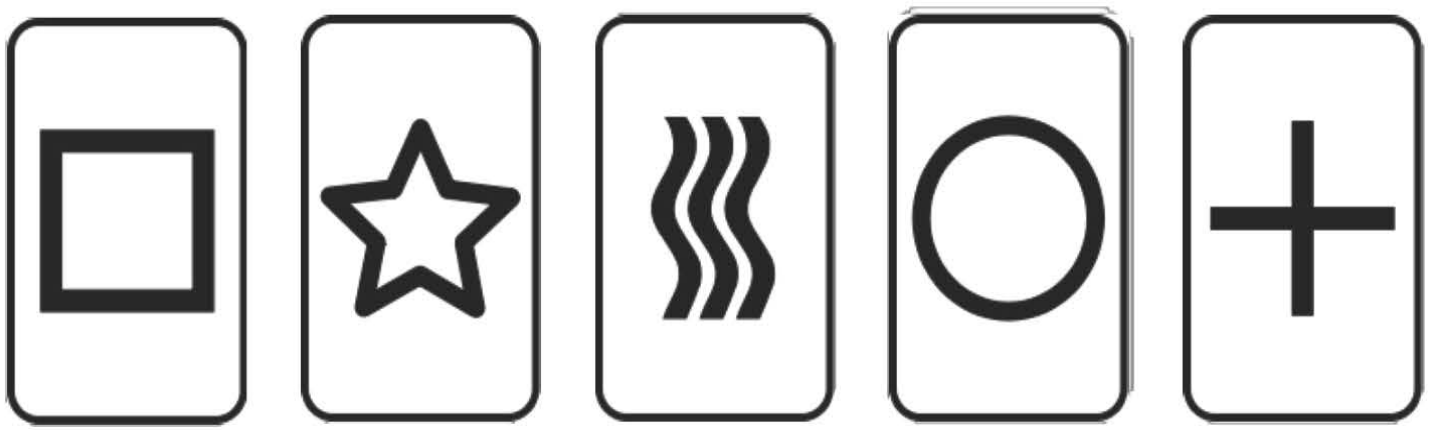

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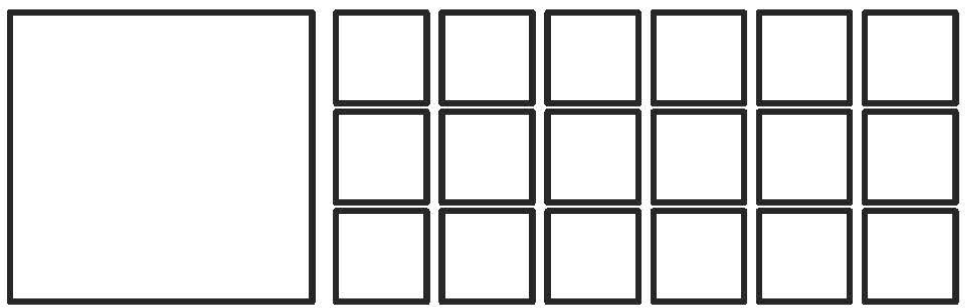

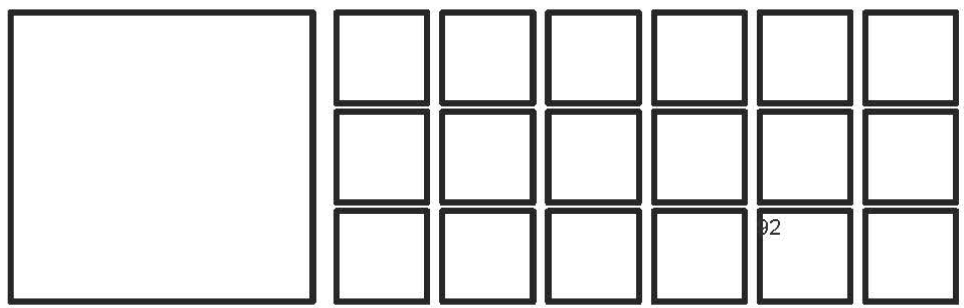

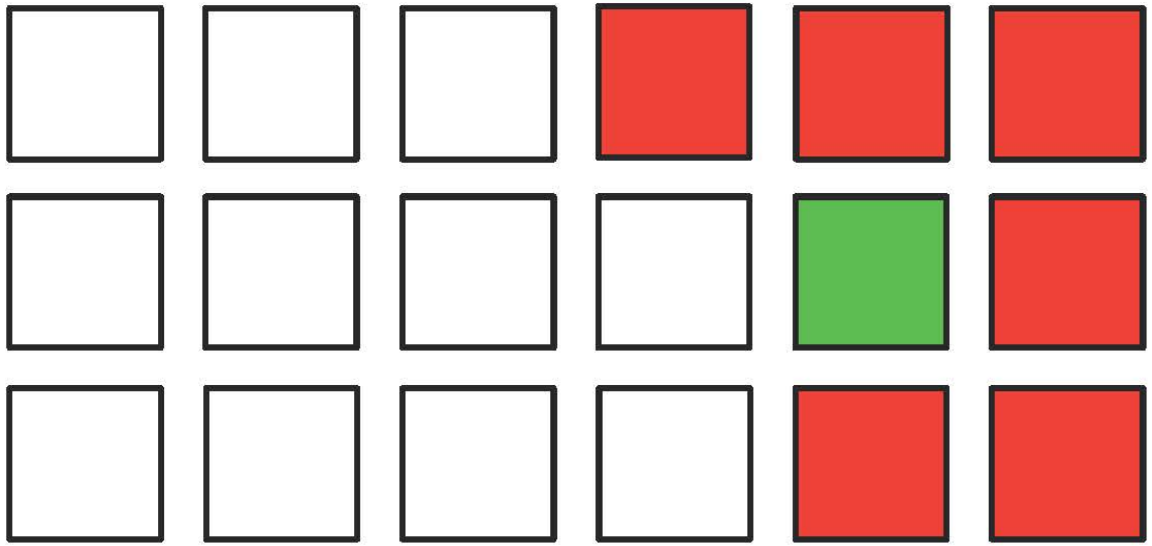

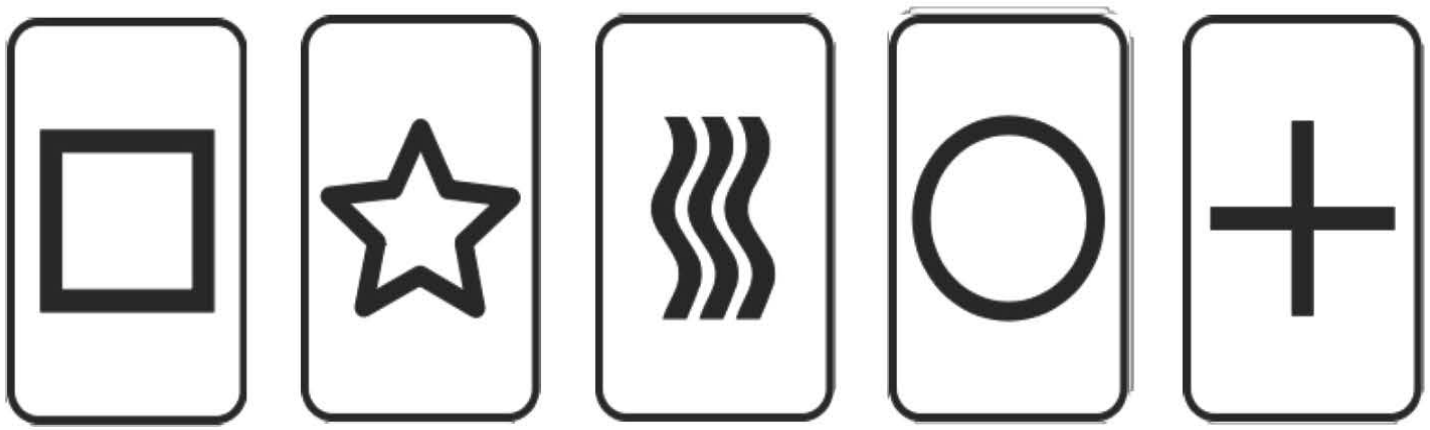

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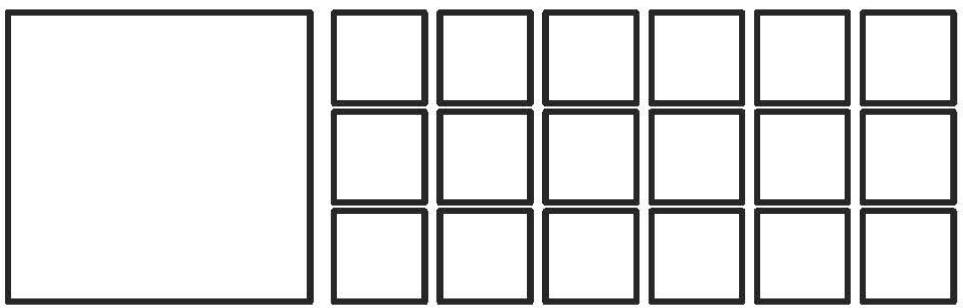

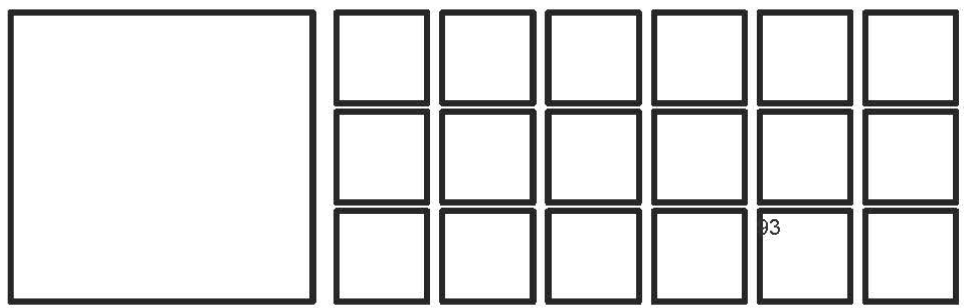

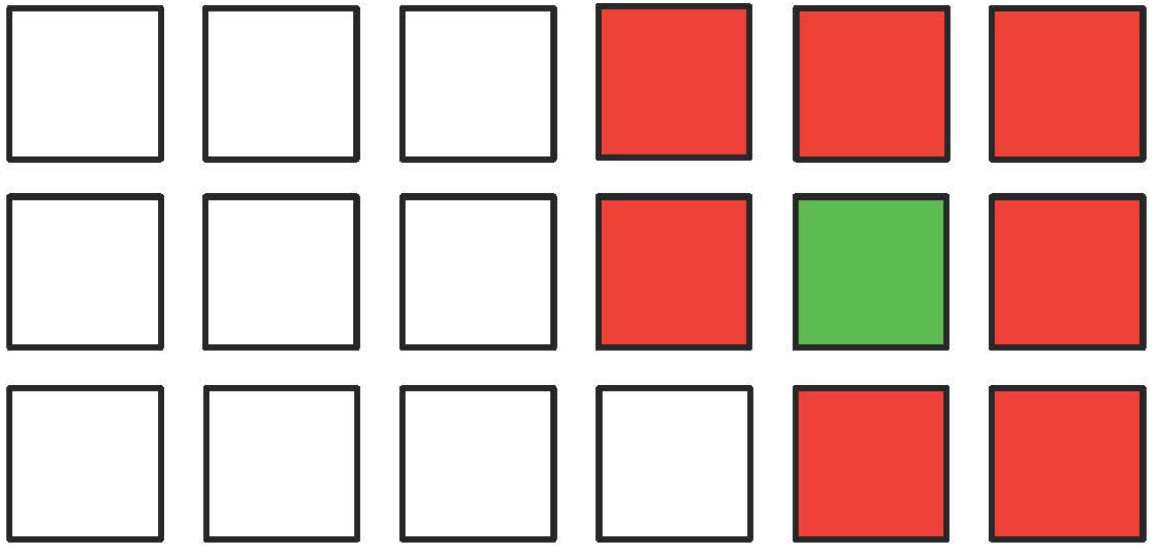

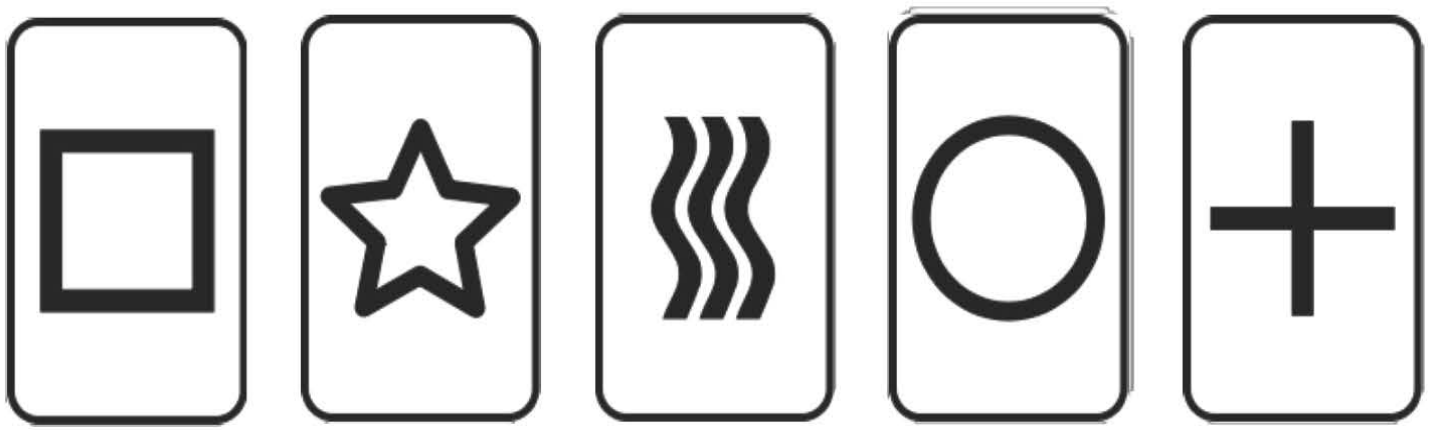

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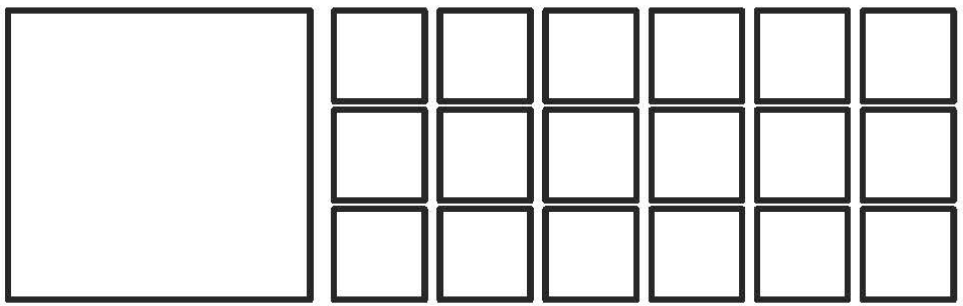

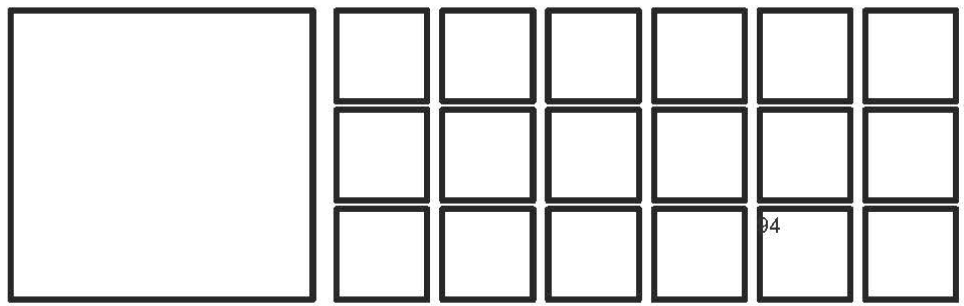

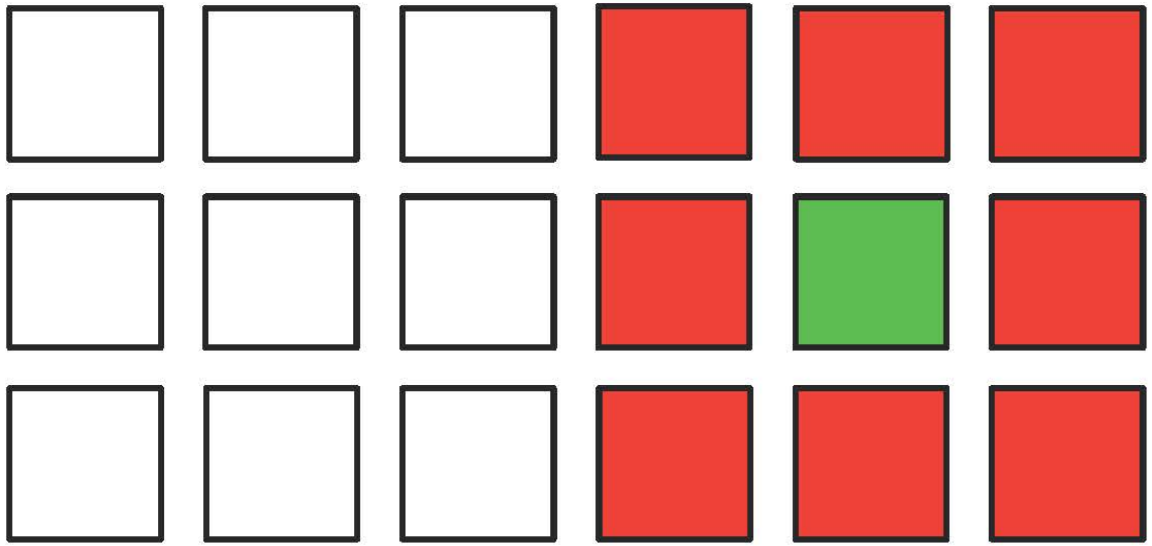

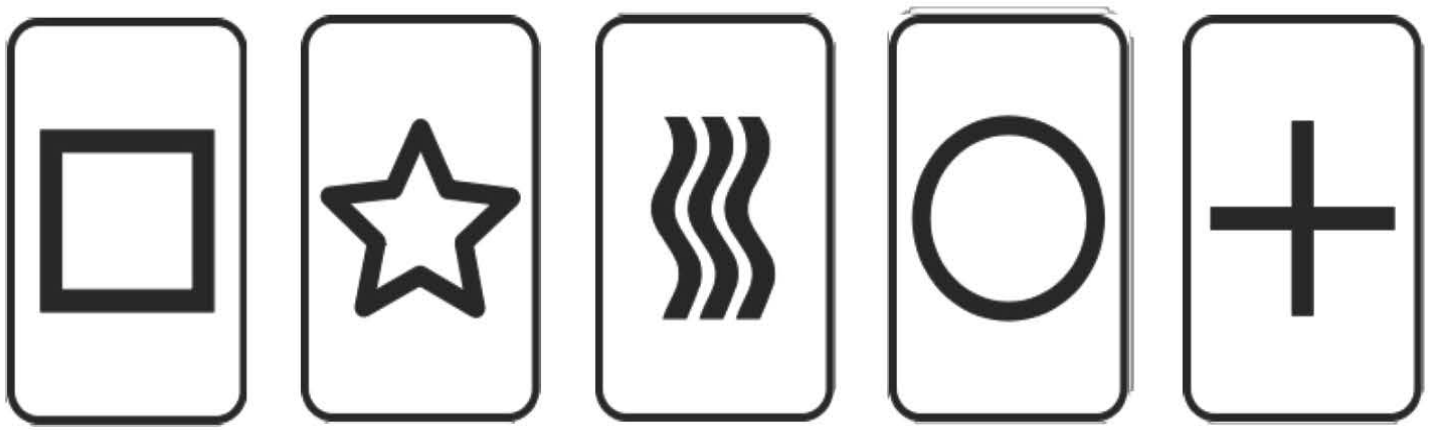

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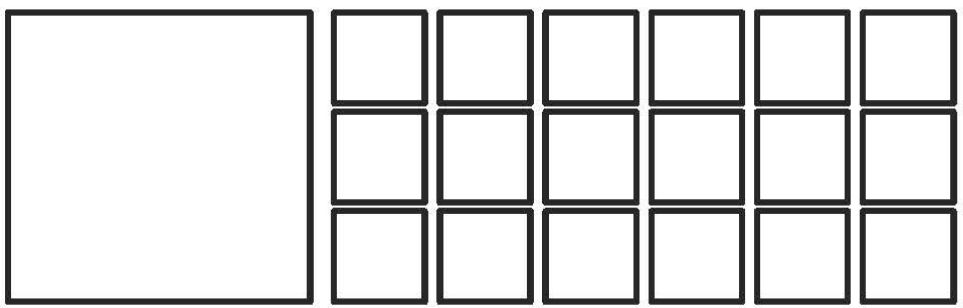

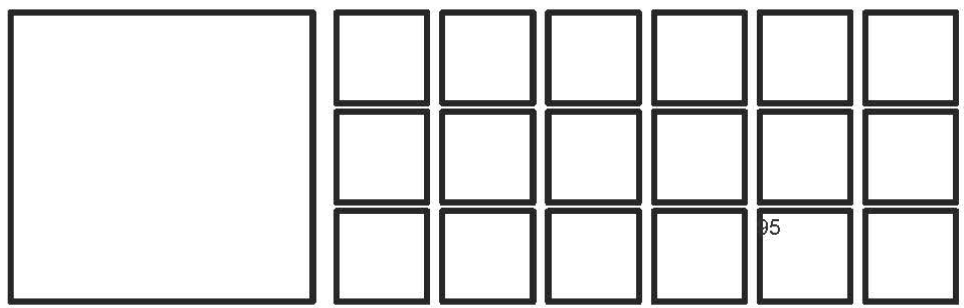

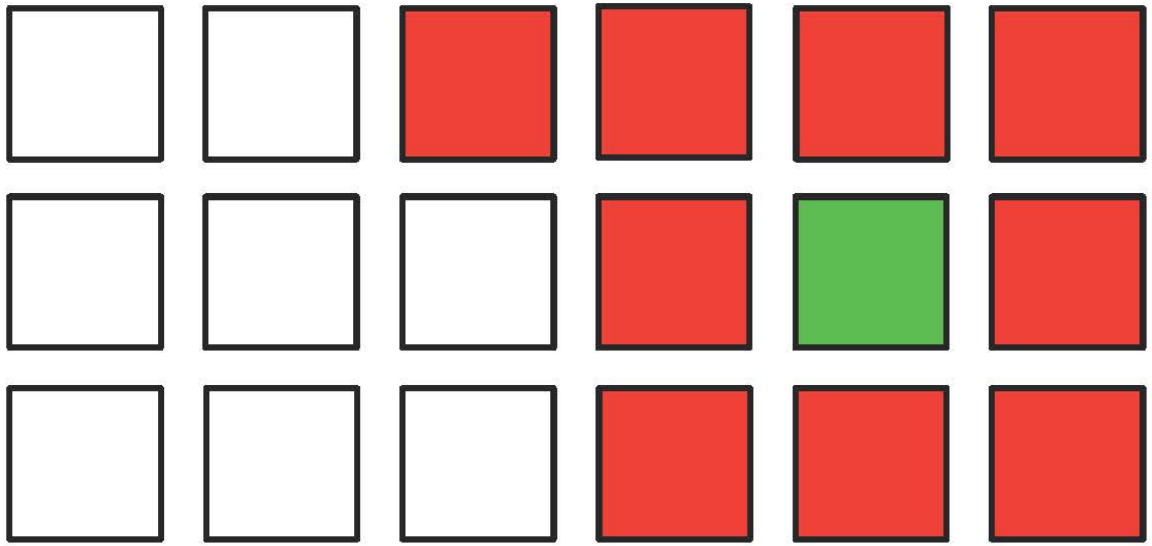

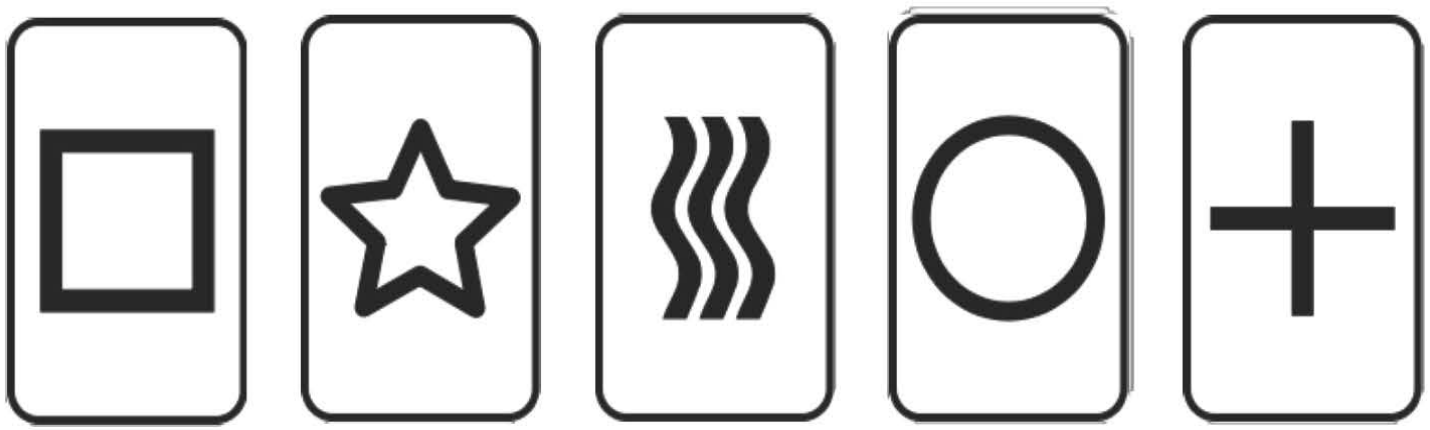

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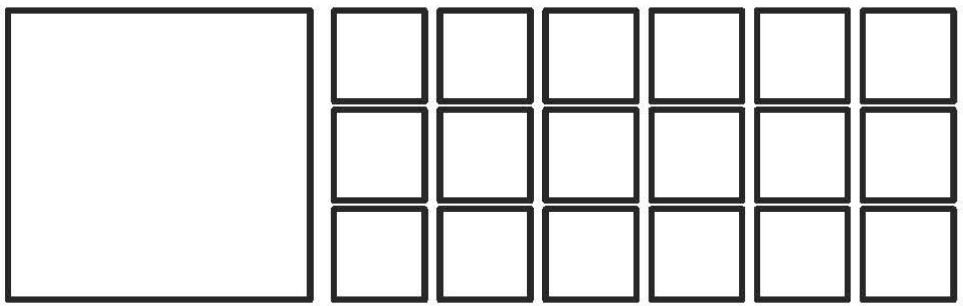

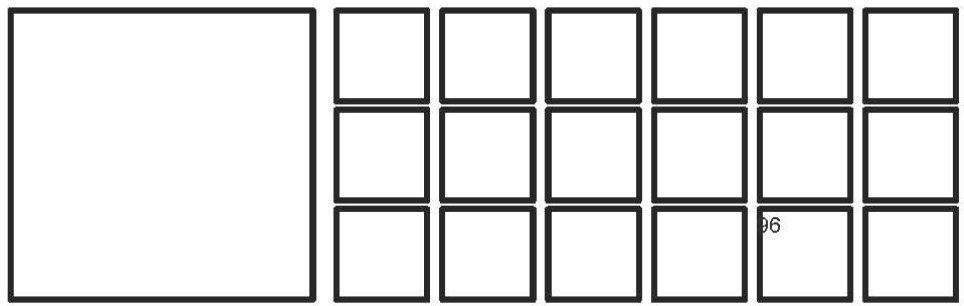

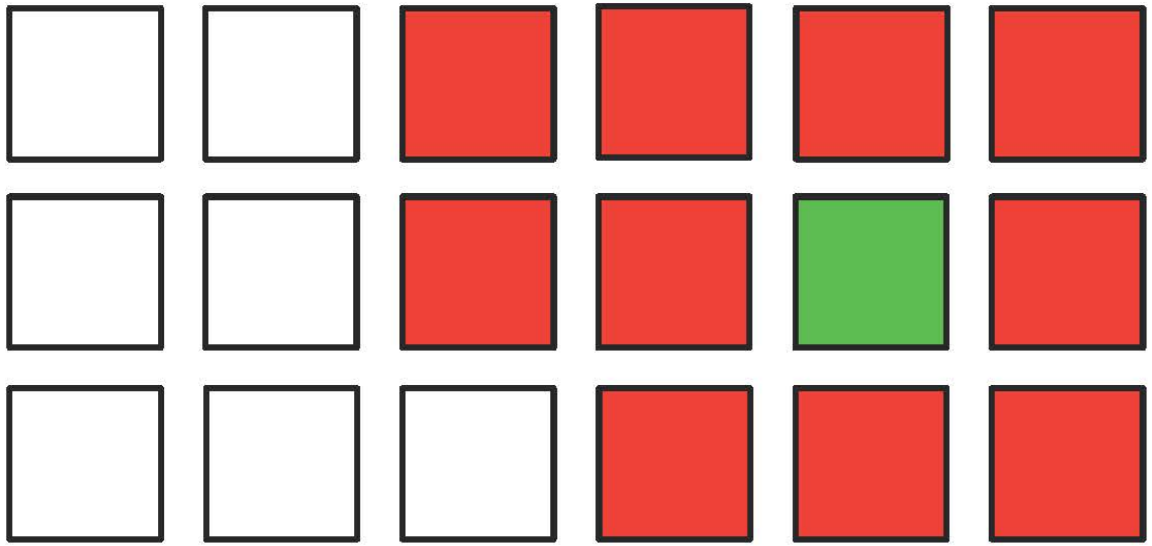

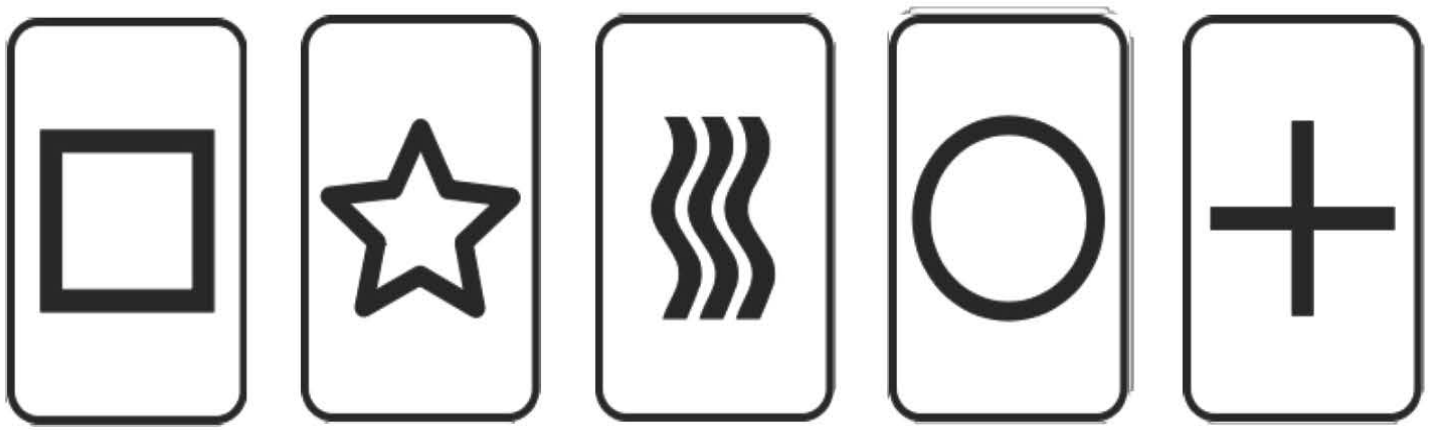

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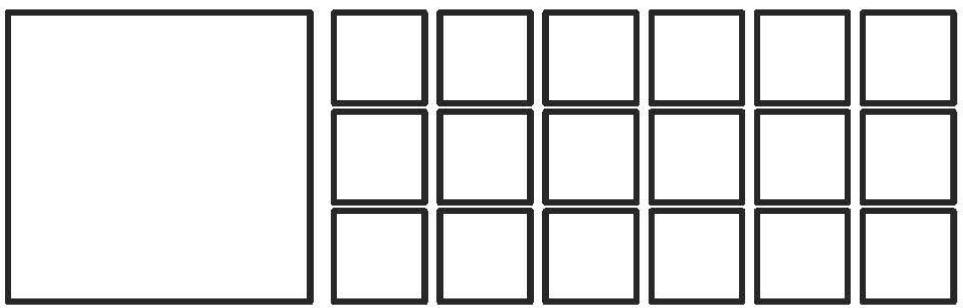

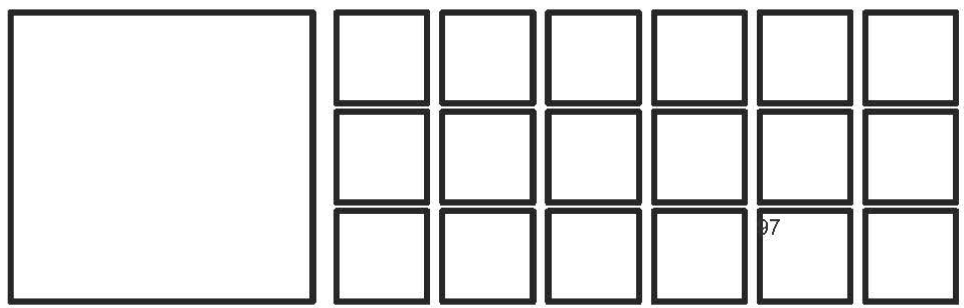

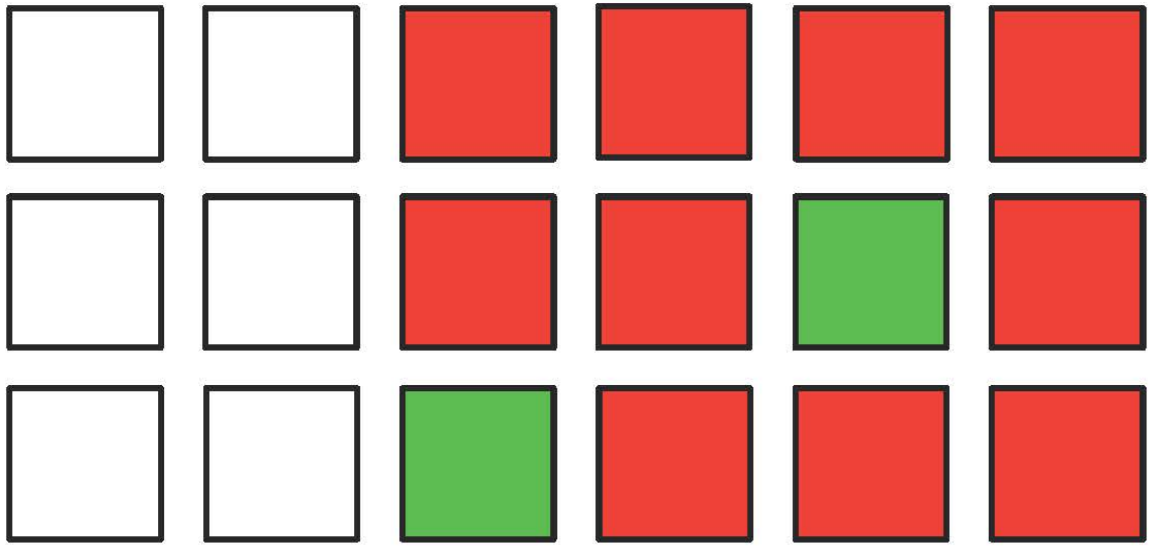

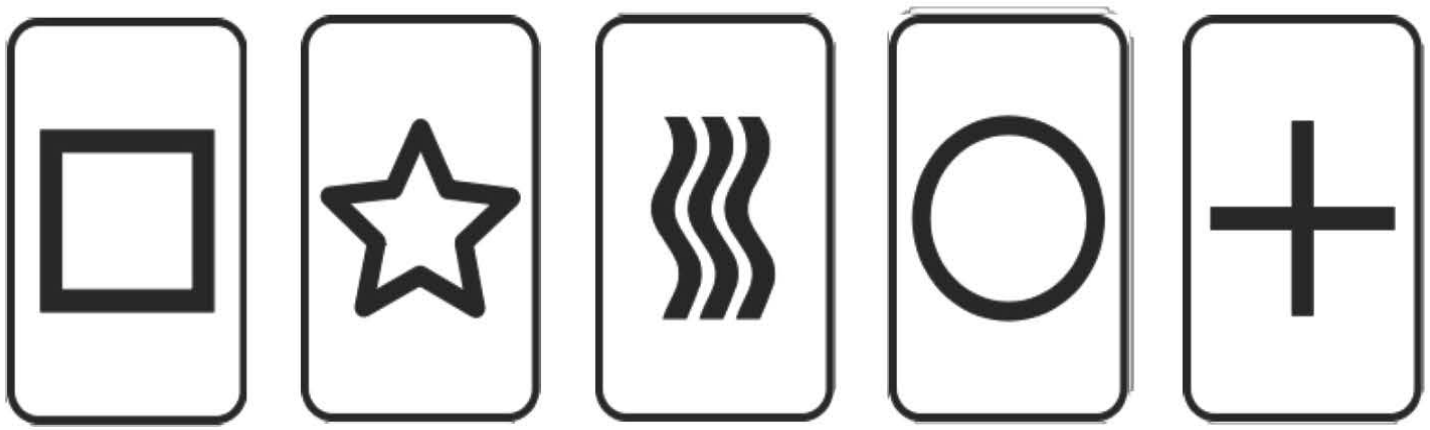

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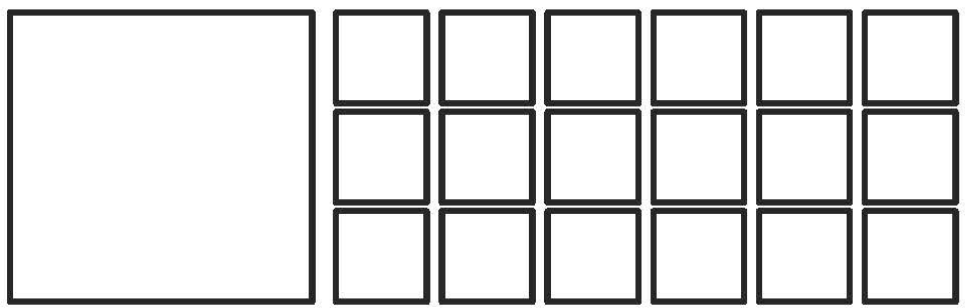

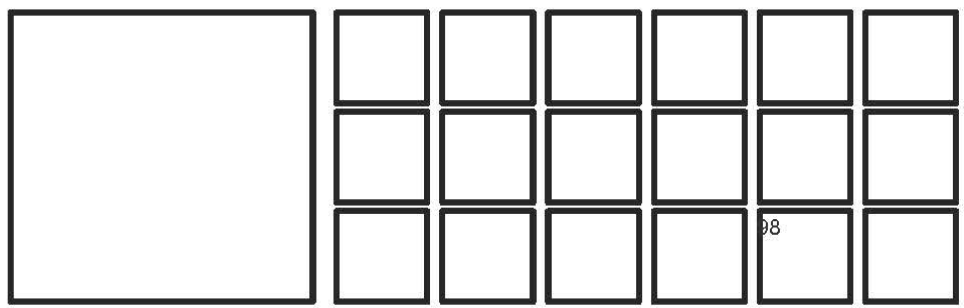

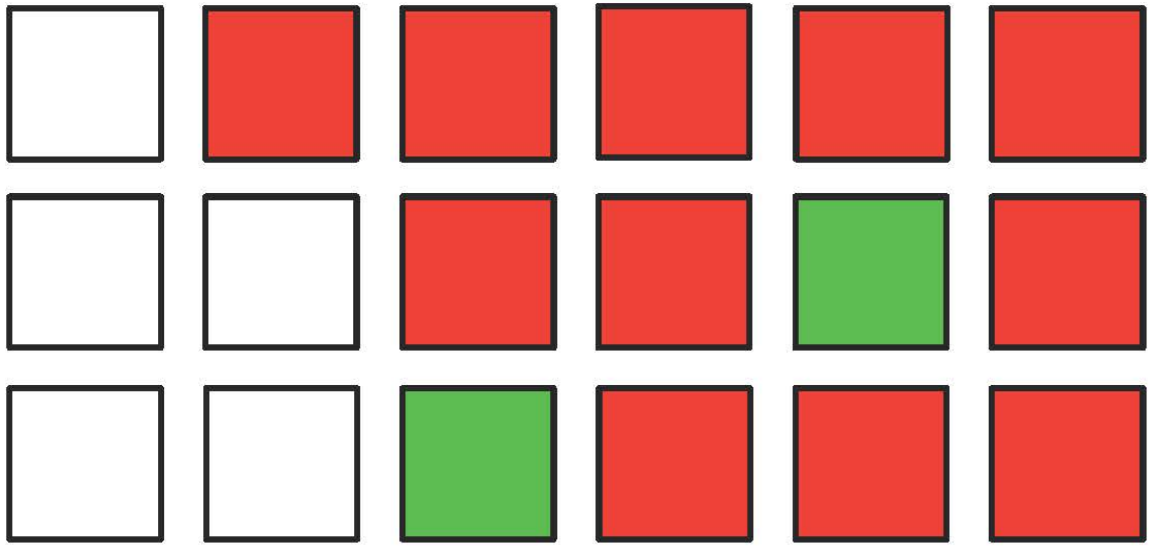

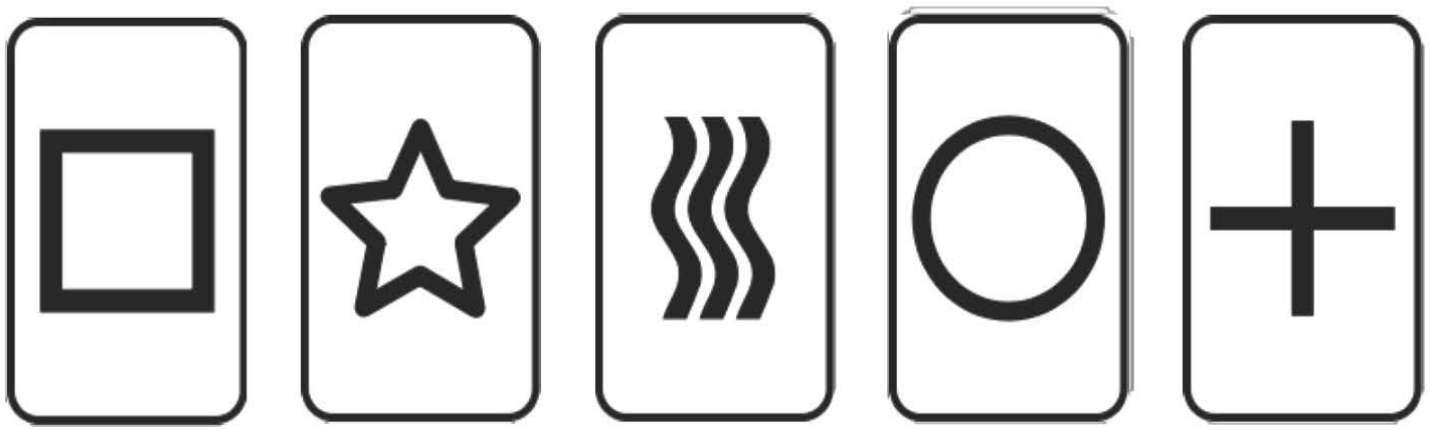

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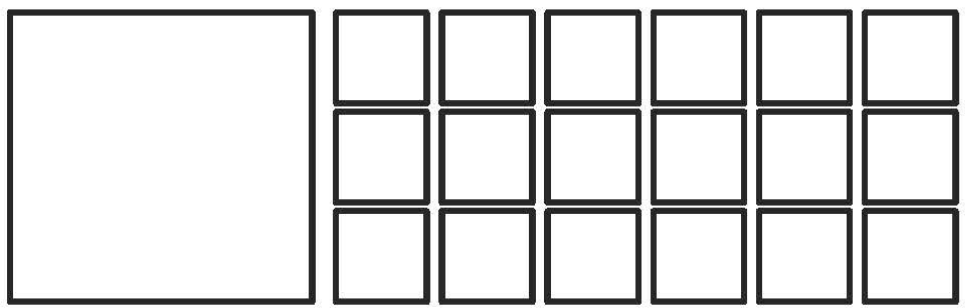

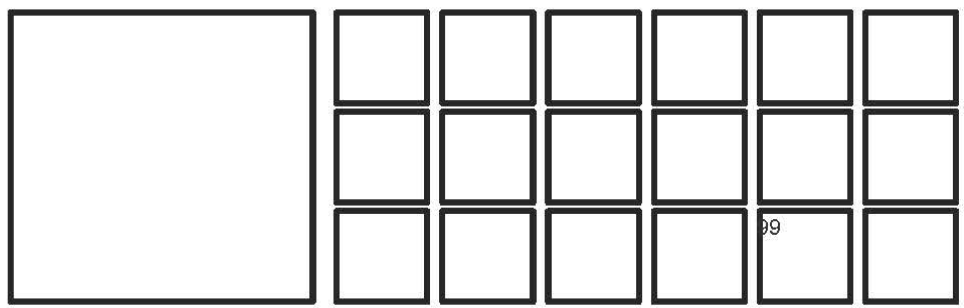

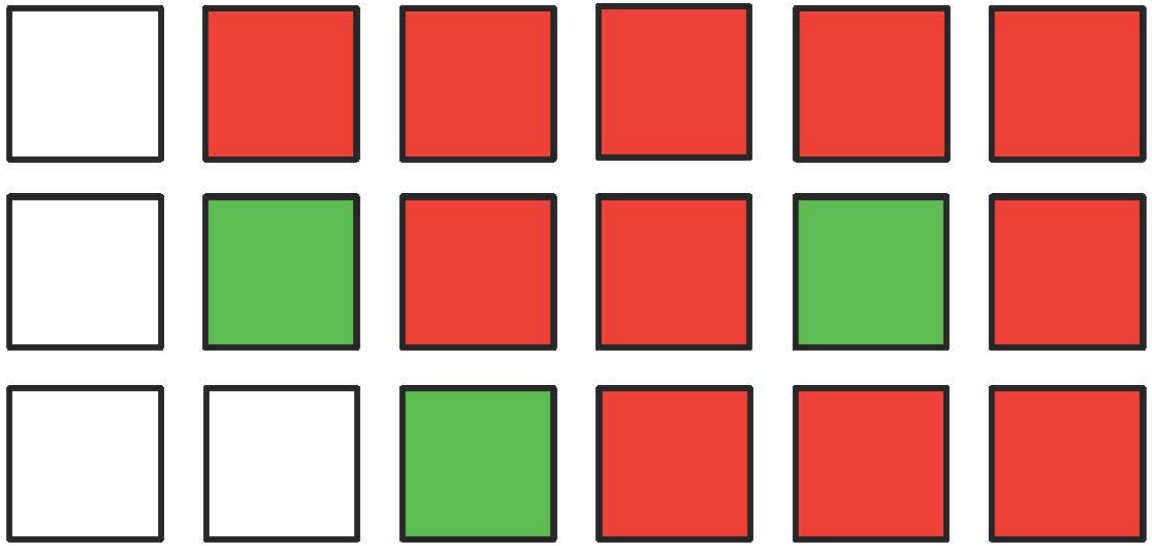

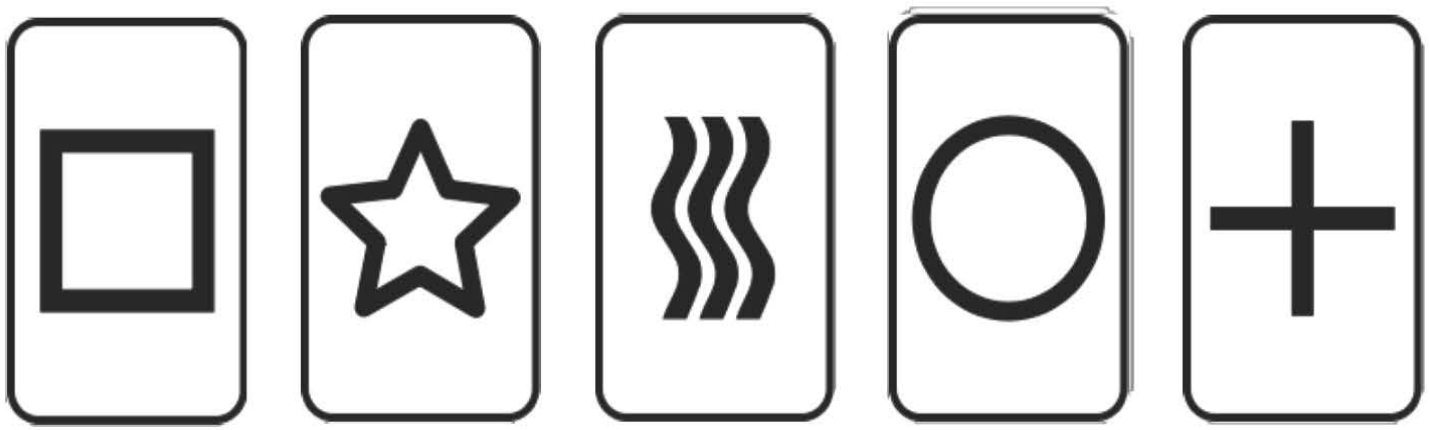

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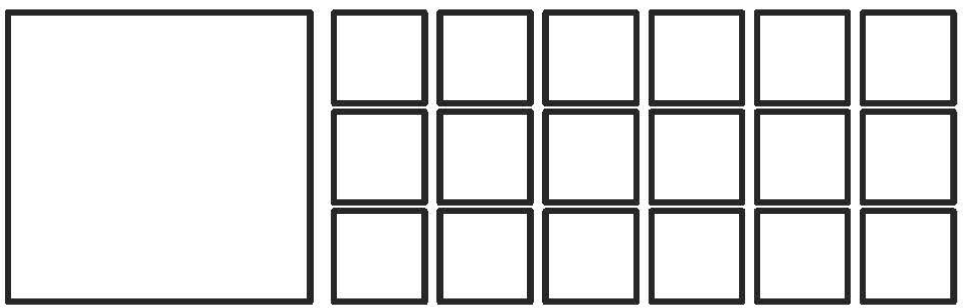

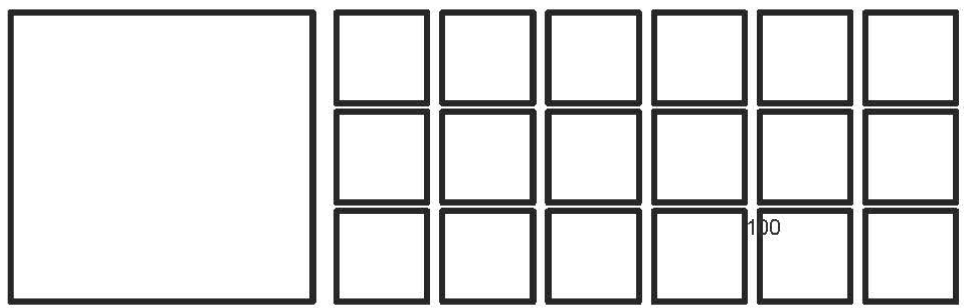

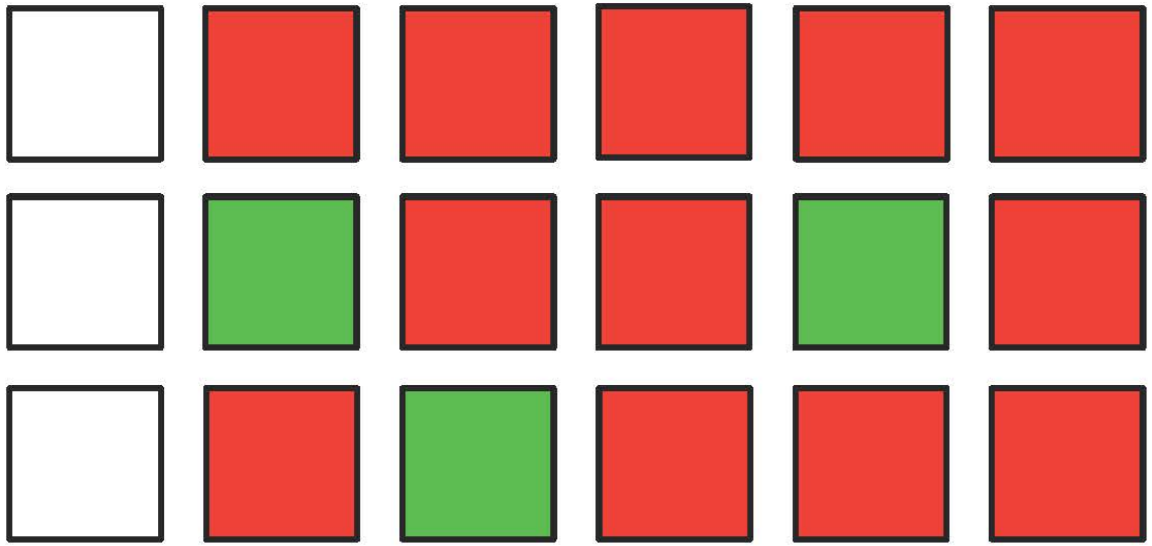

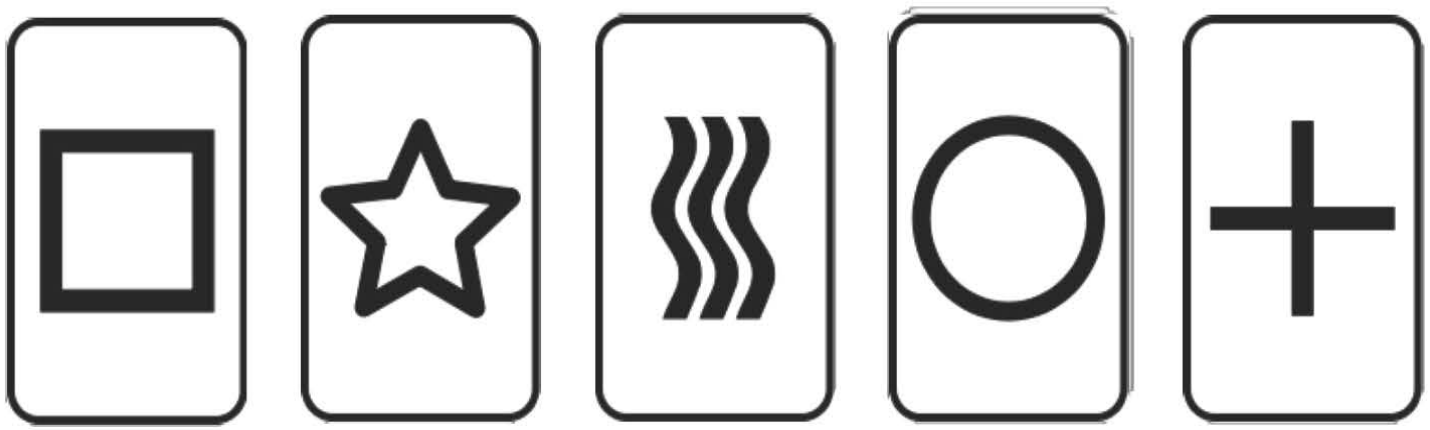

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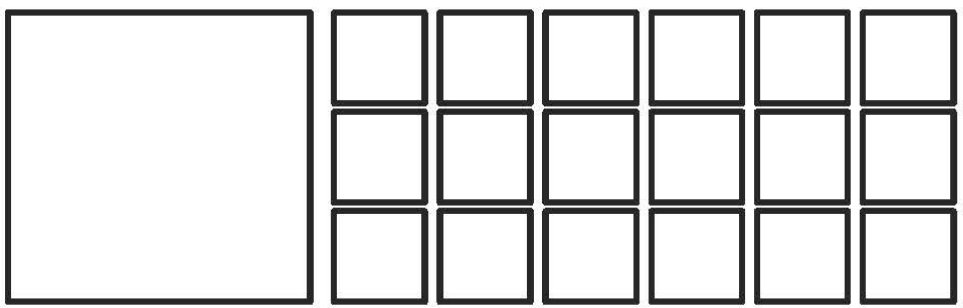

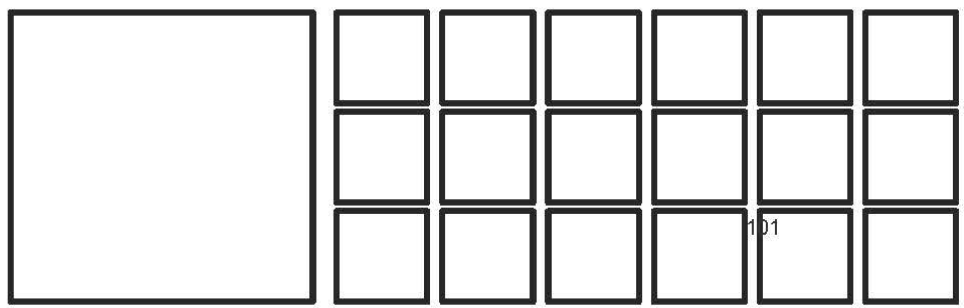

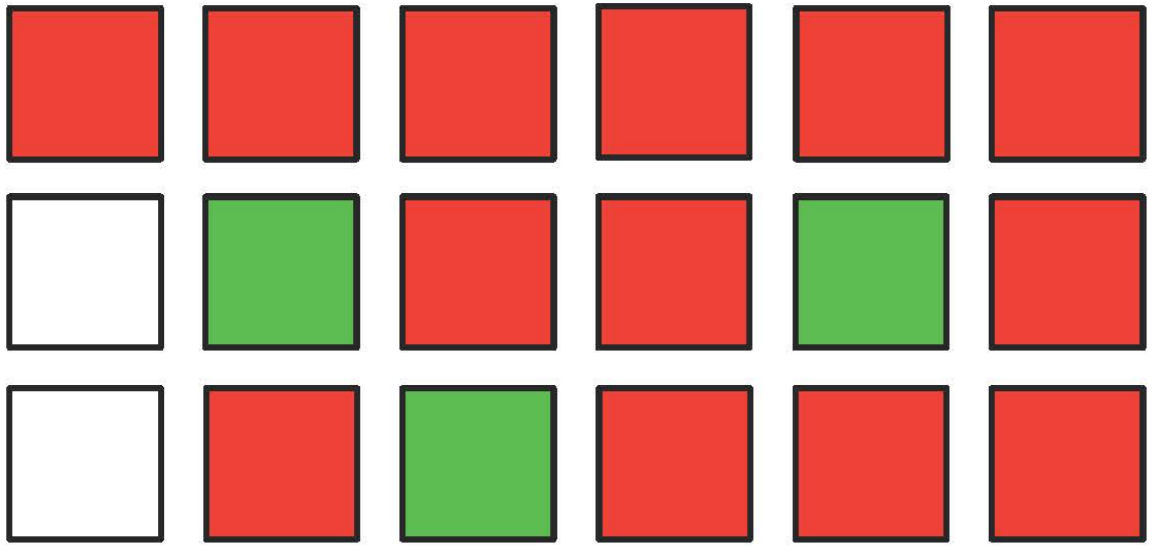

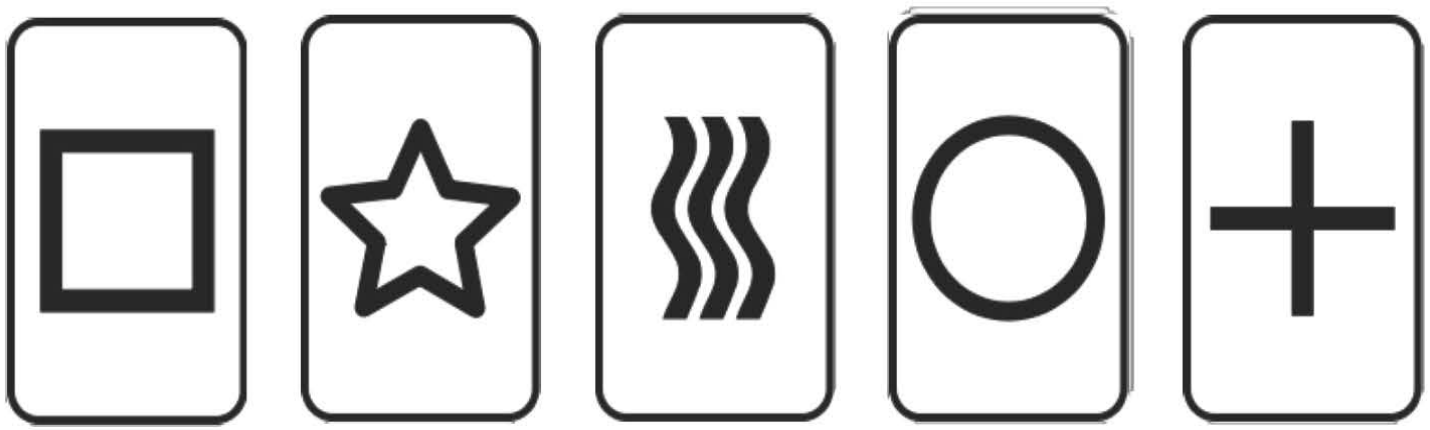

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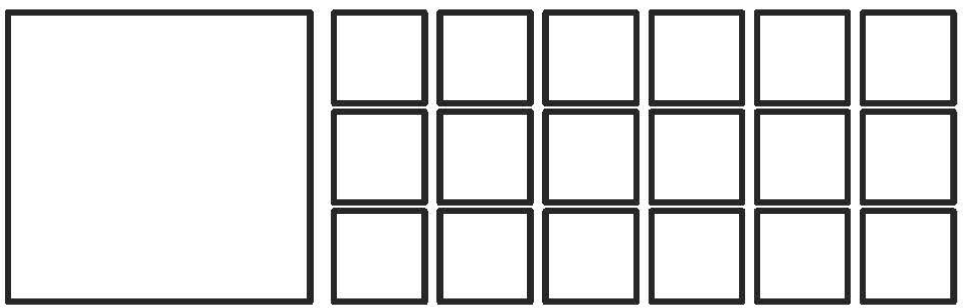

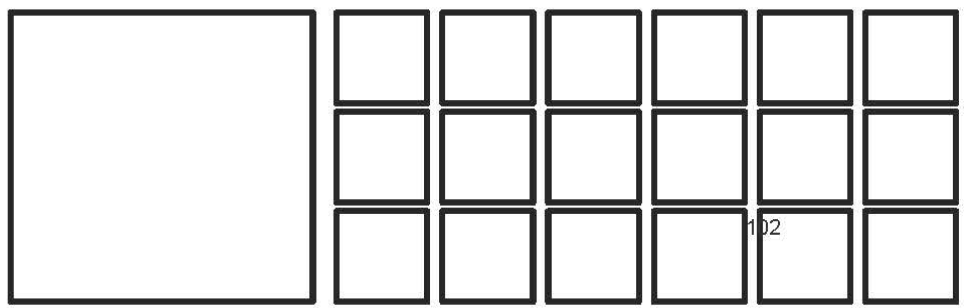

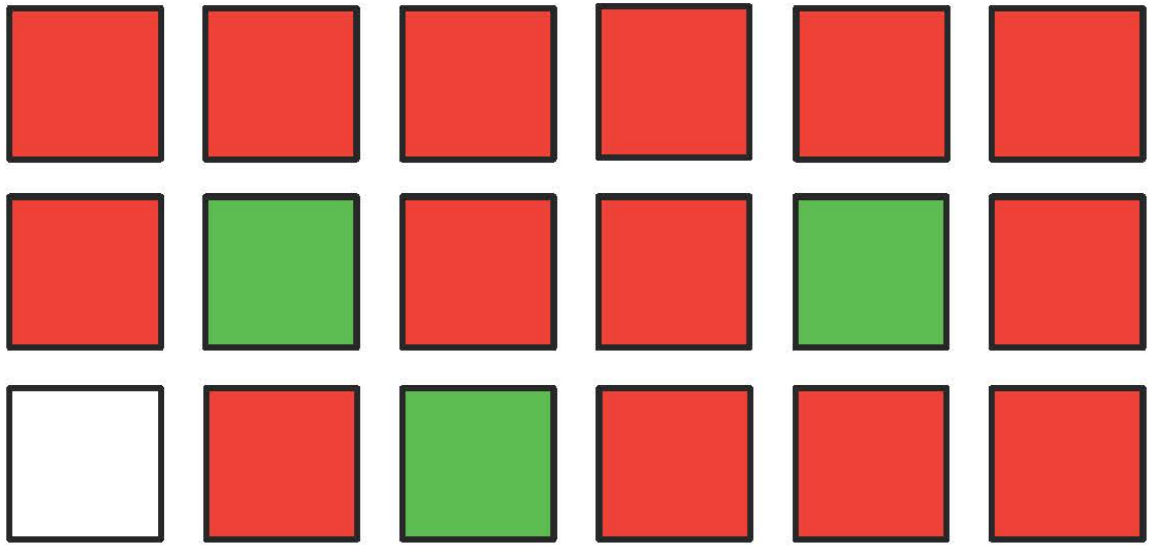

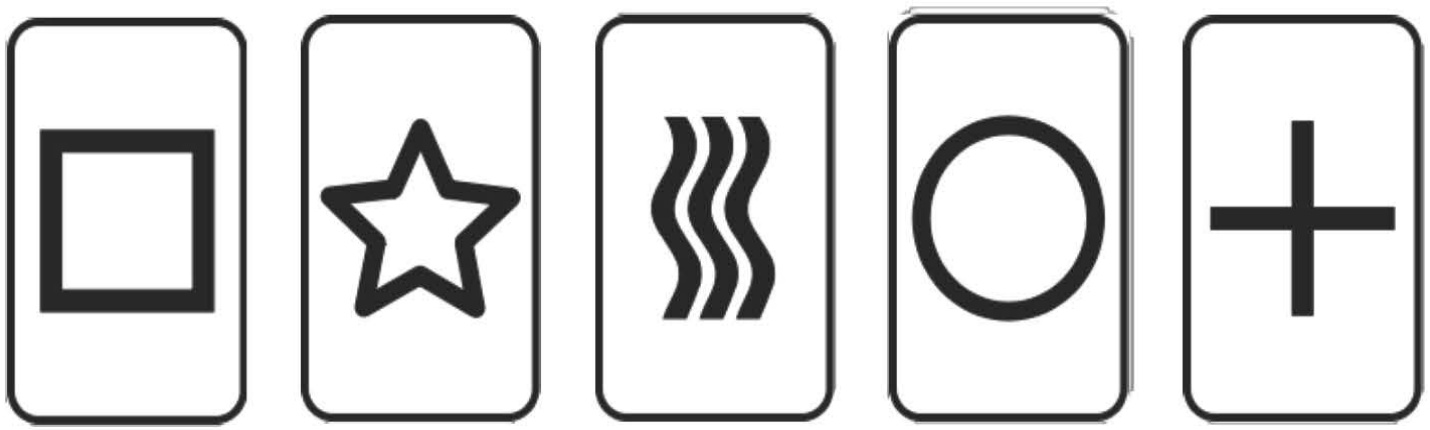

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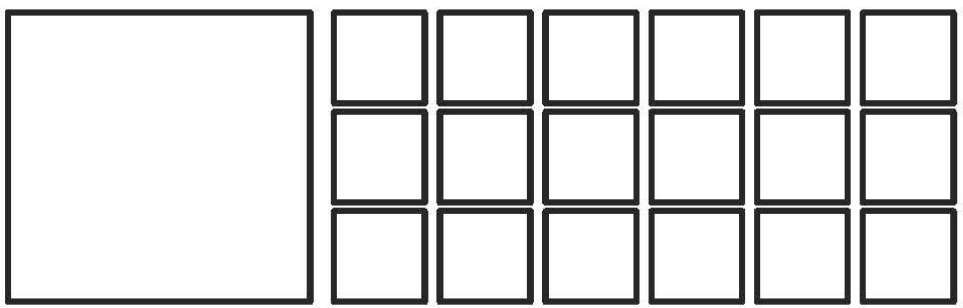

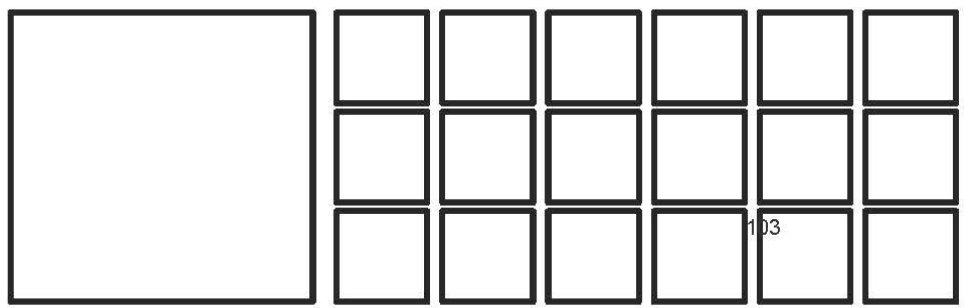

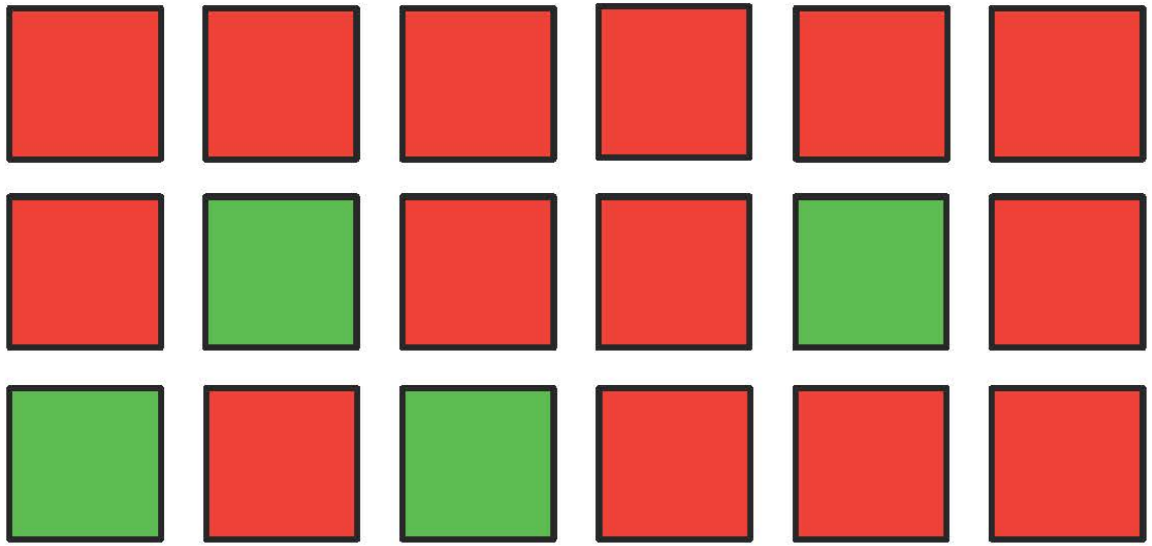

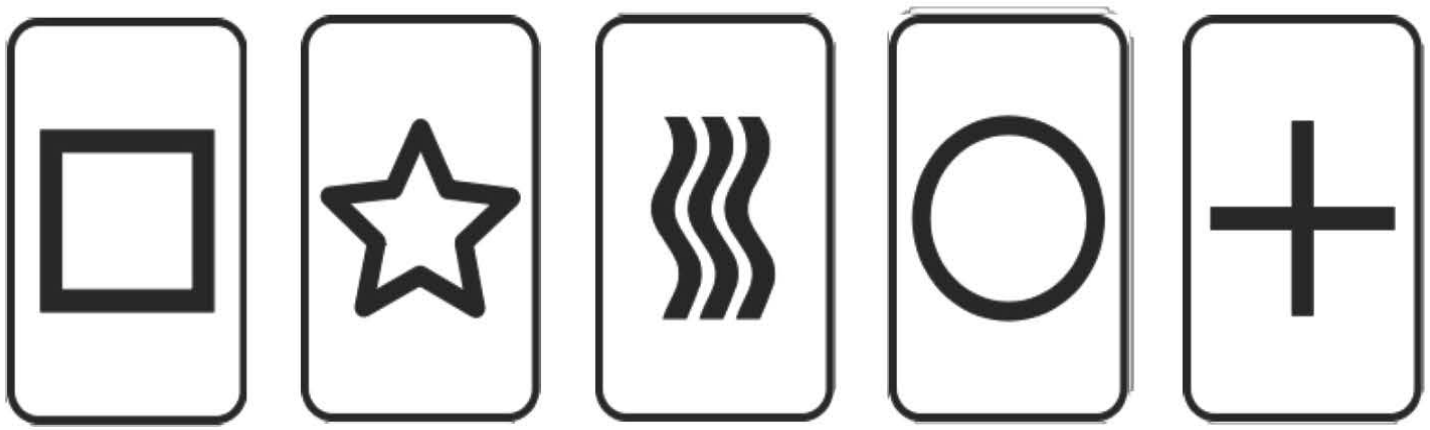

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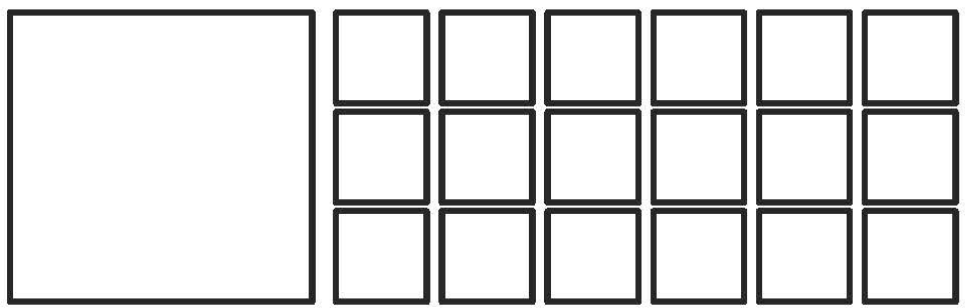
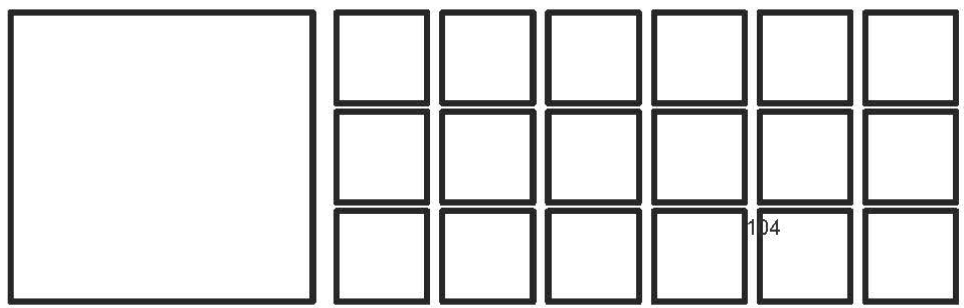
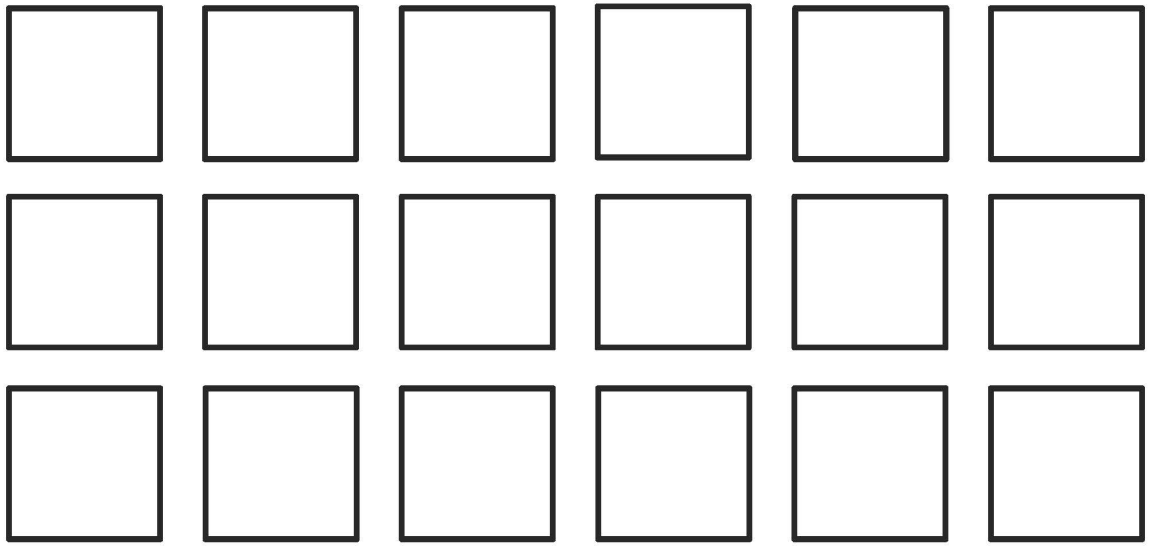
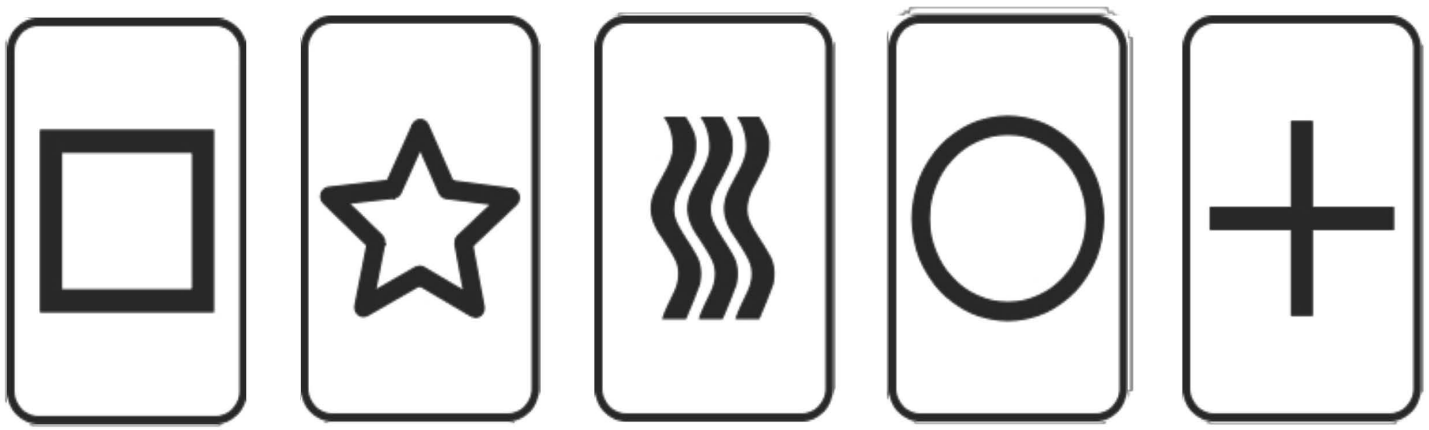




The next player is being selected.
After a short countdown the test will begin again.





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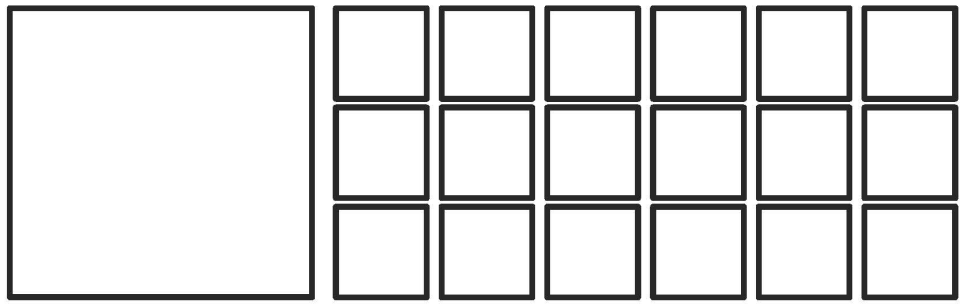

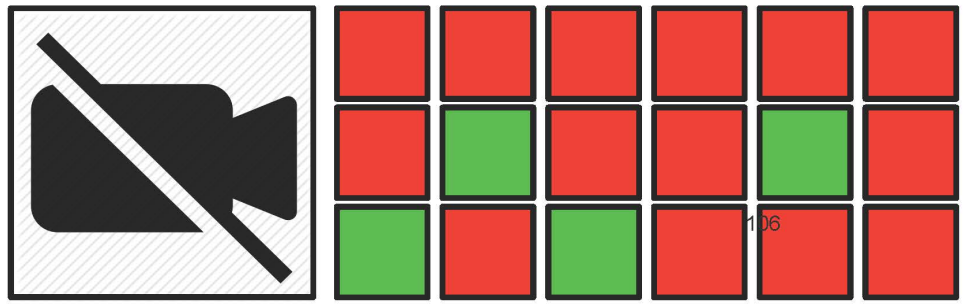

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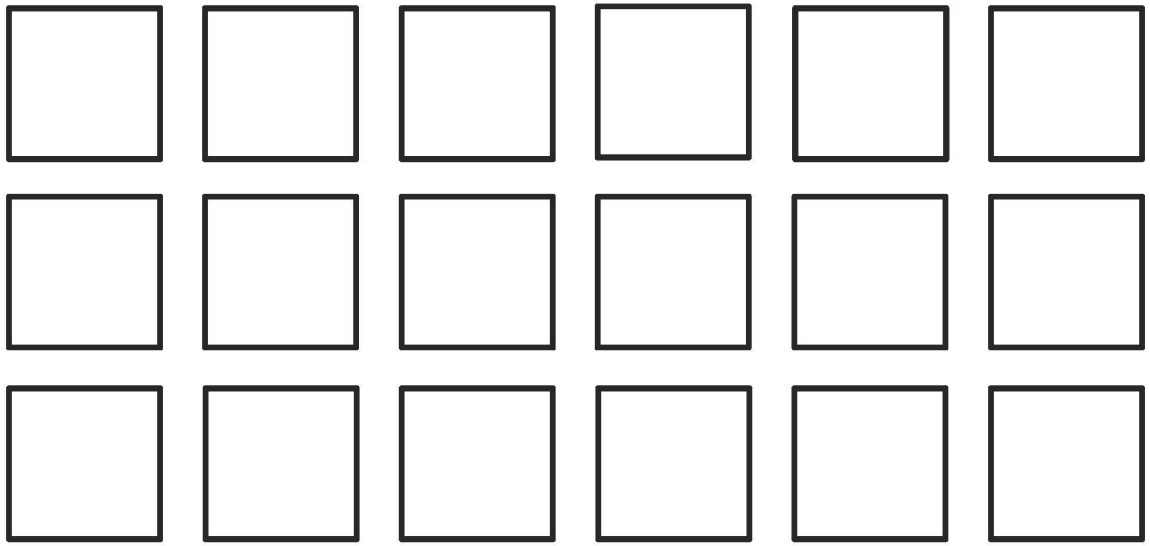

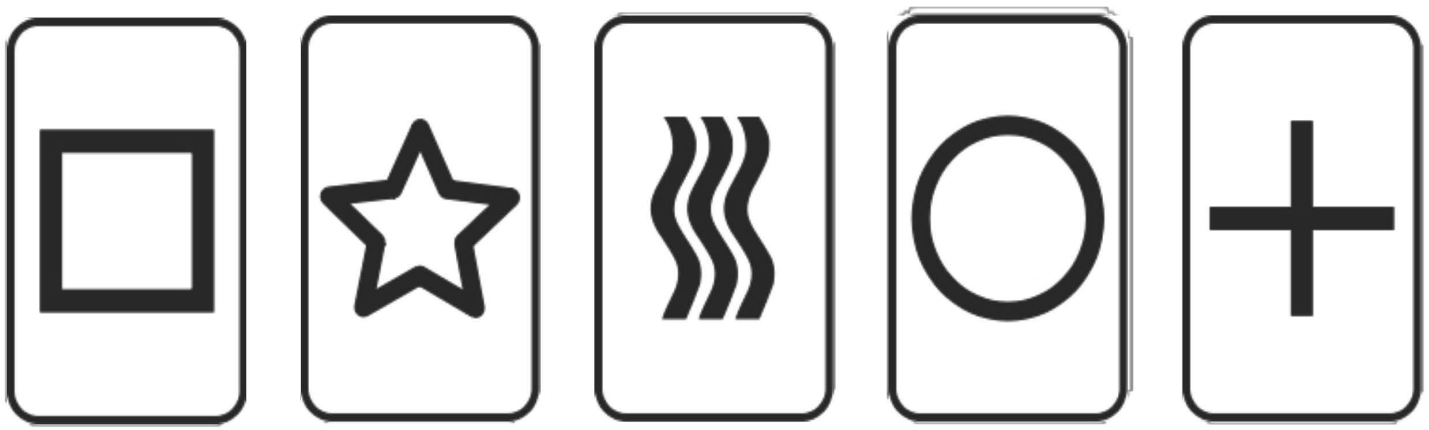

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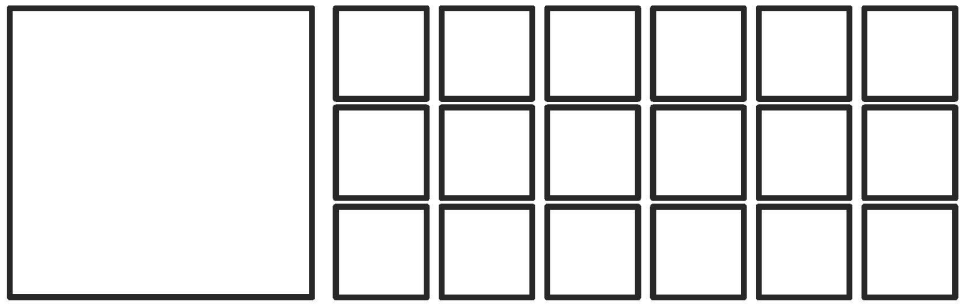

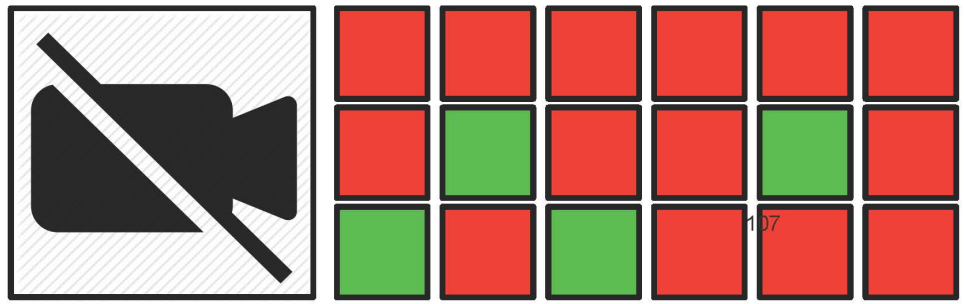

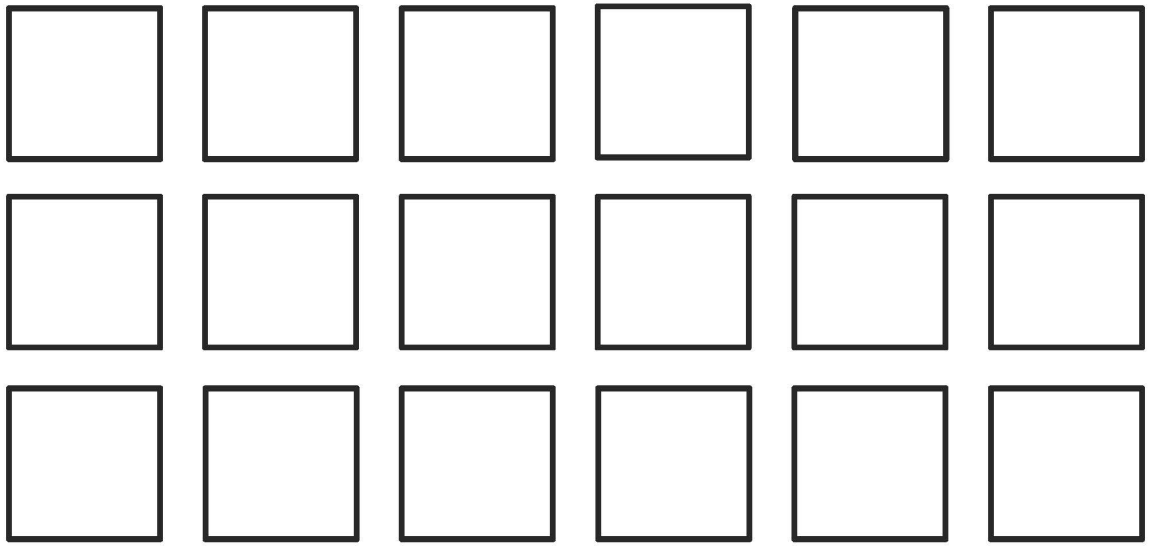

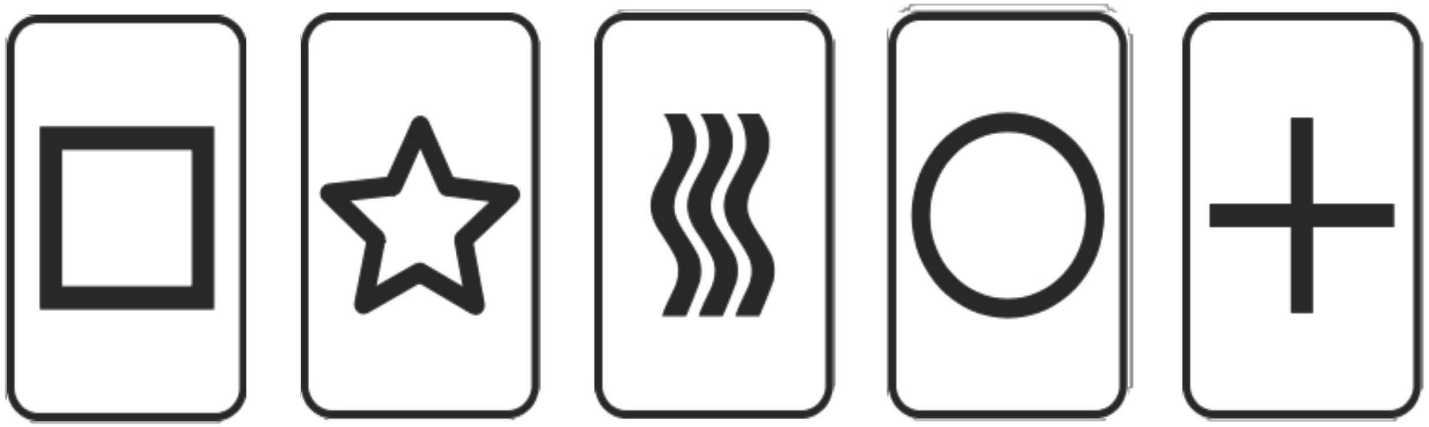

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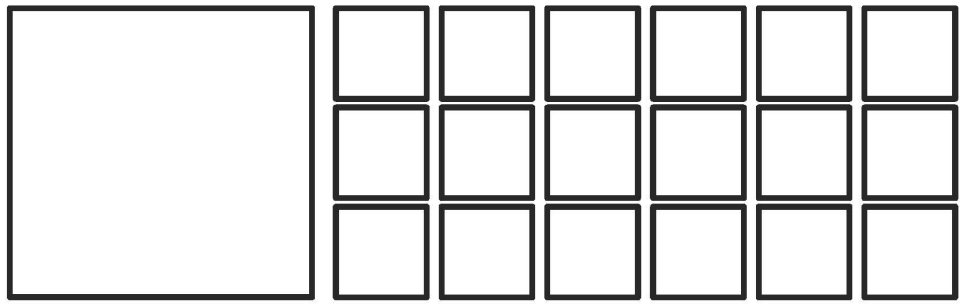

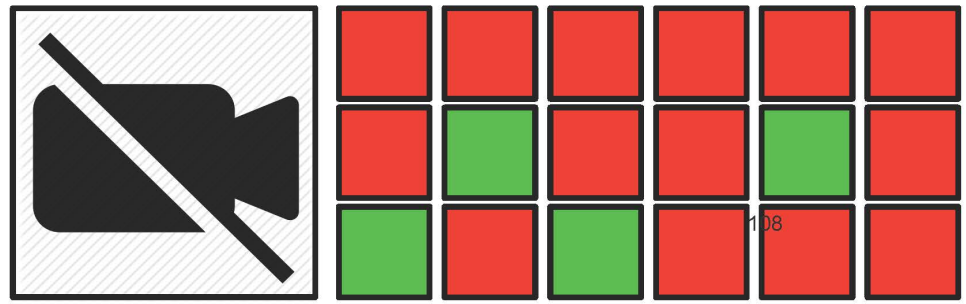

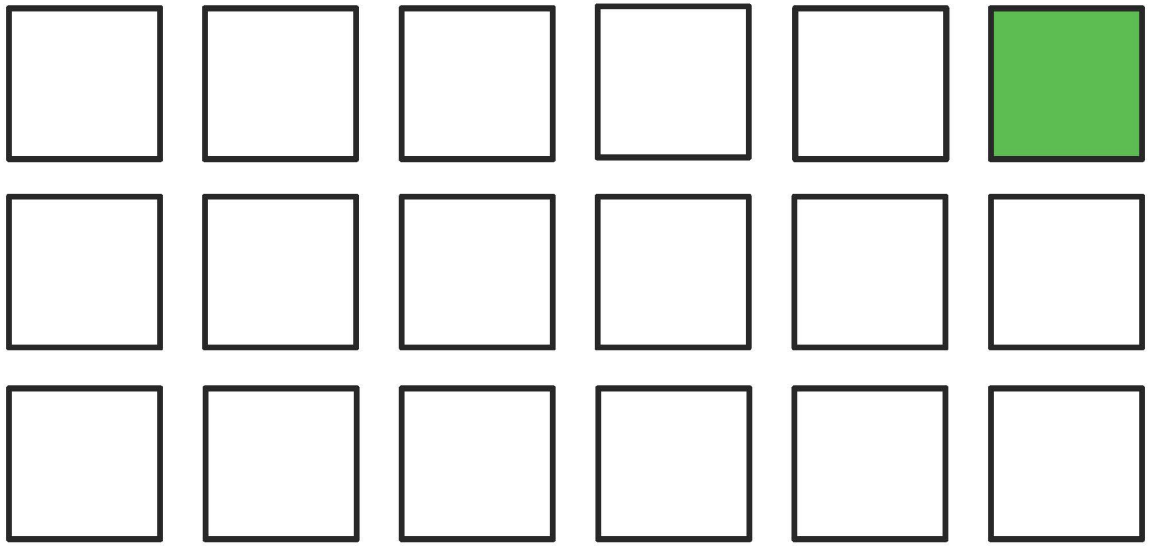

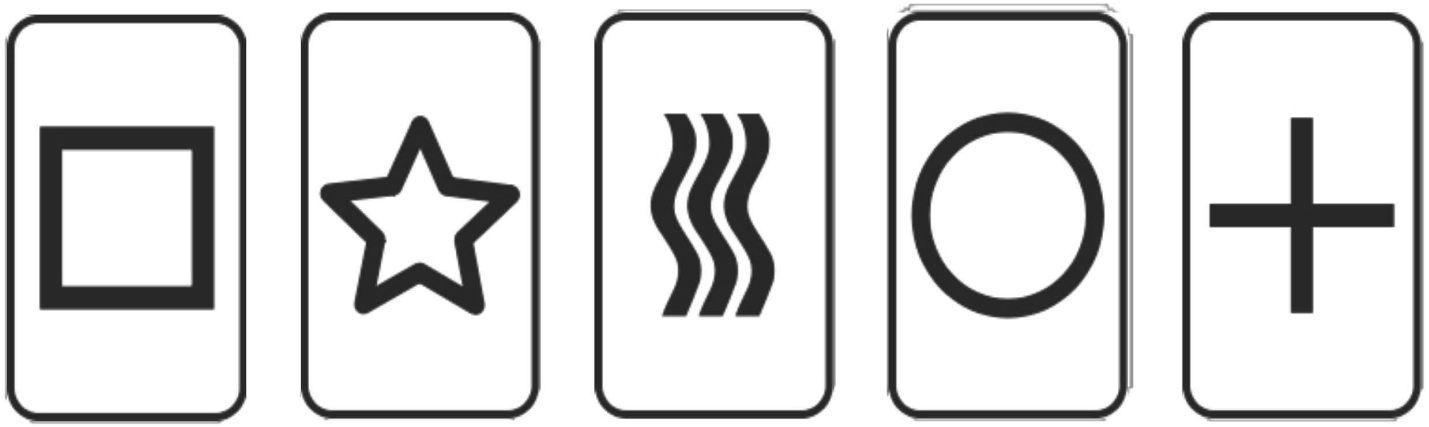

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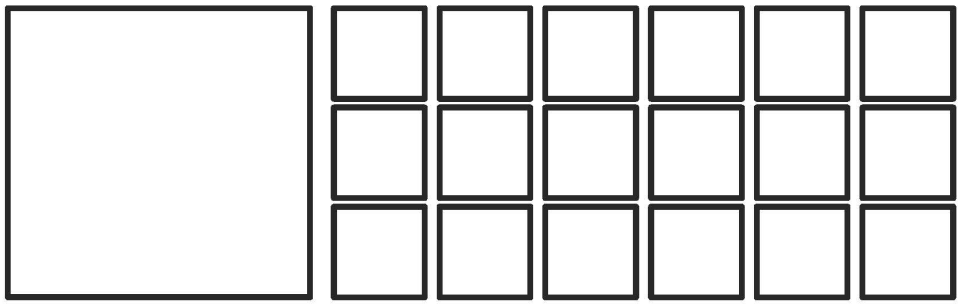

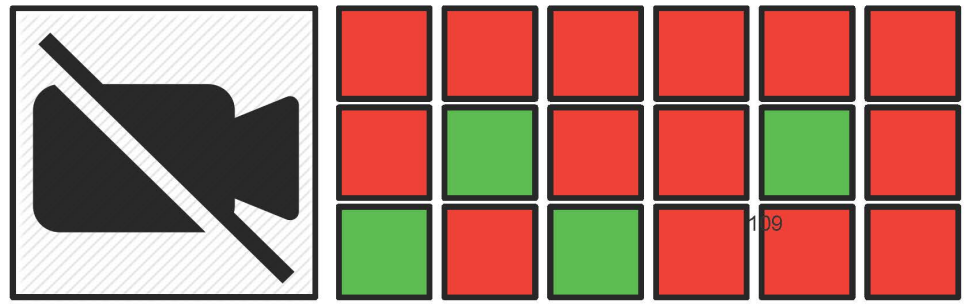

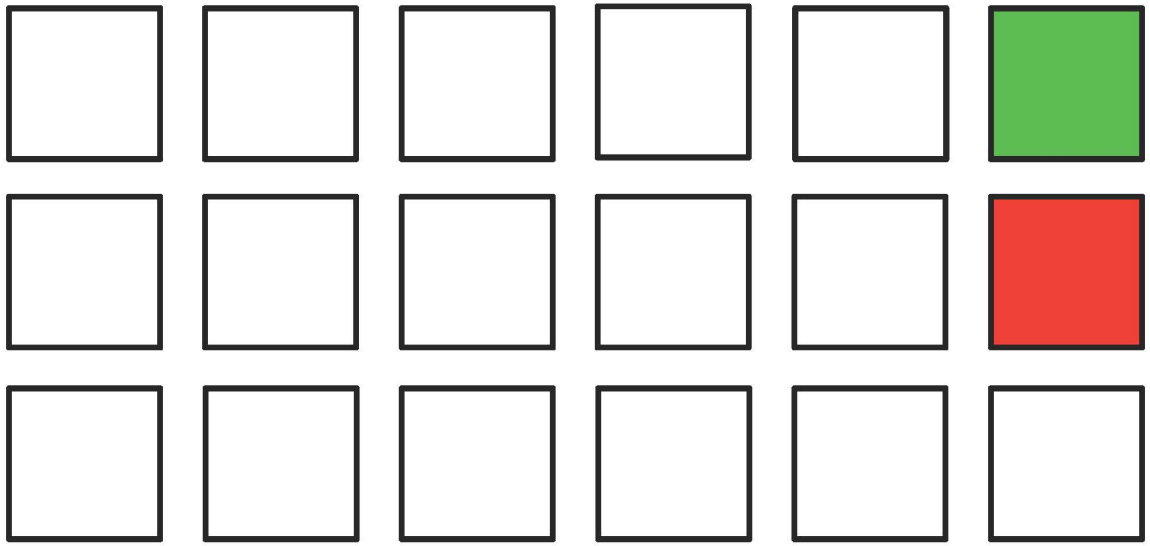

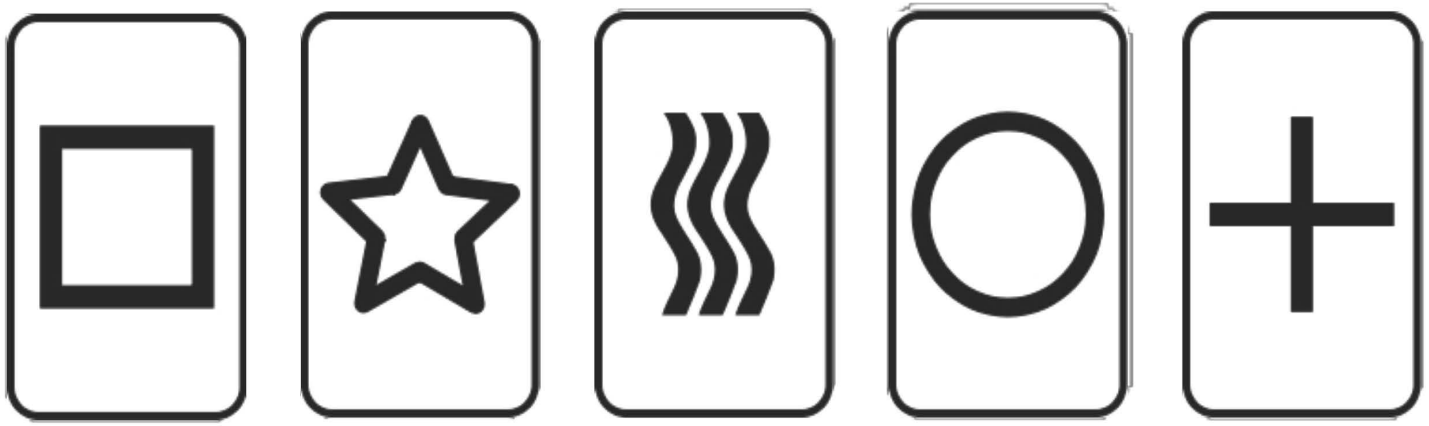

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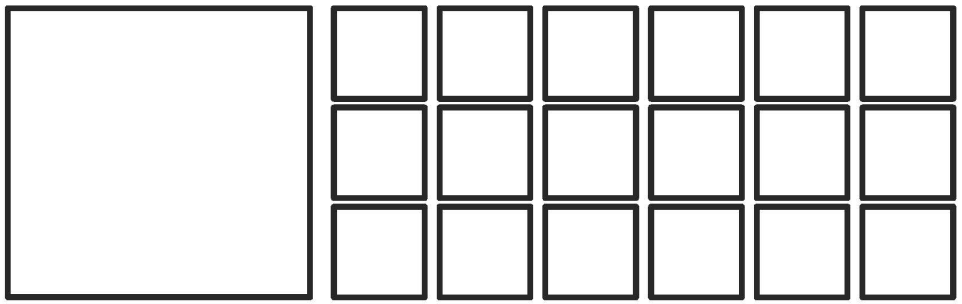

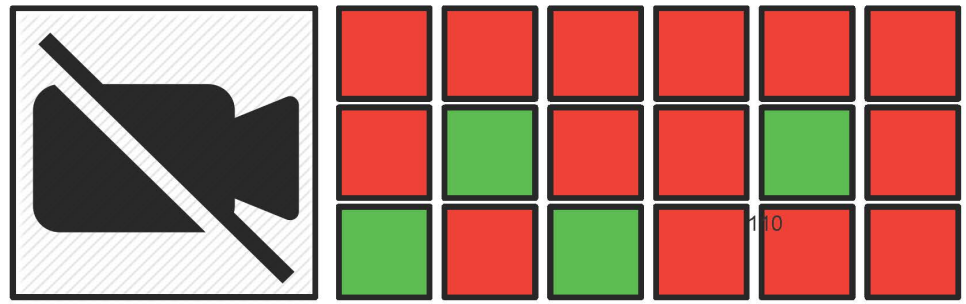

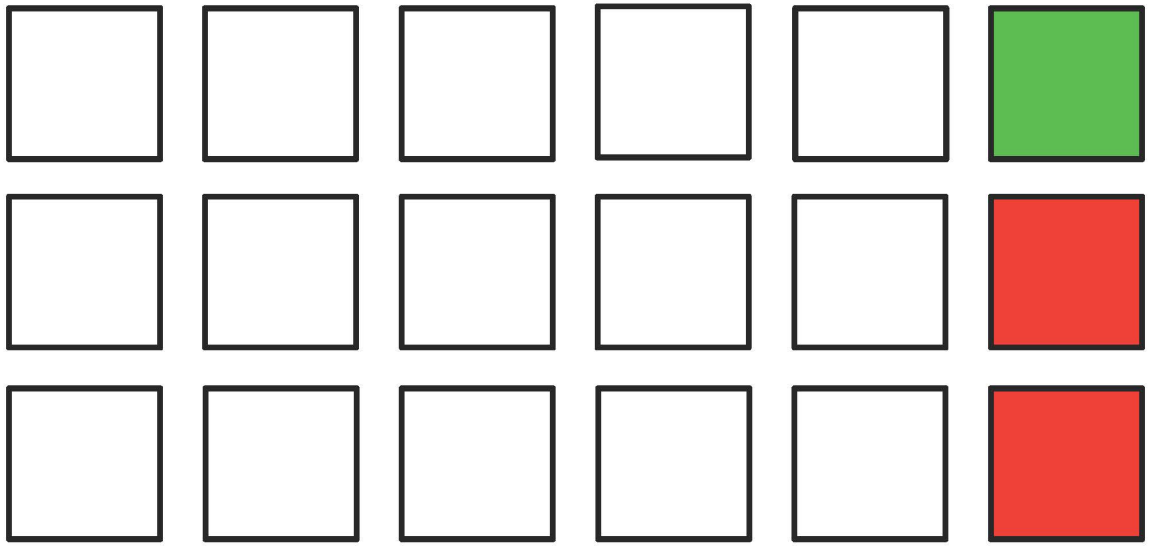

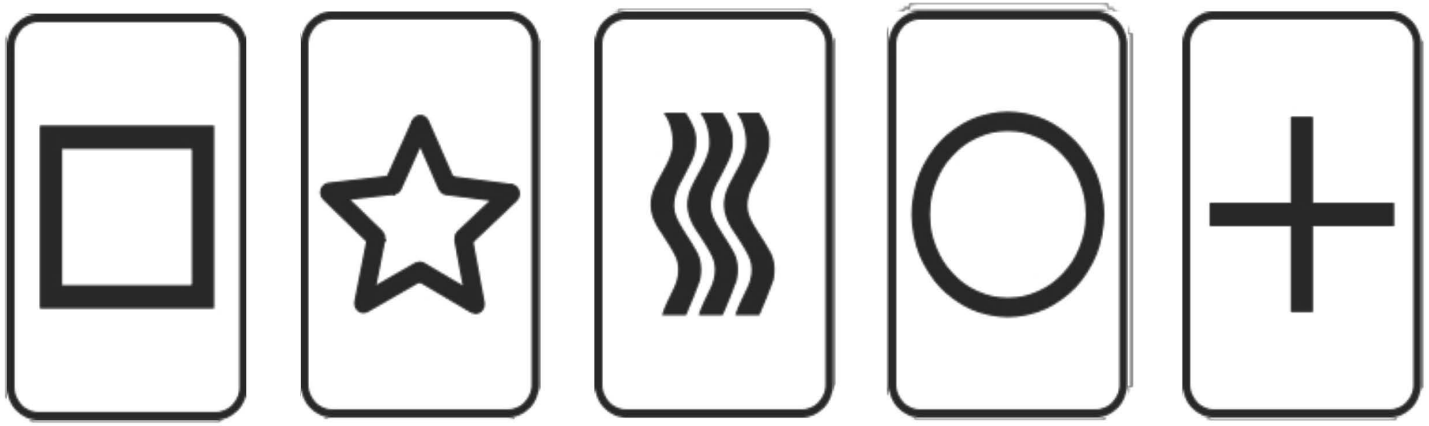

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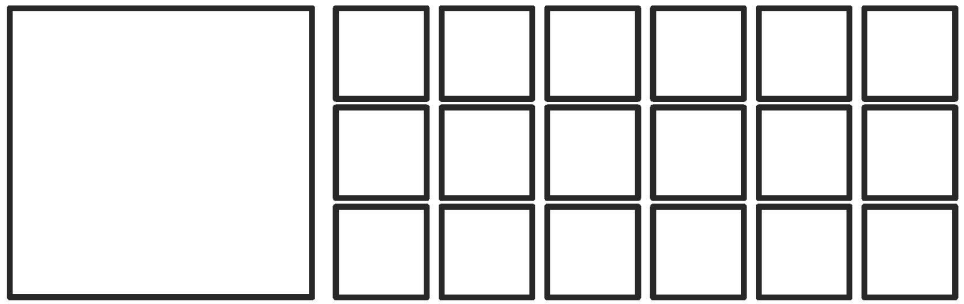

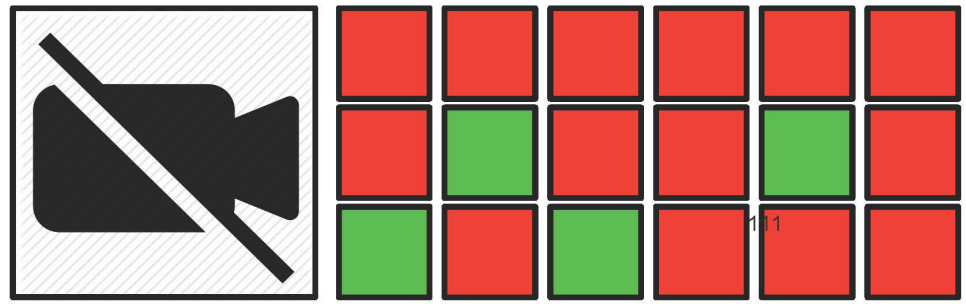

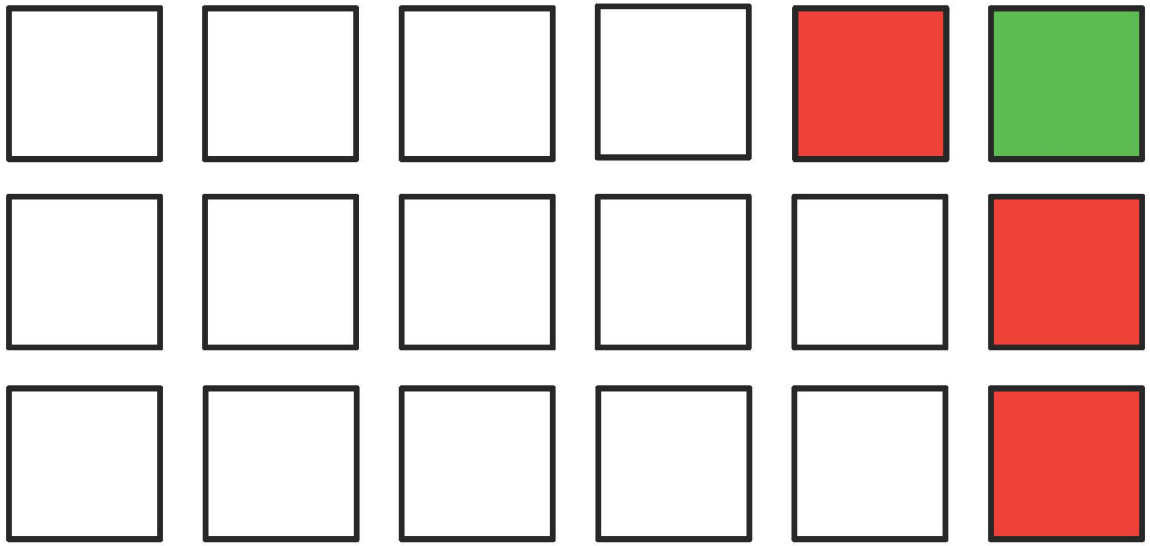

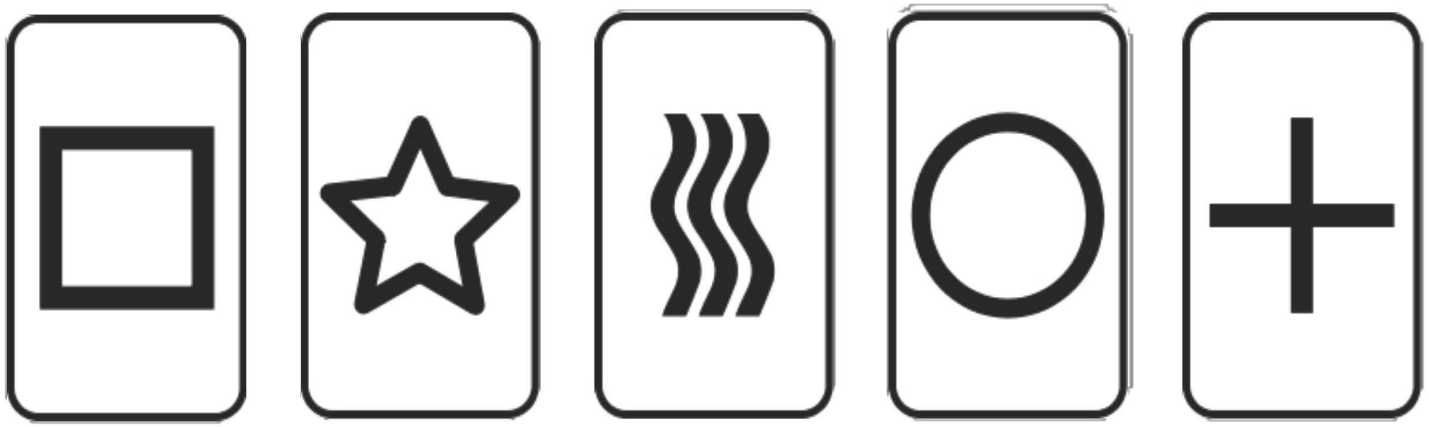

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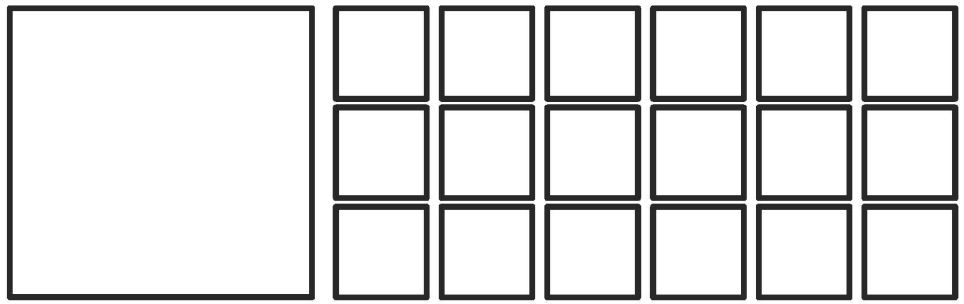

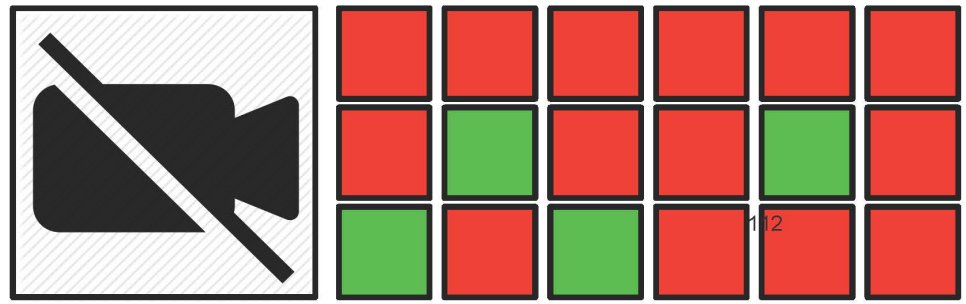

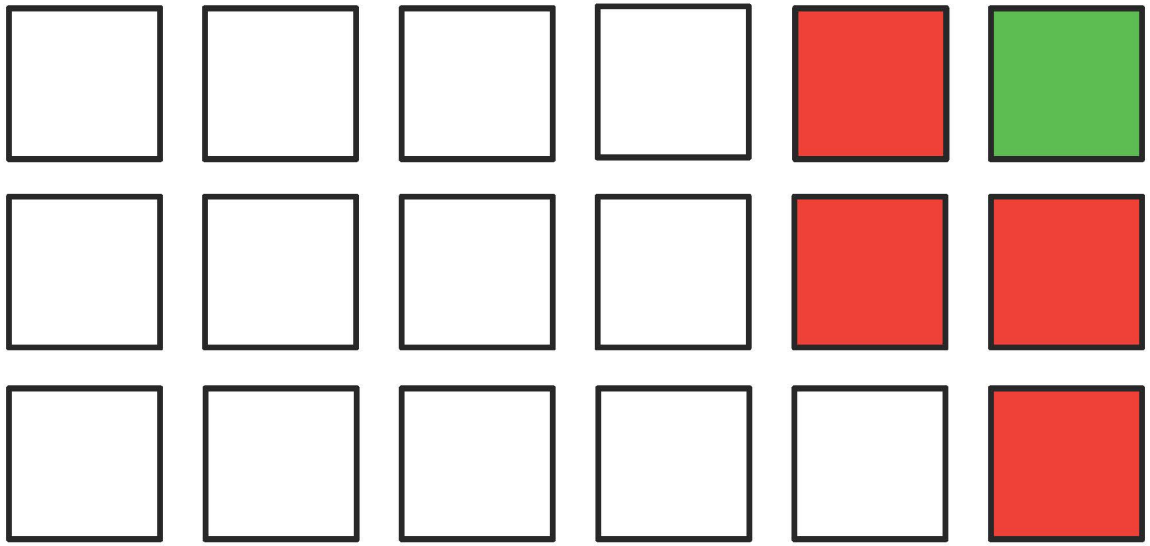

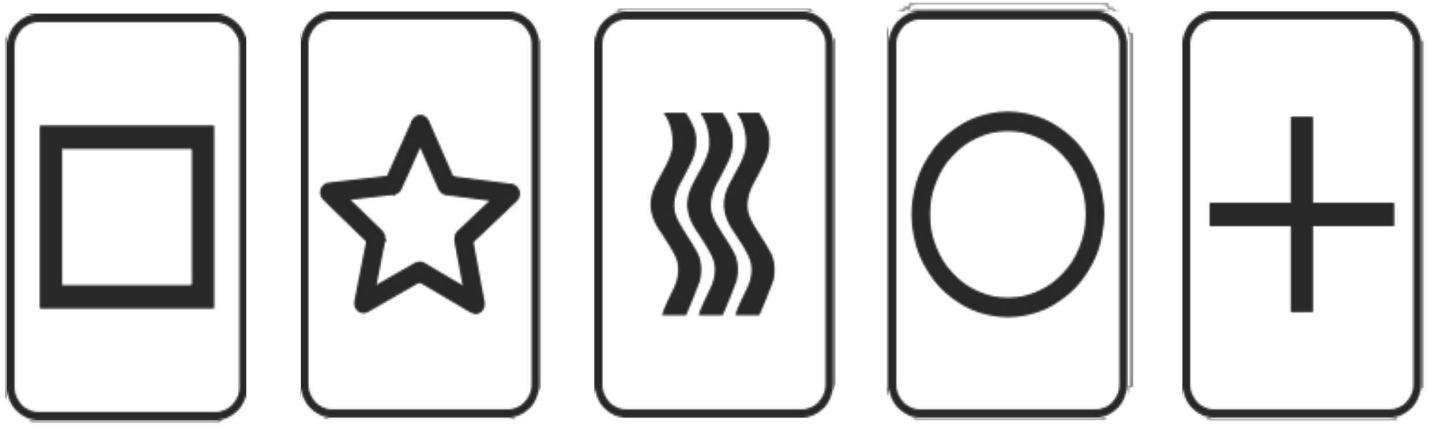

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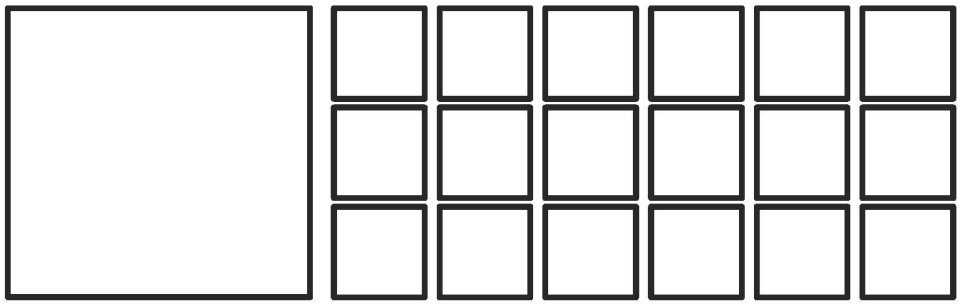

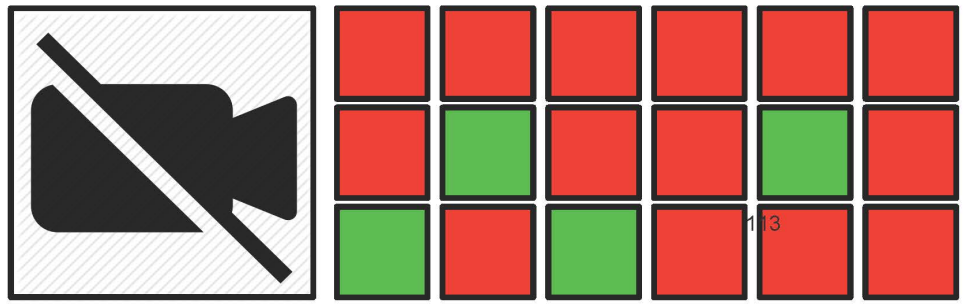

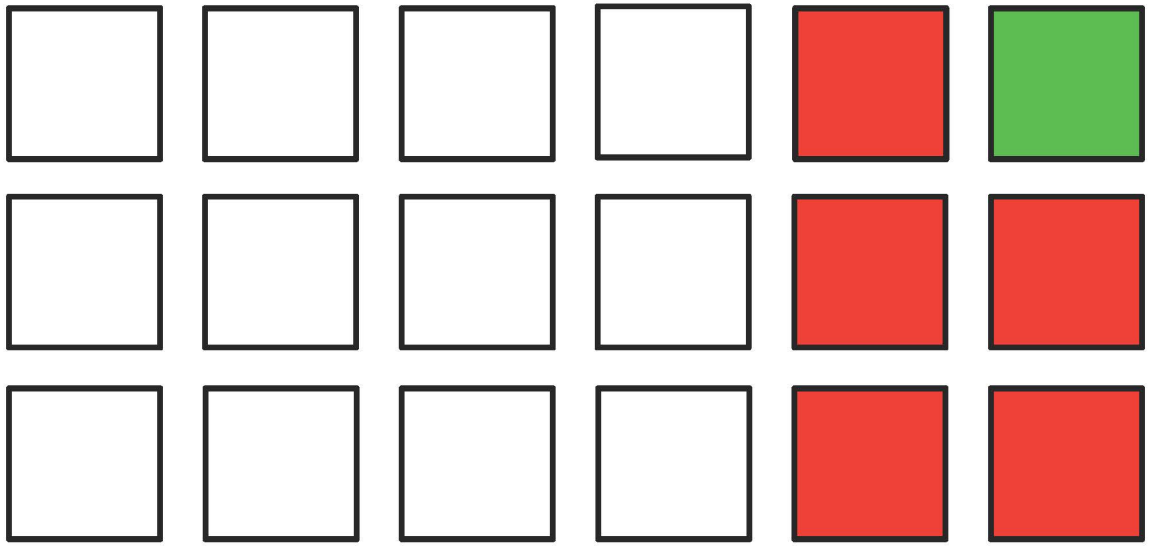

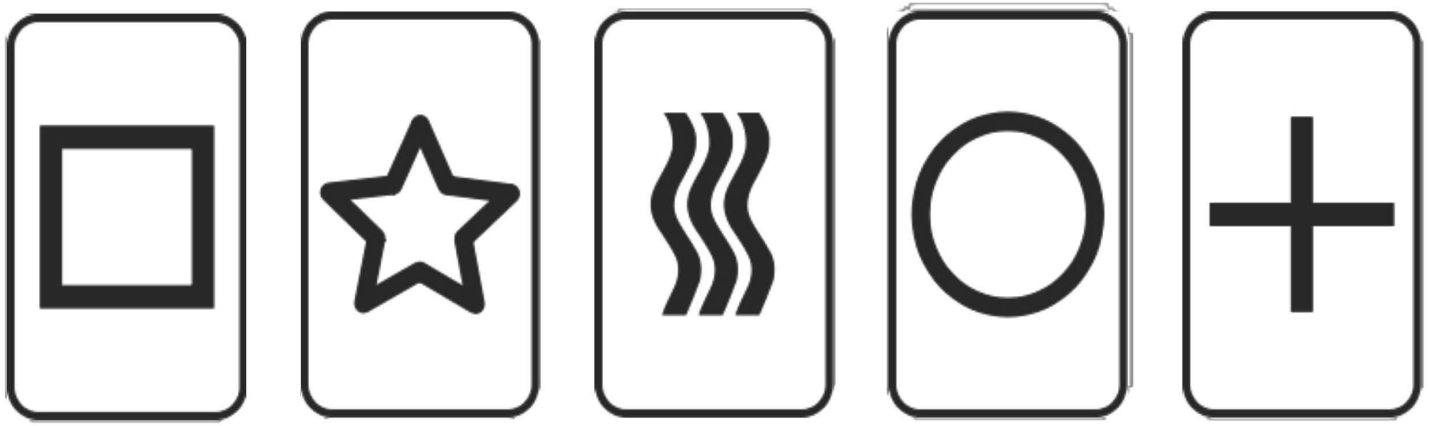

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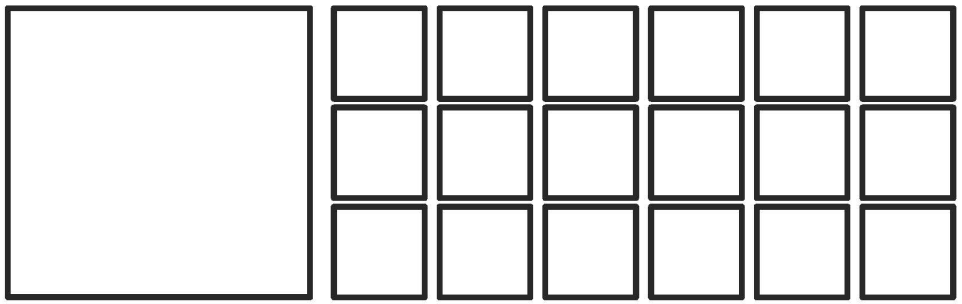

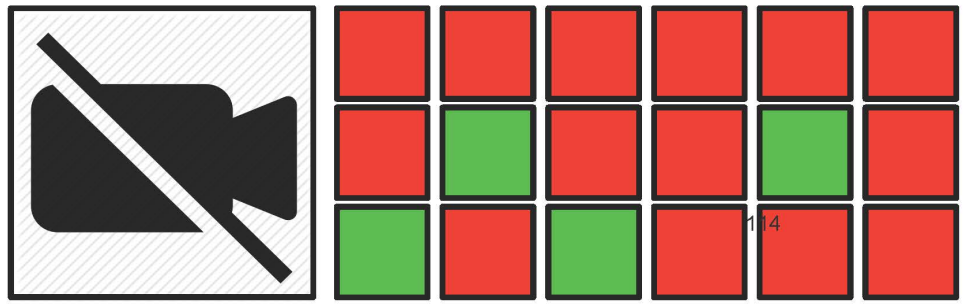

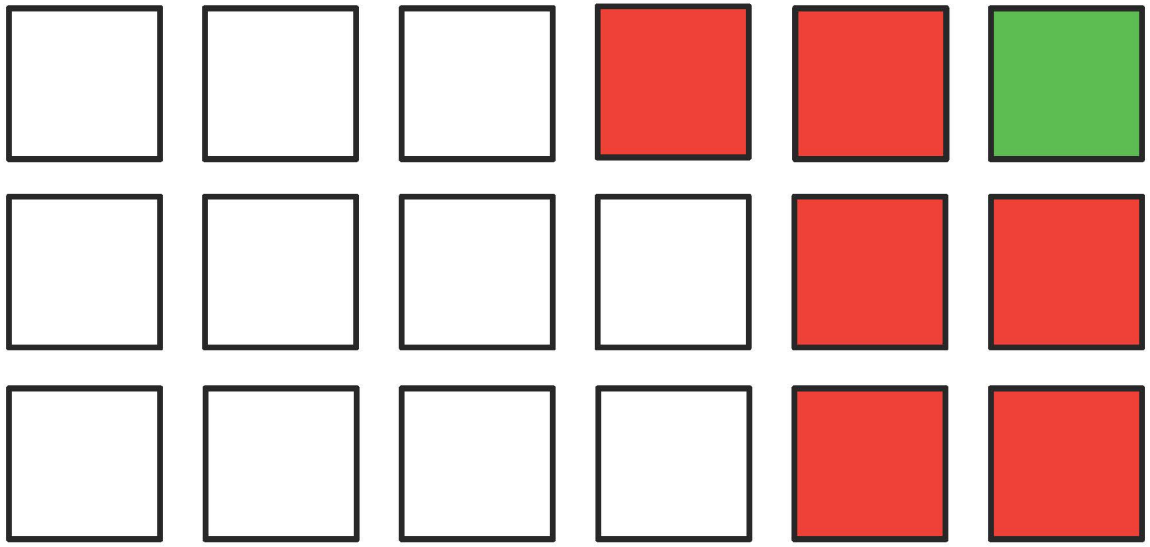

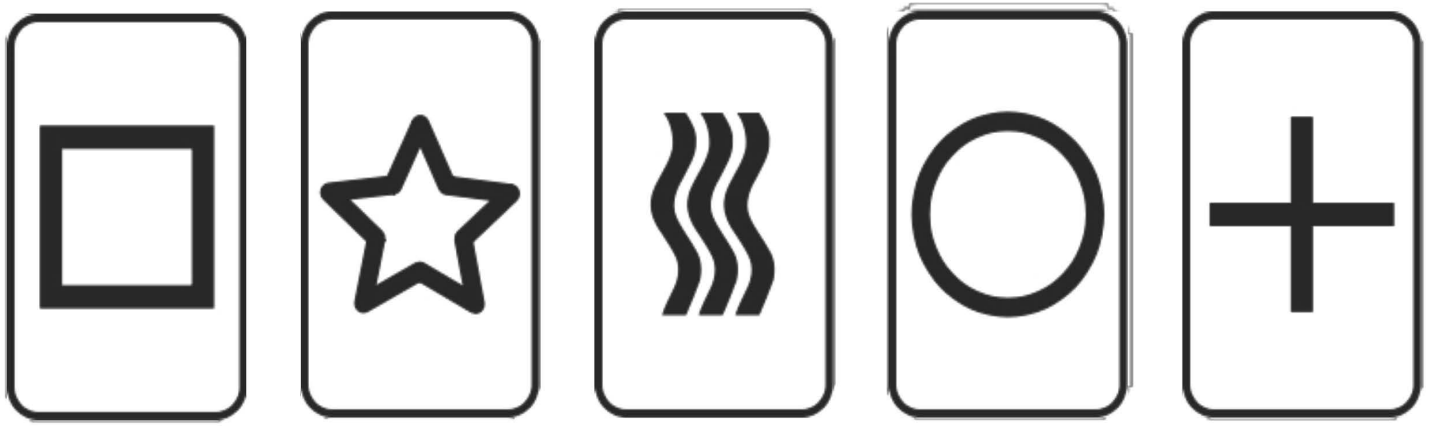

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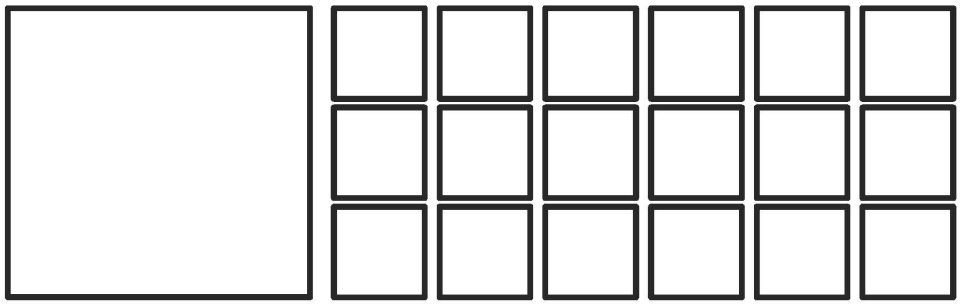

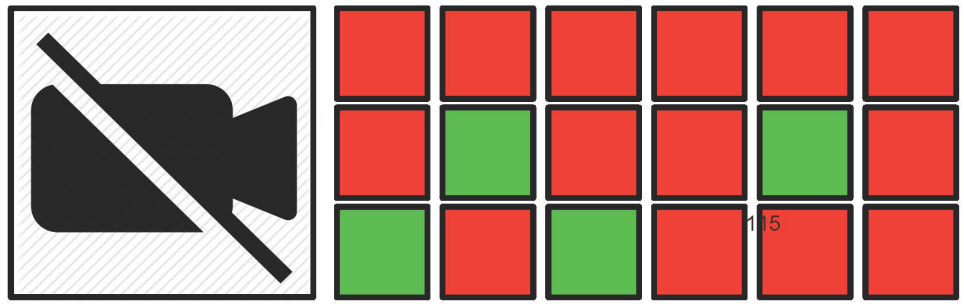

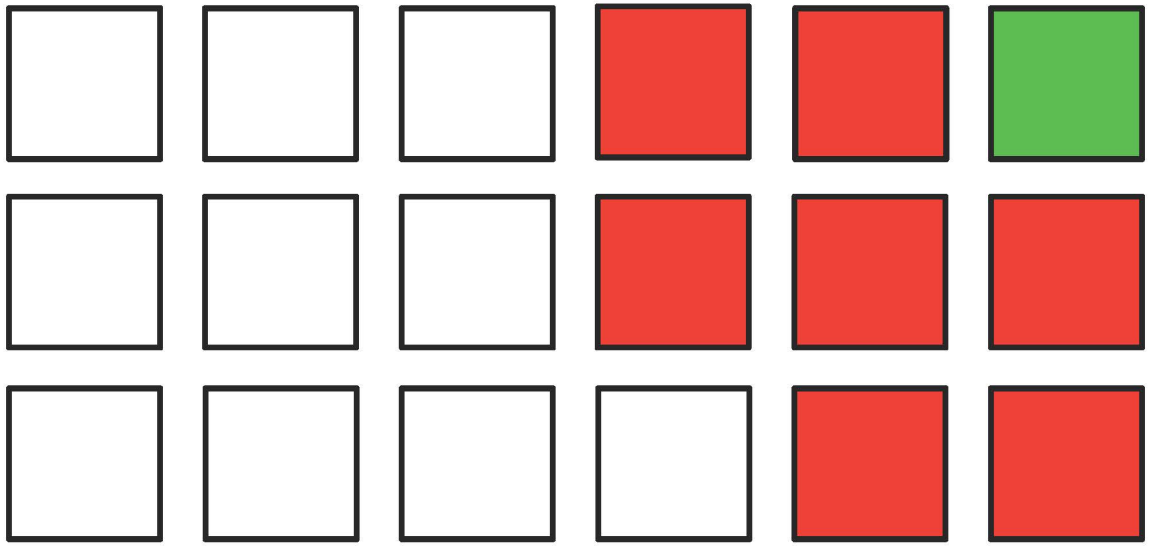

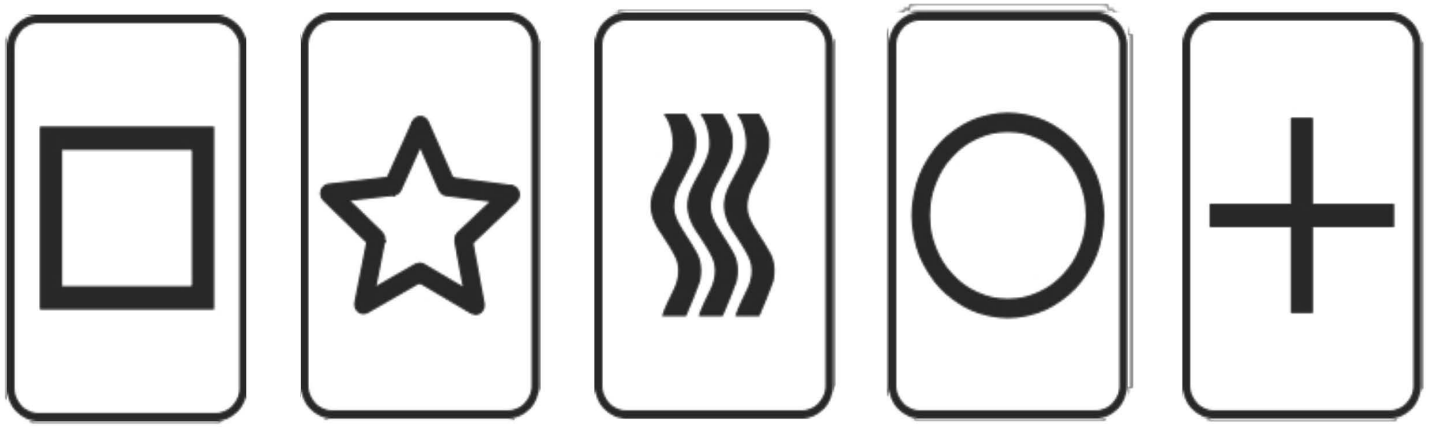

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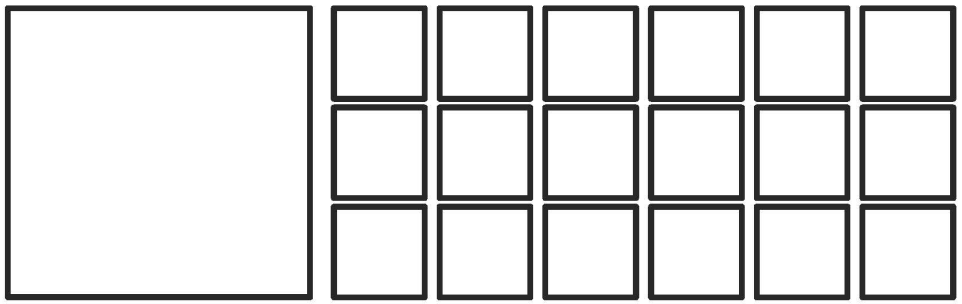

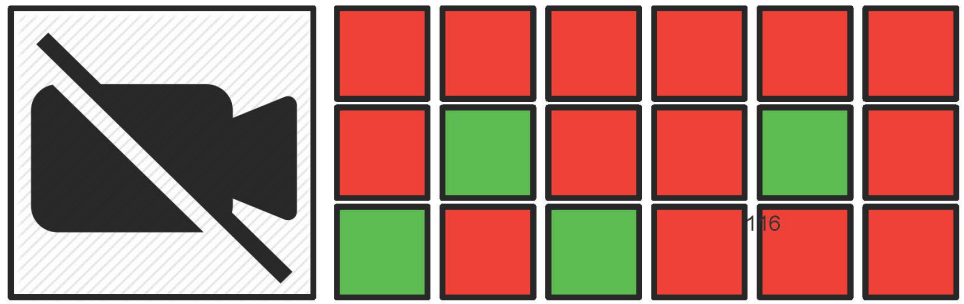

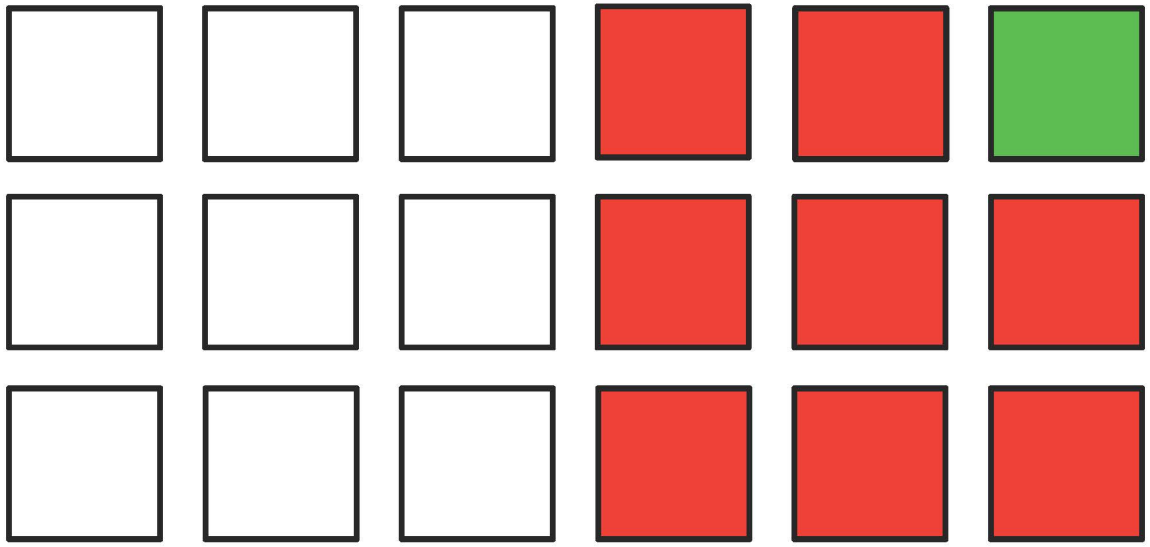

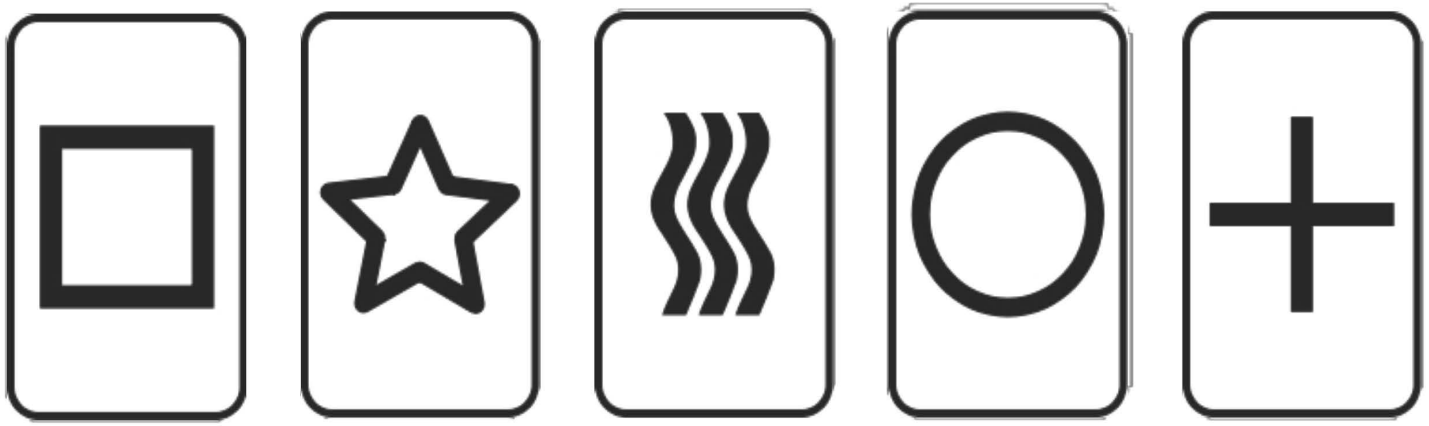

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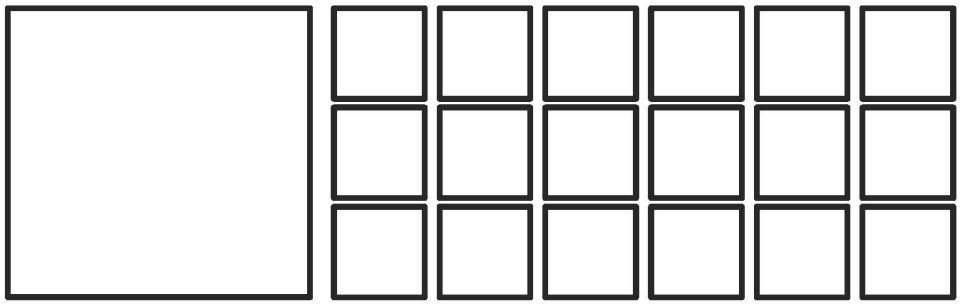

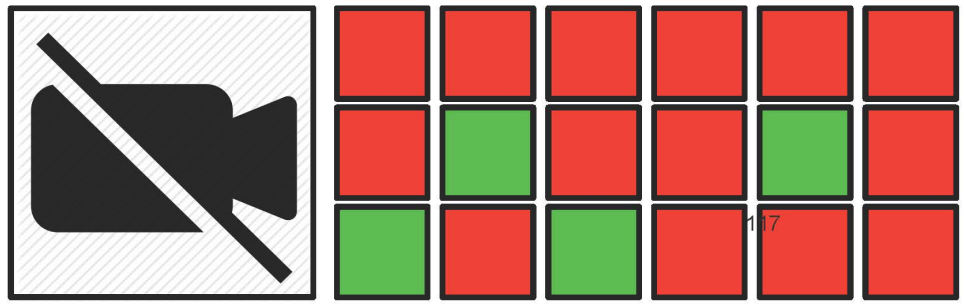

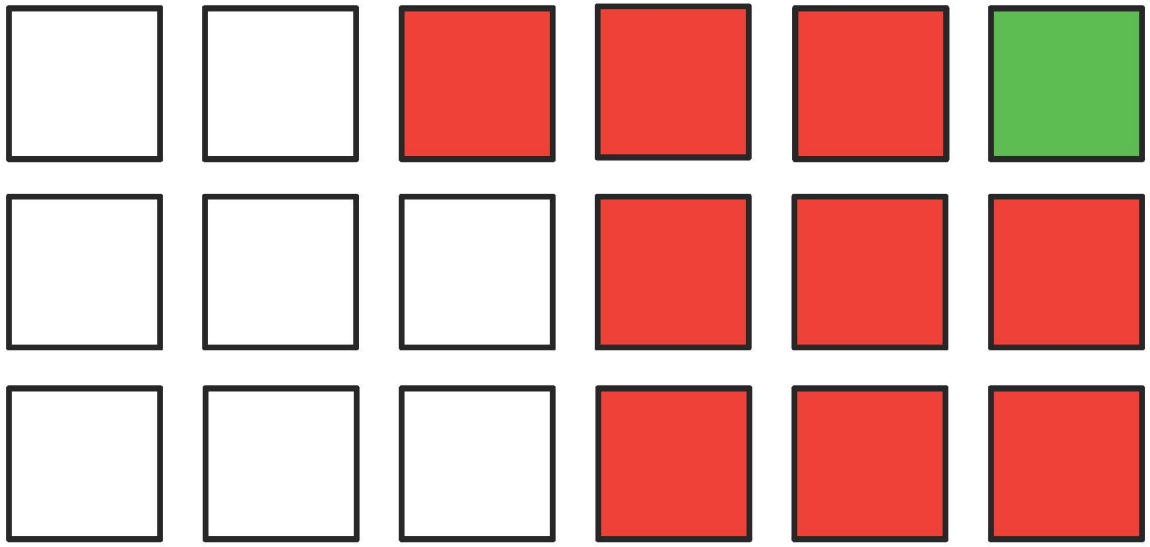

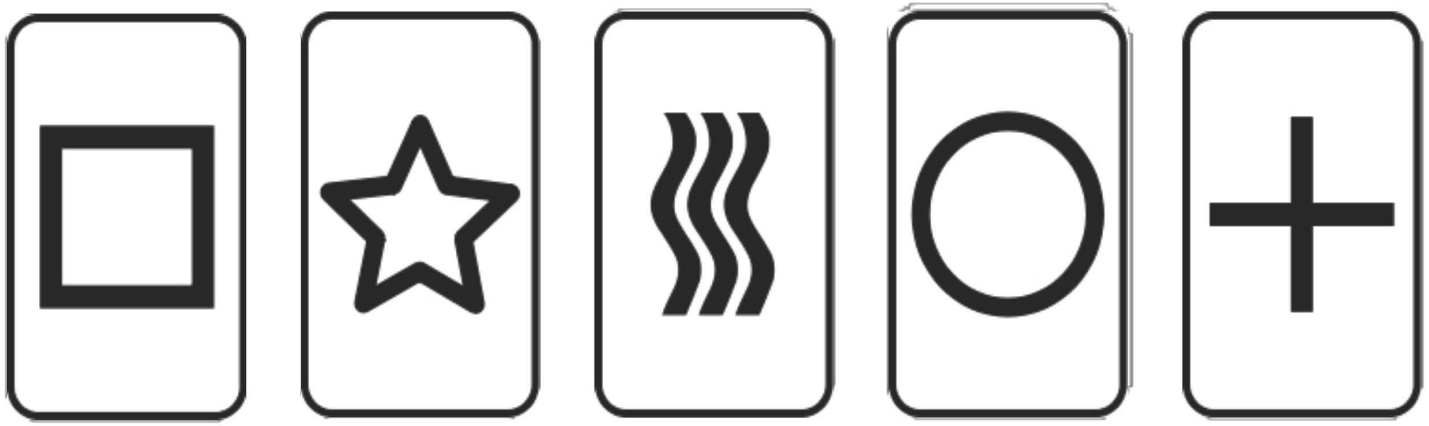

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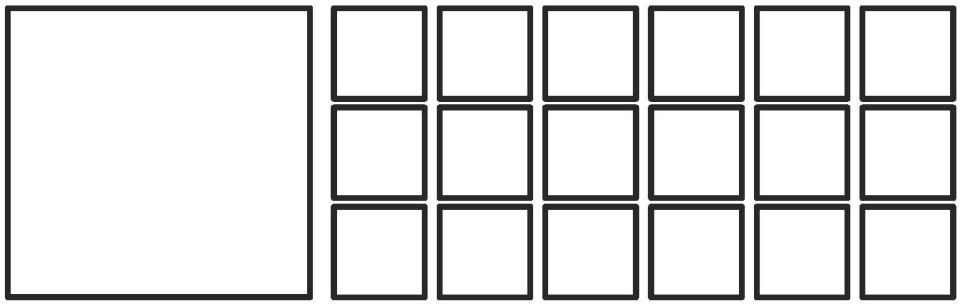

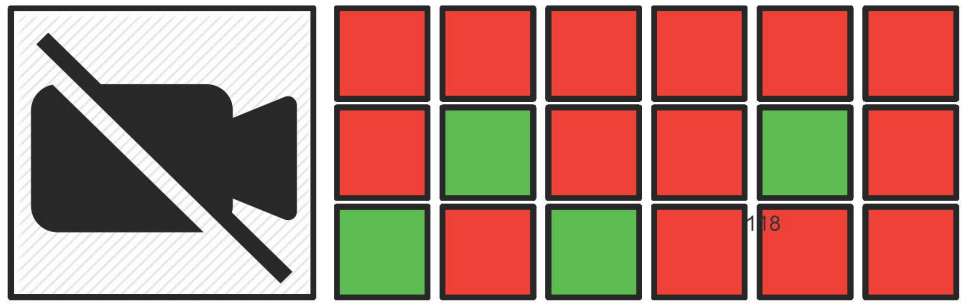

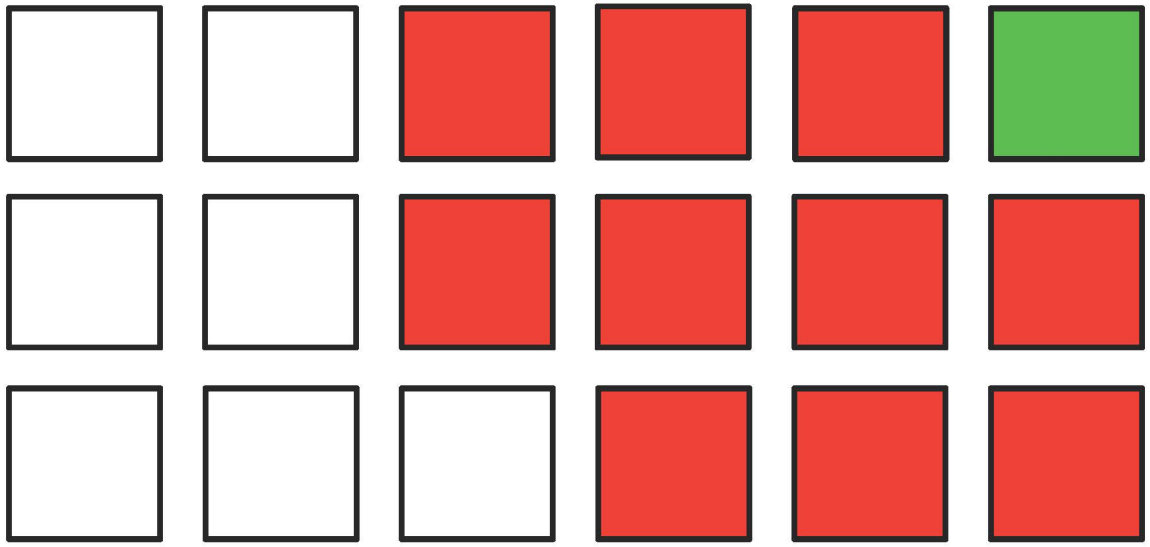

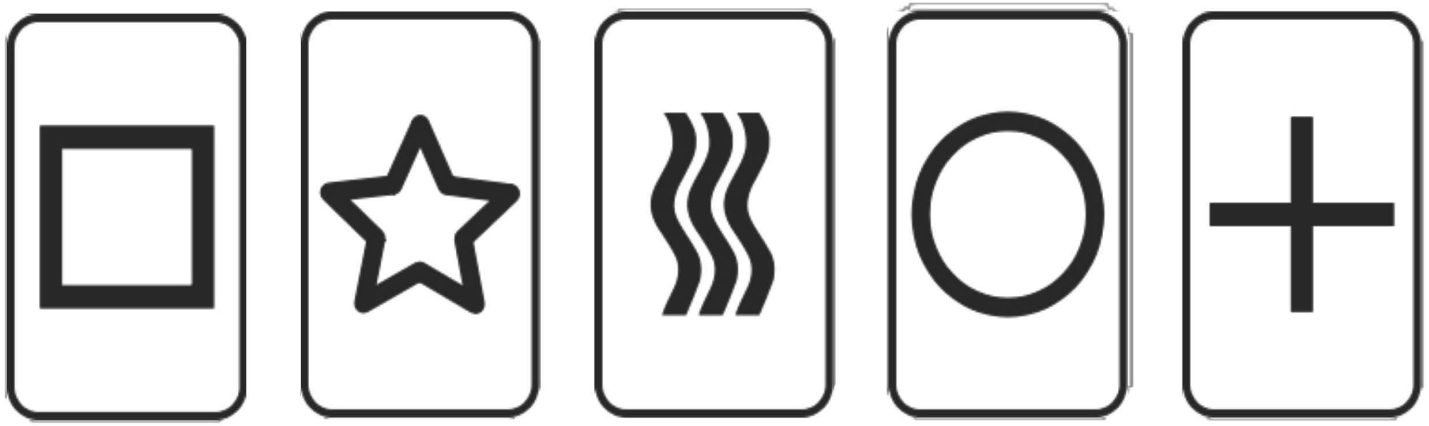

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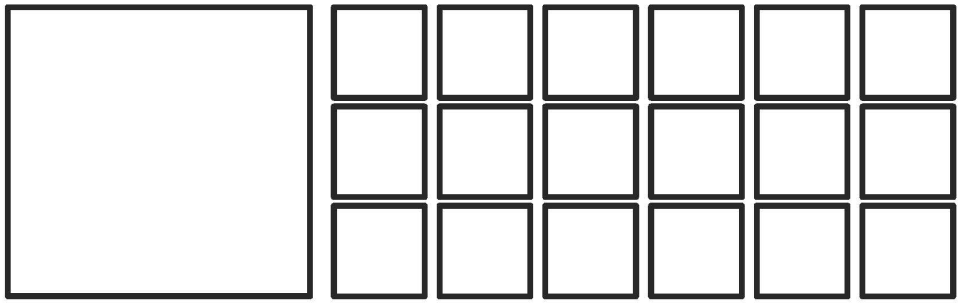

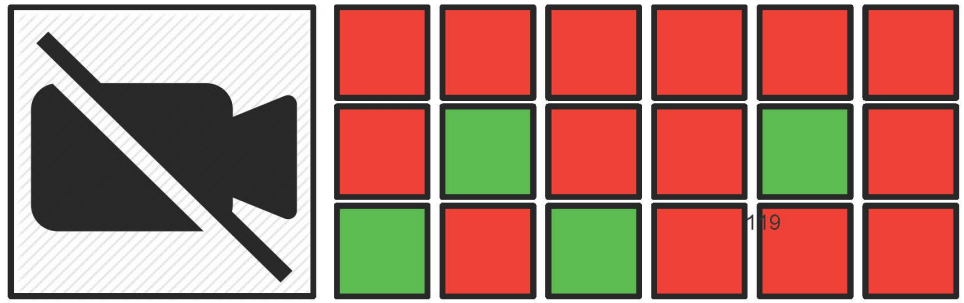

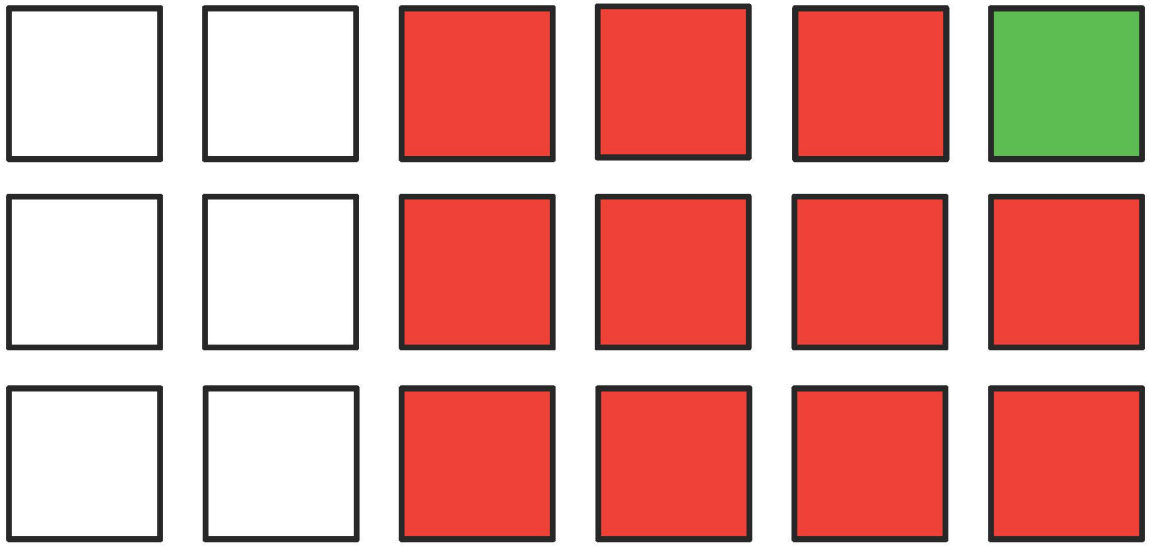

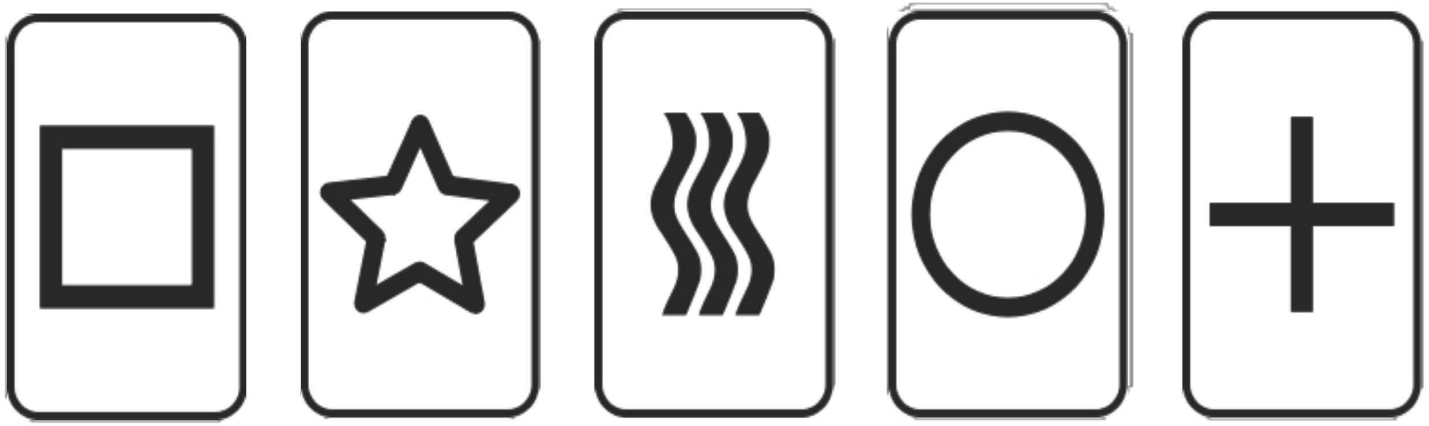

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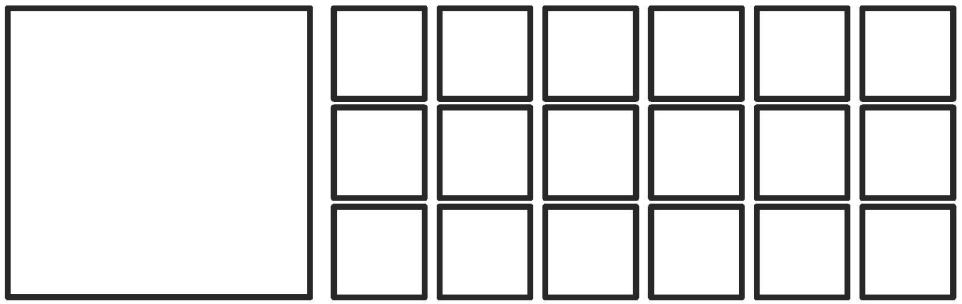

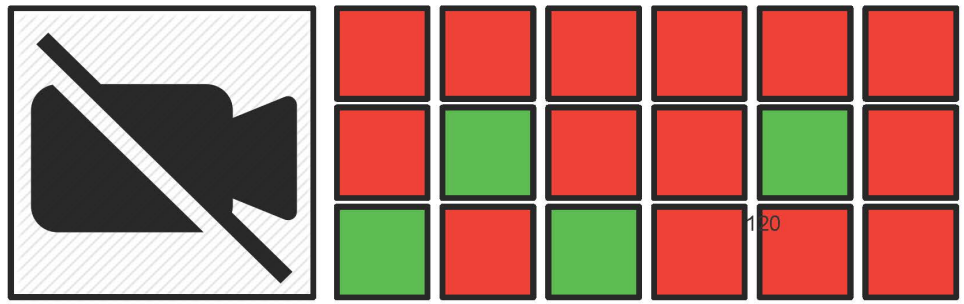

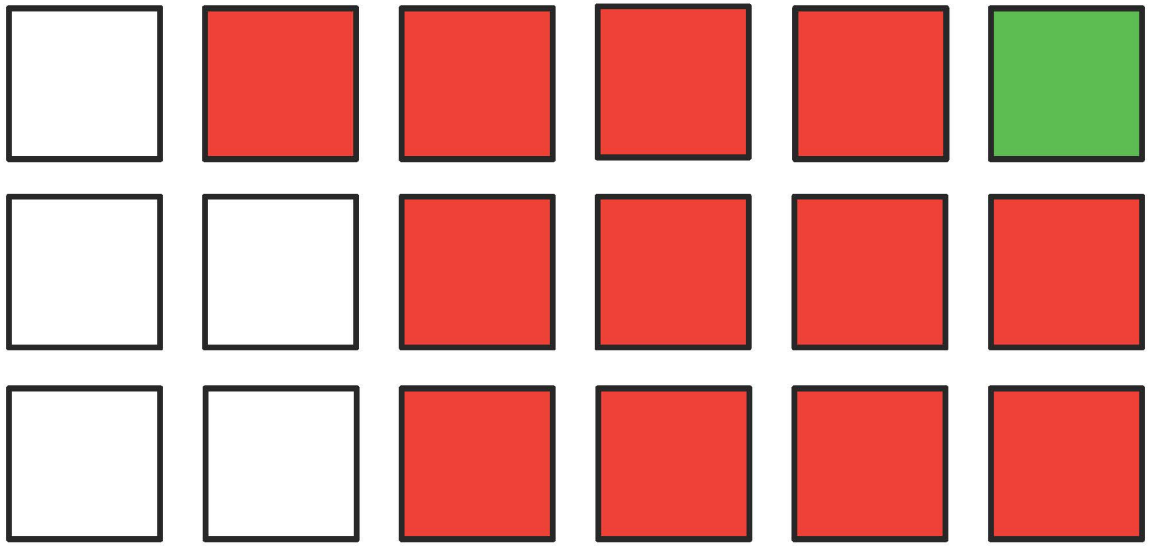

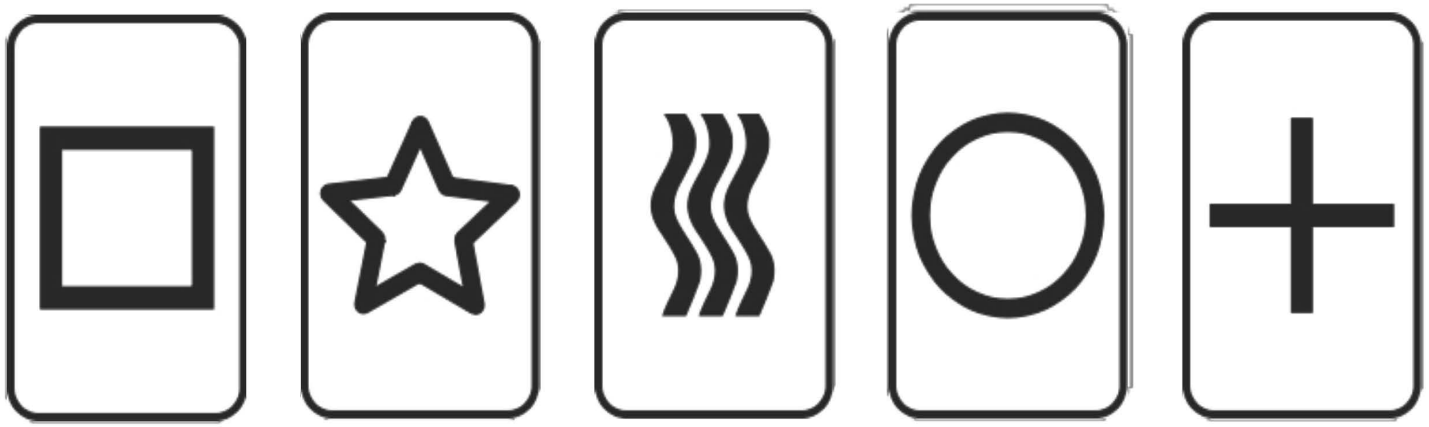

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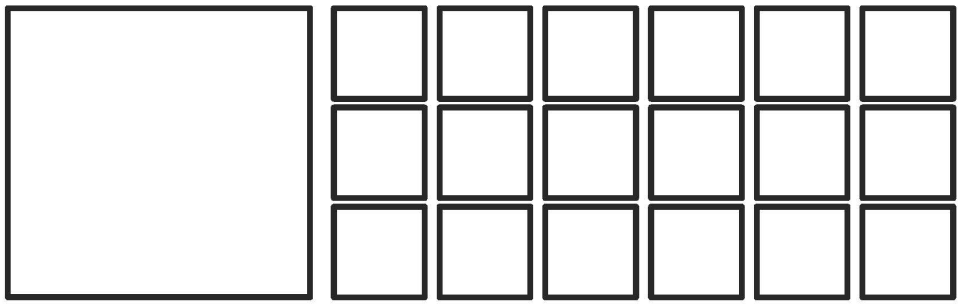

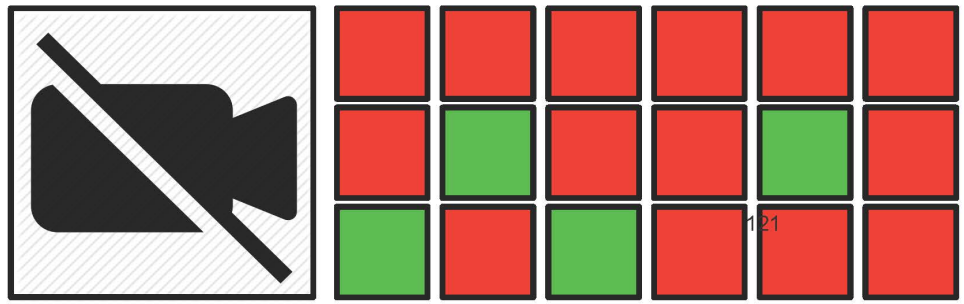

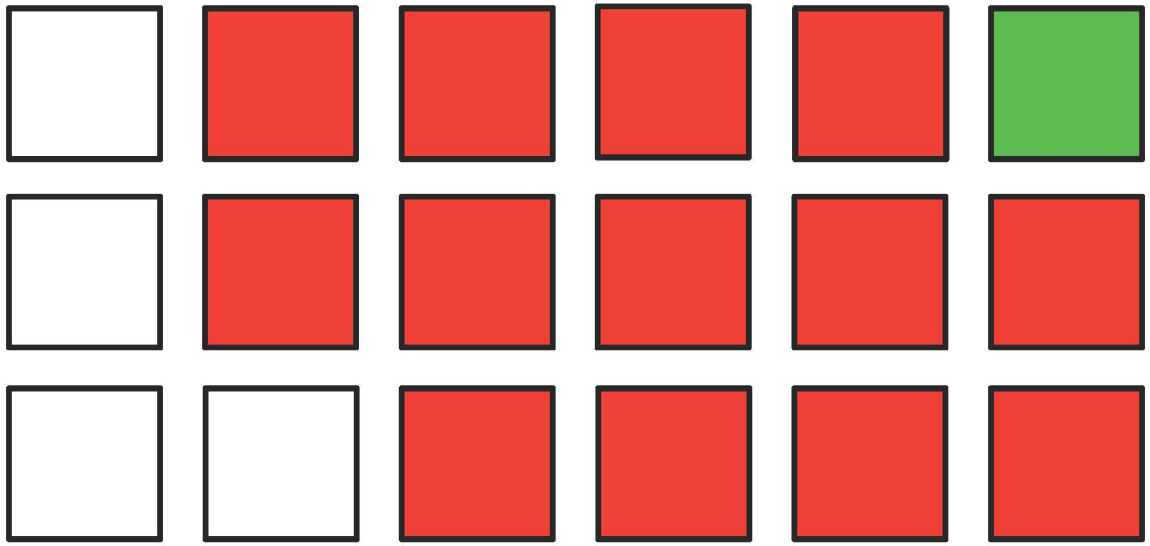

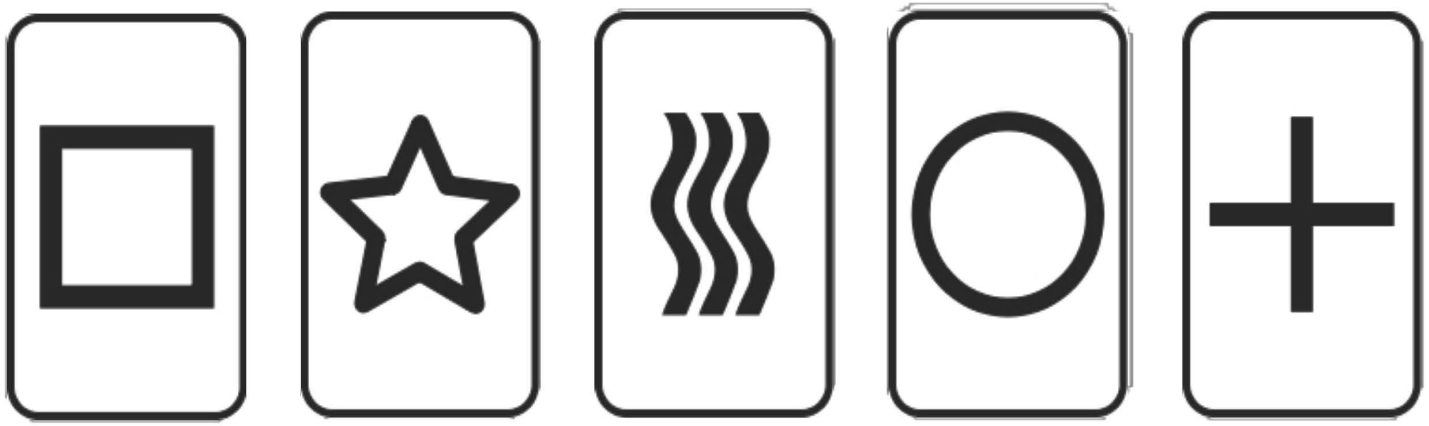

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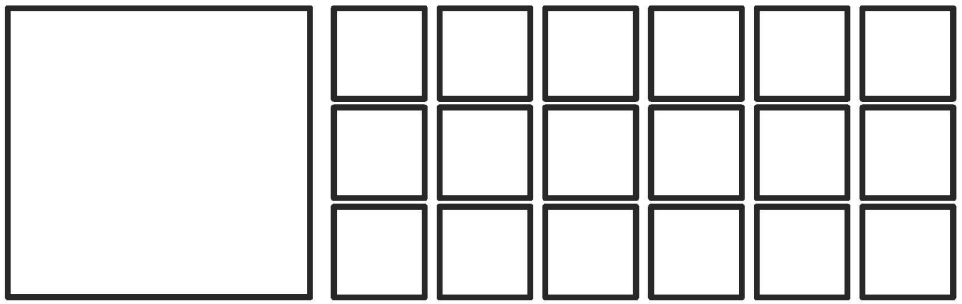

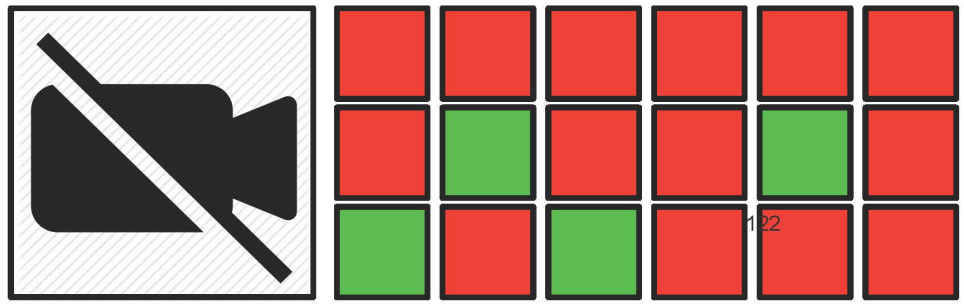

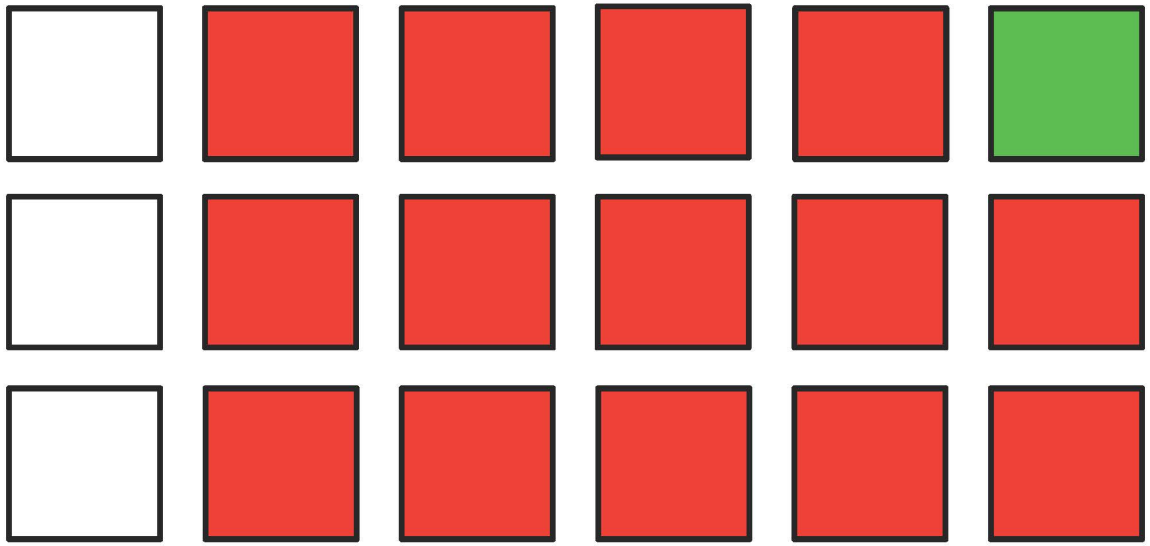

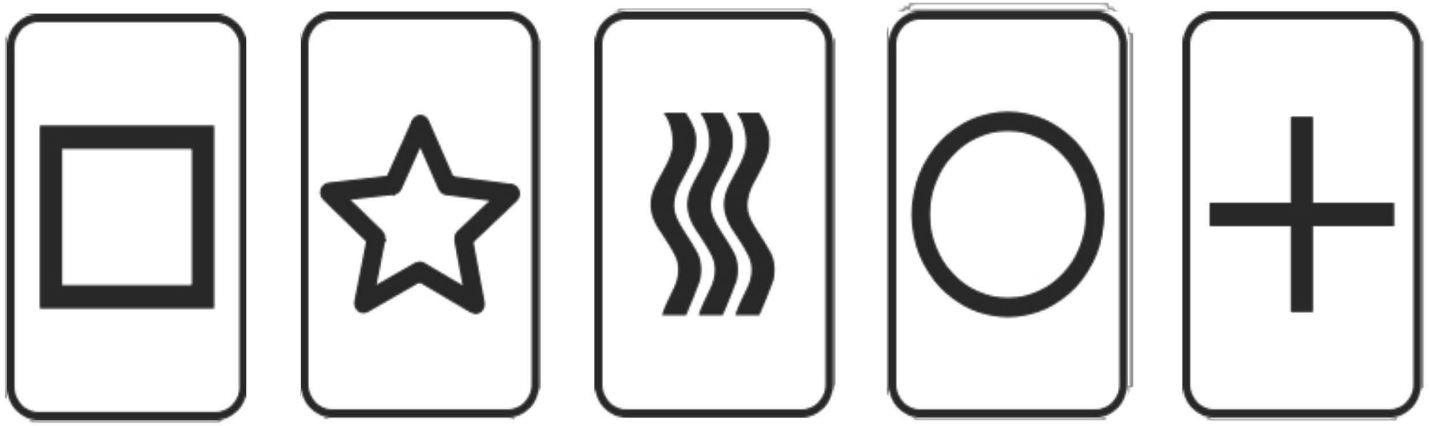

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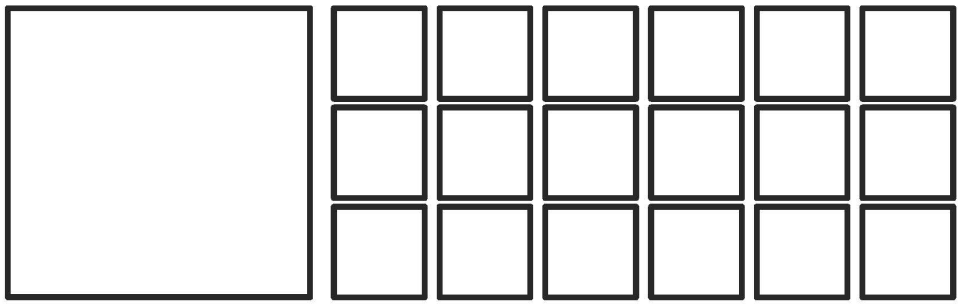

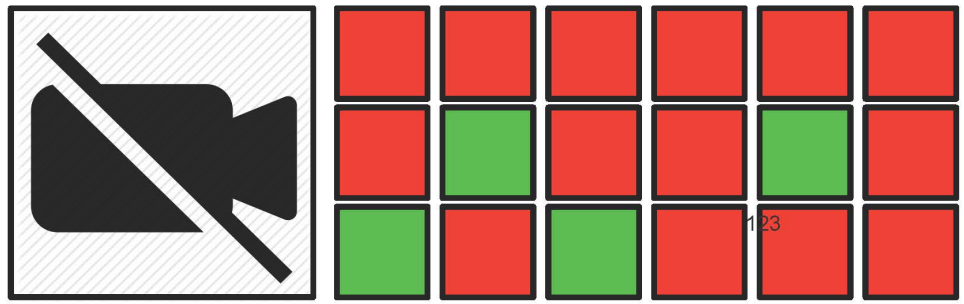

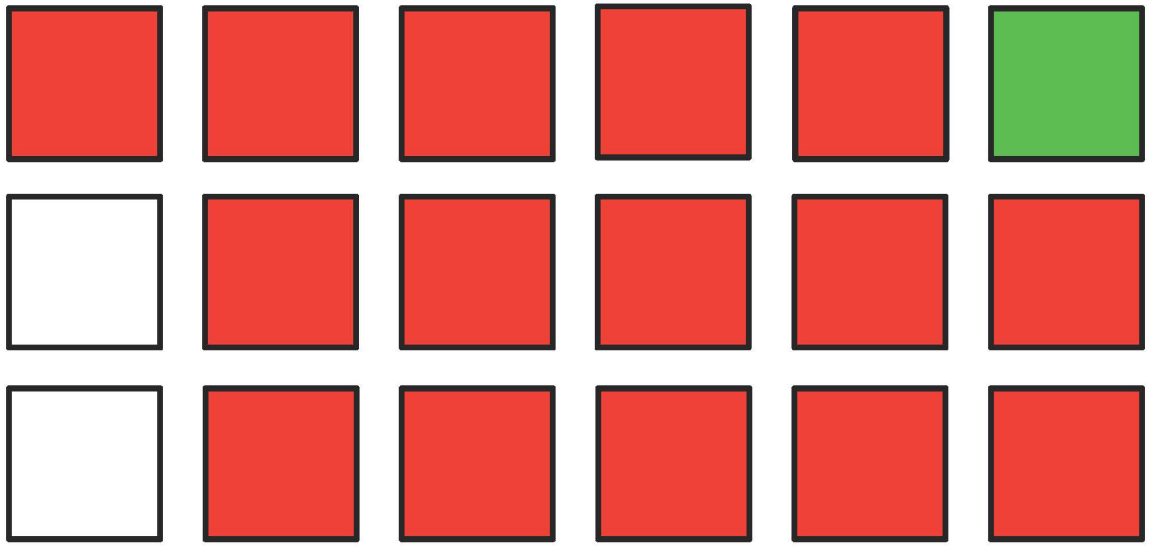

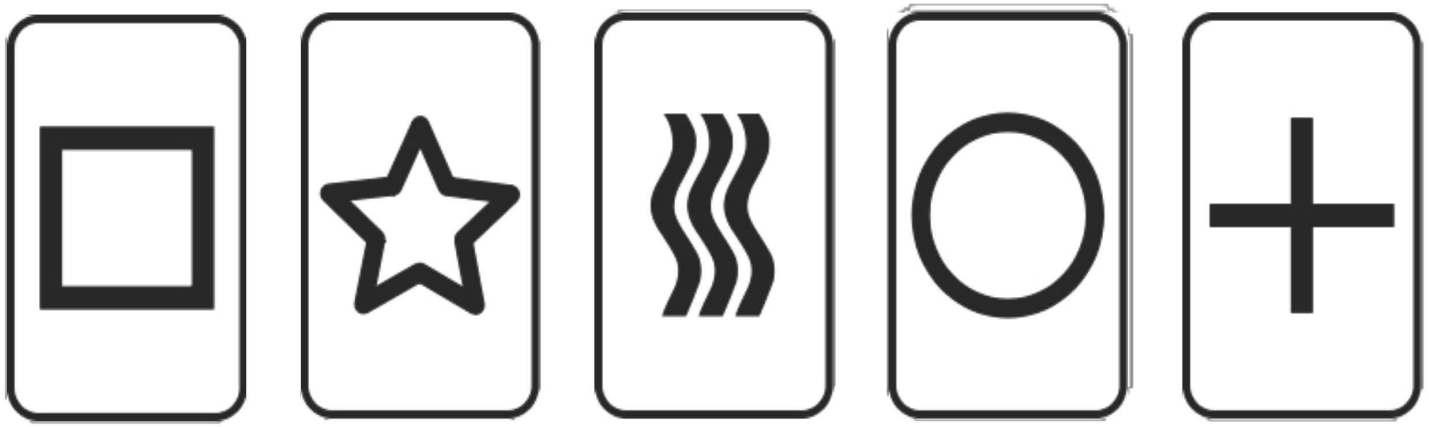

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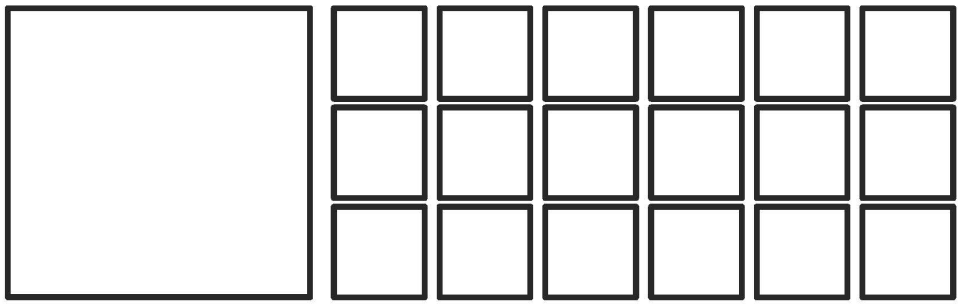

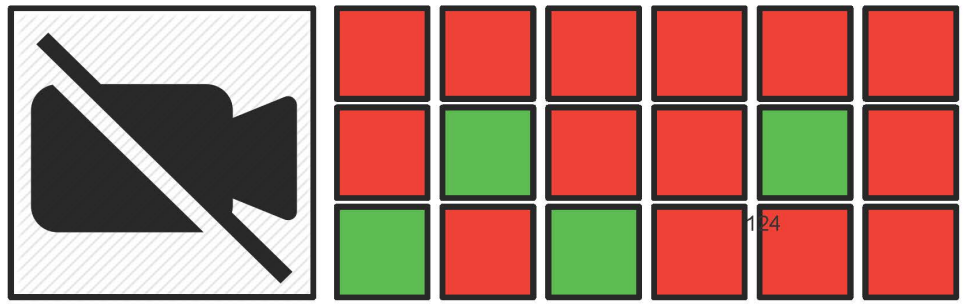

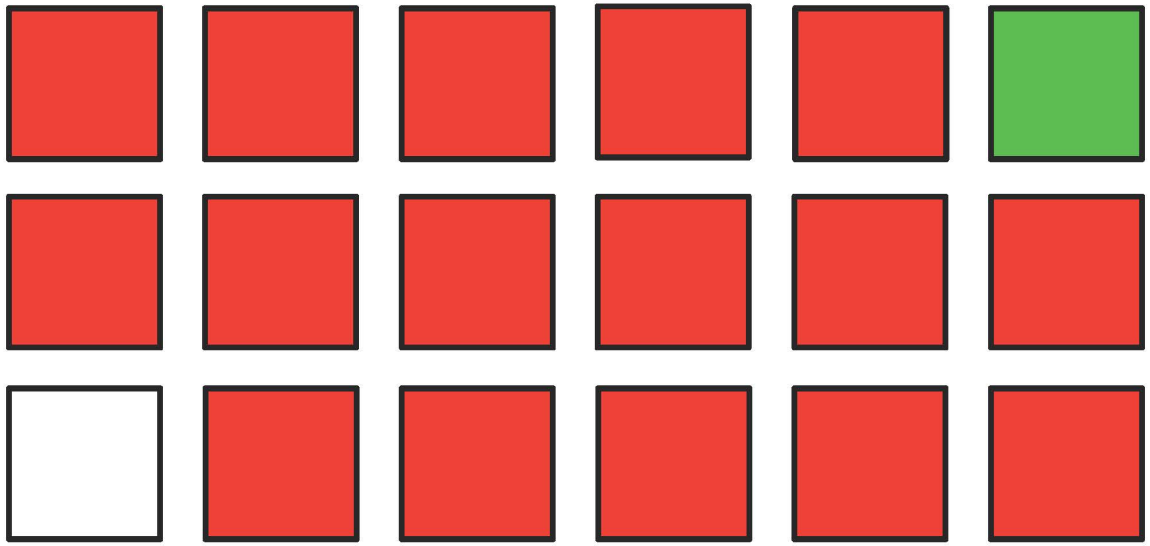

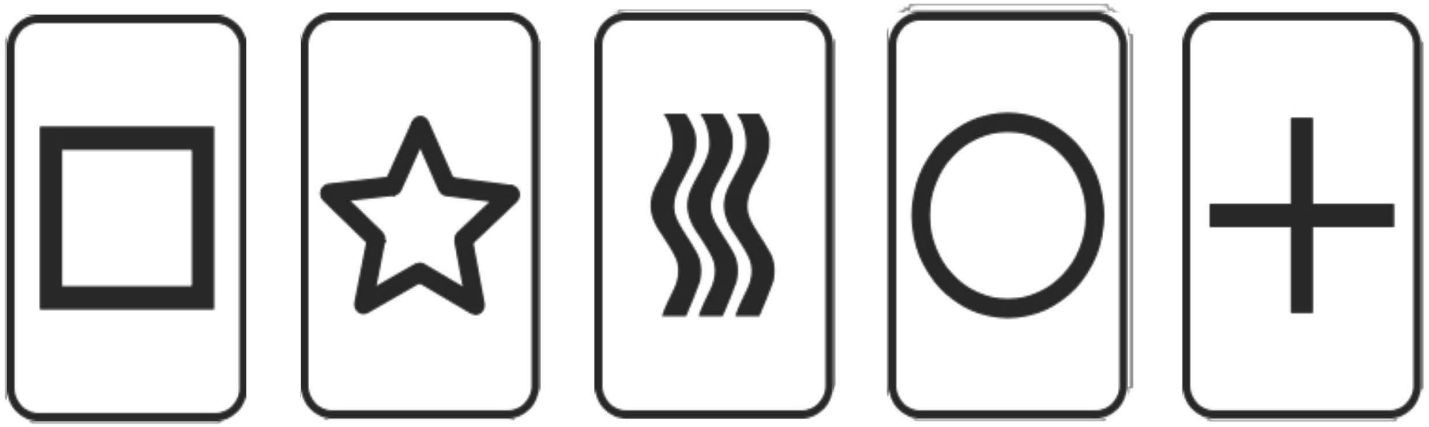

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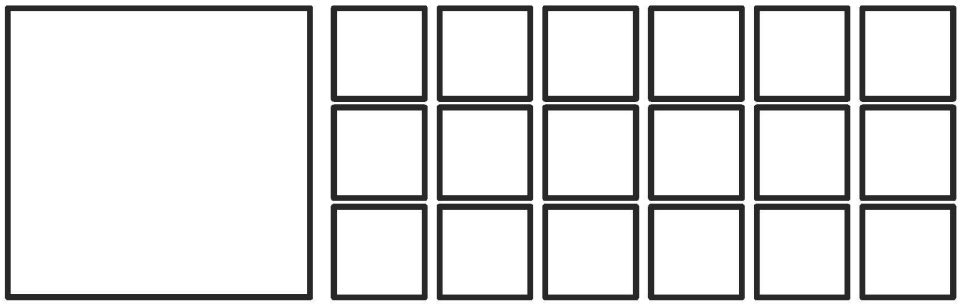

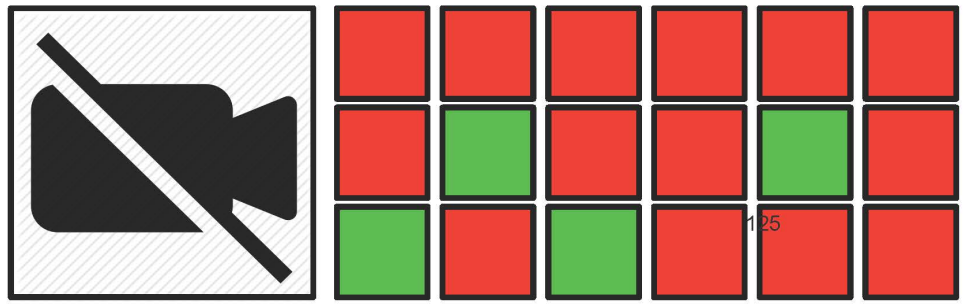

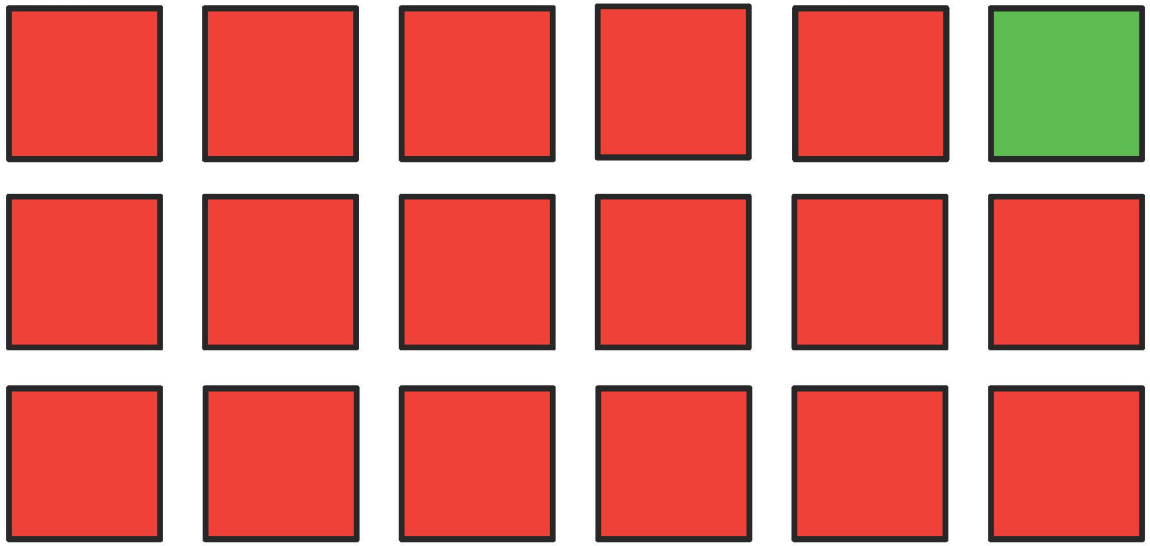

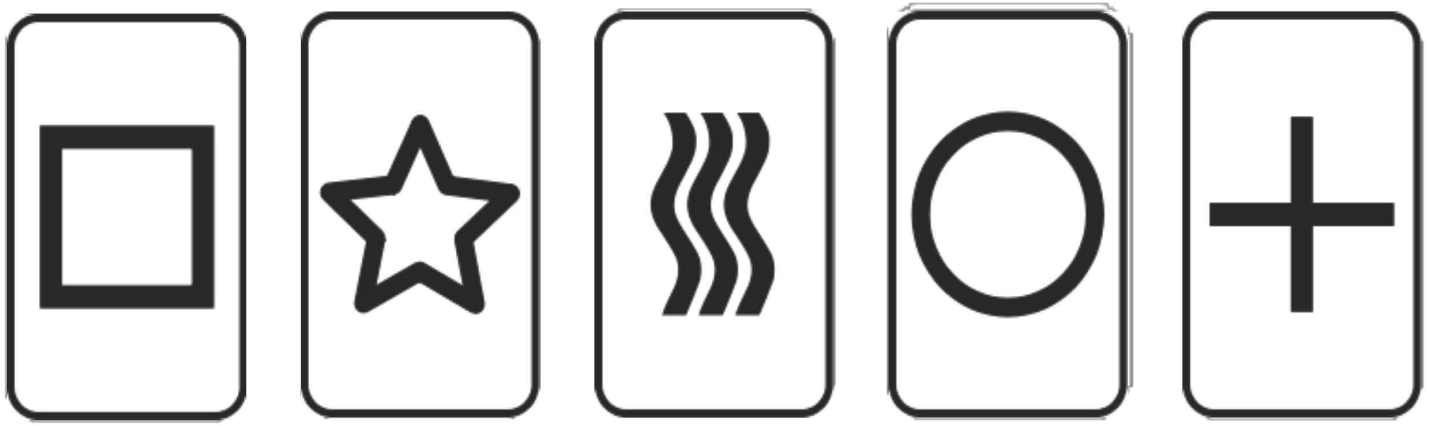

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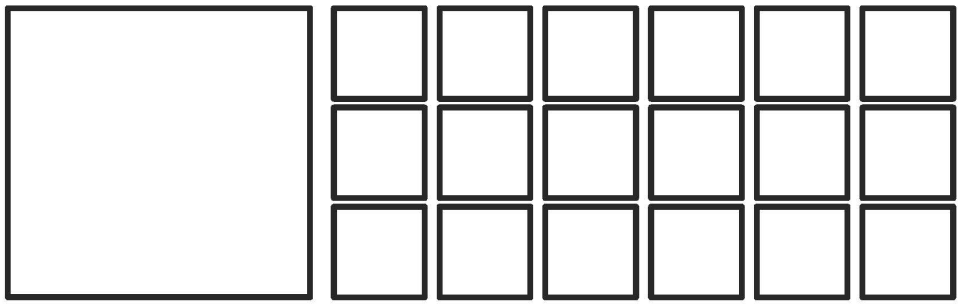
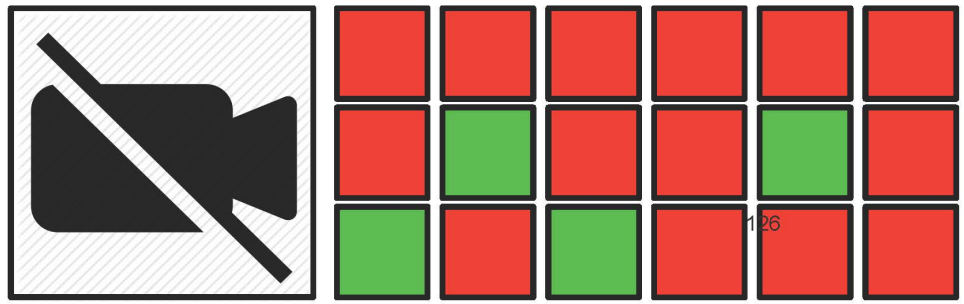
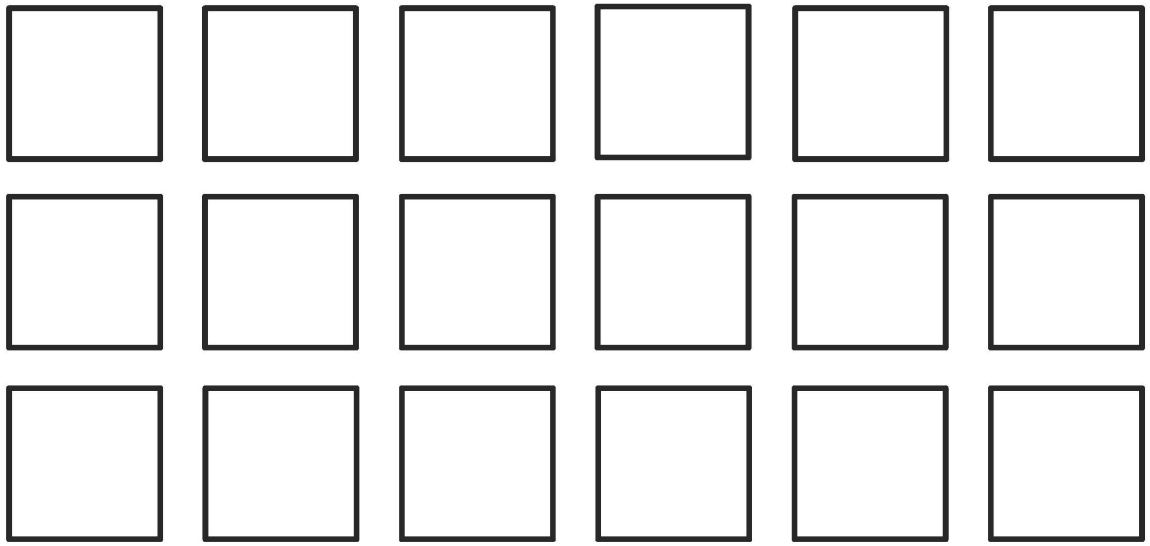
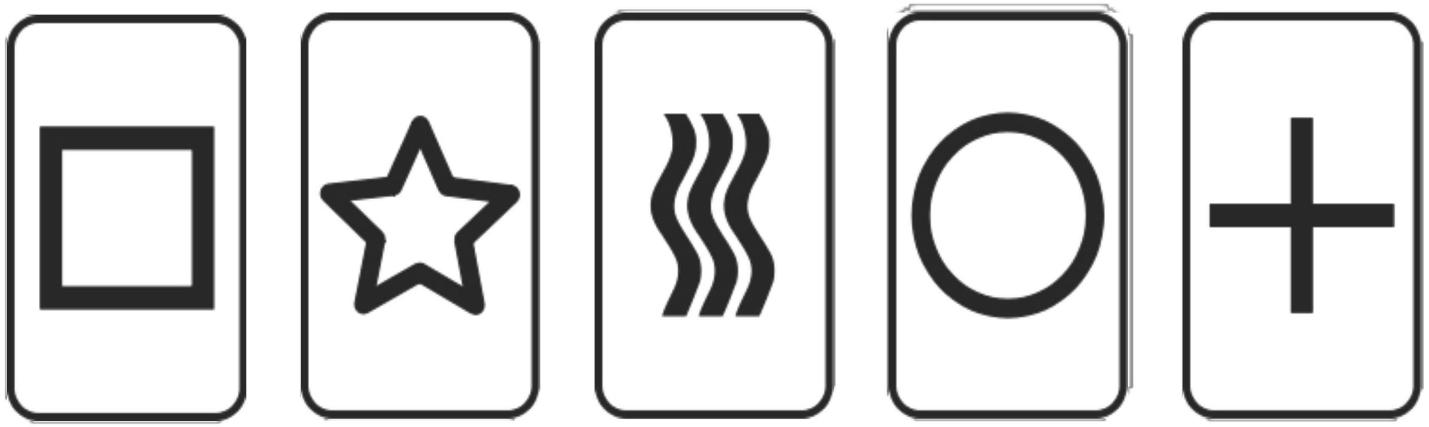




The next player is being selected.
After a short countdown the test will begin again.





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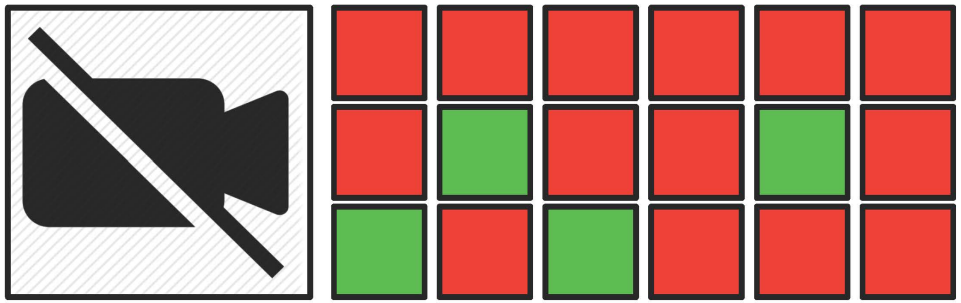

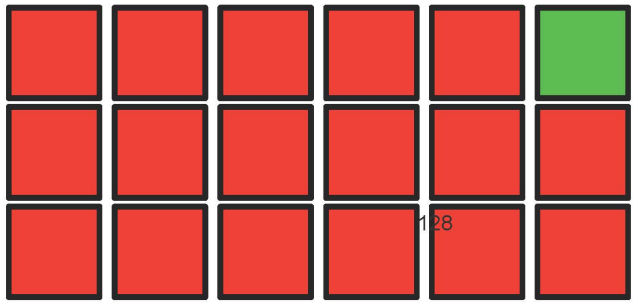

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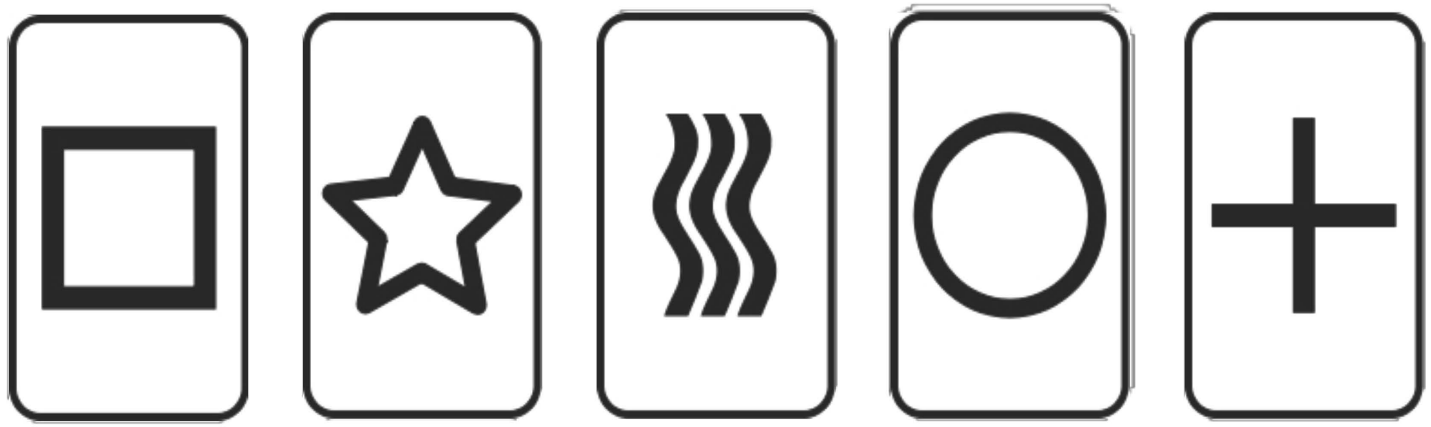

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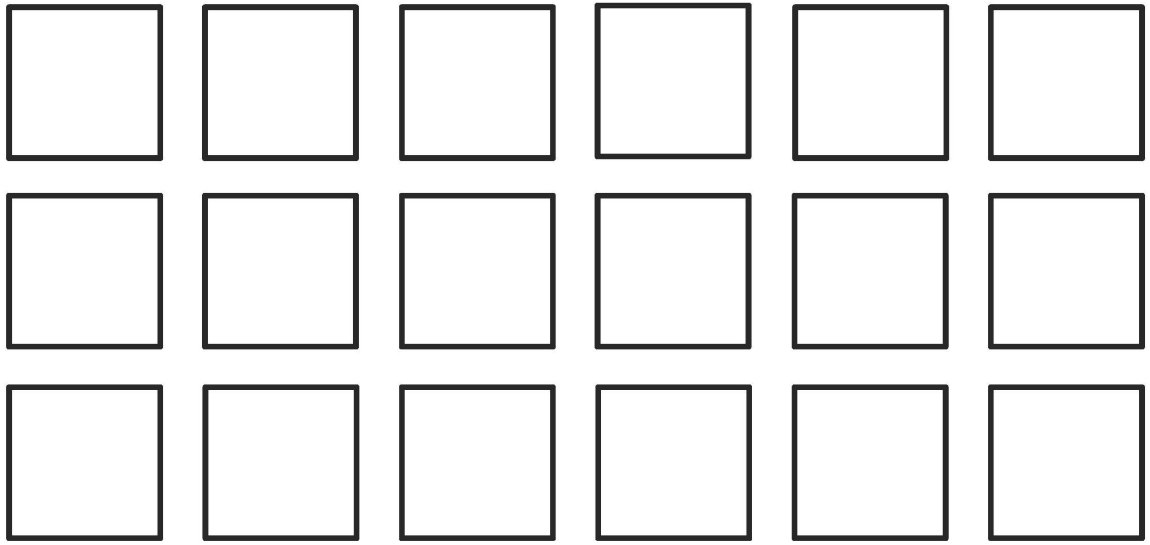

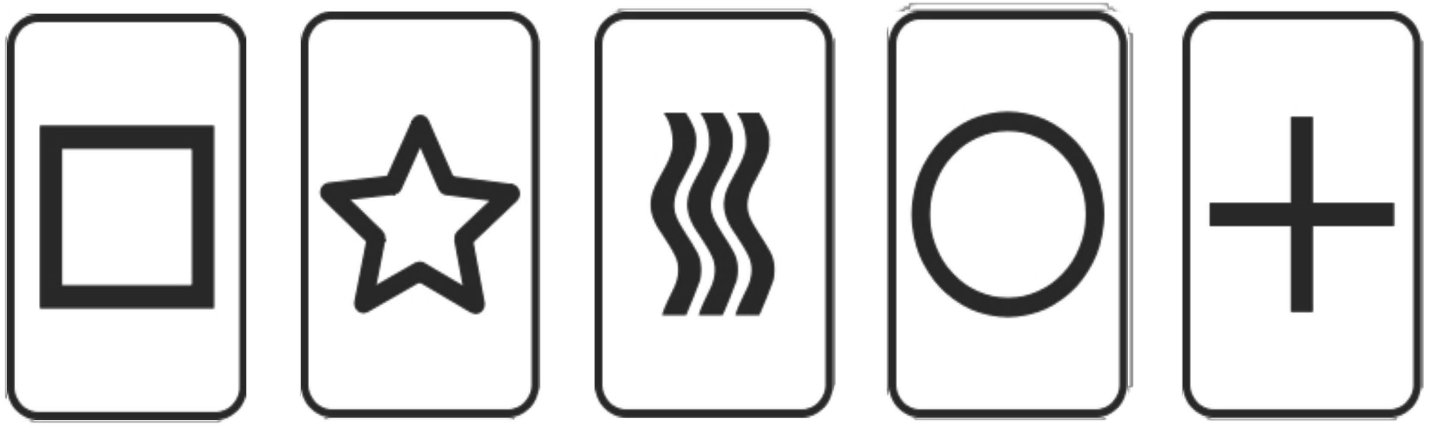

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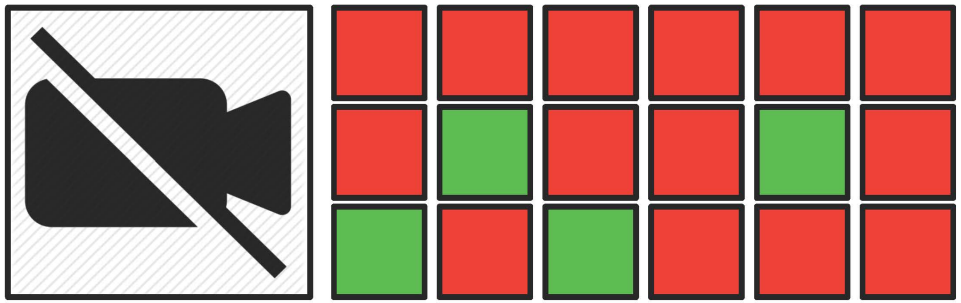

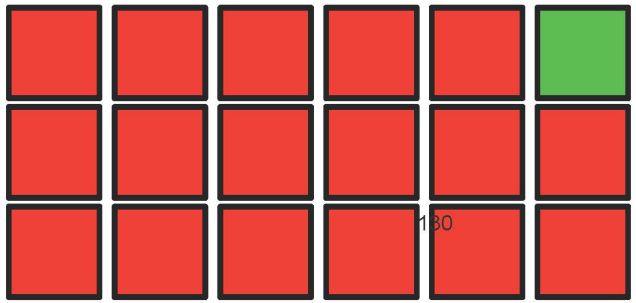

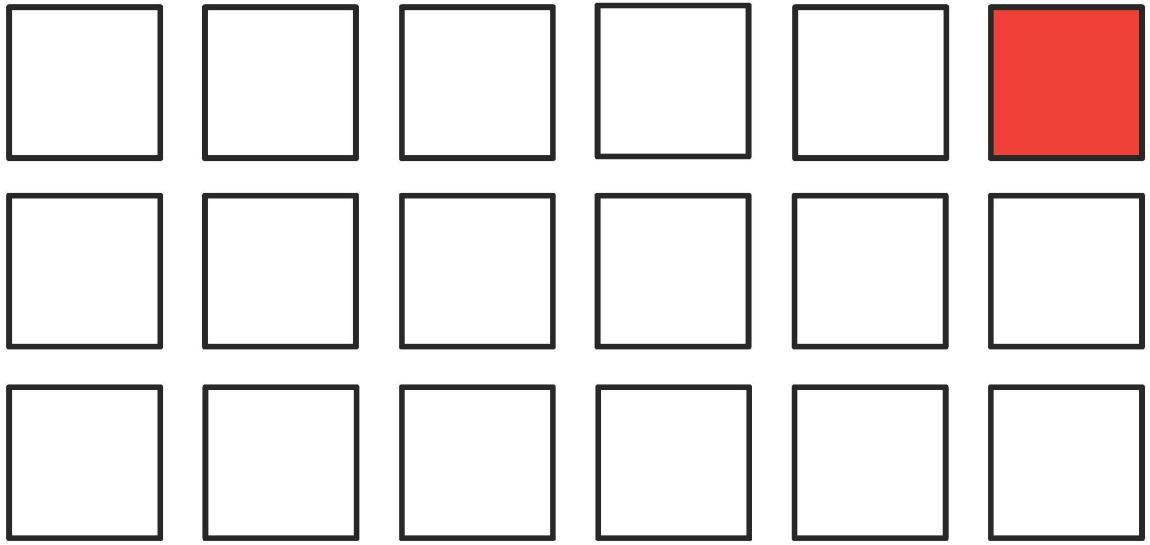

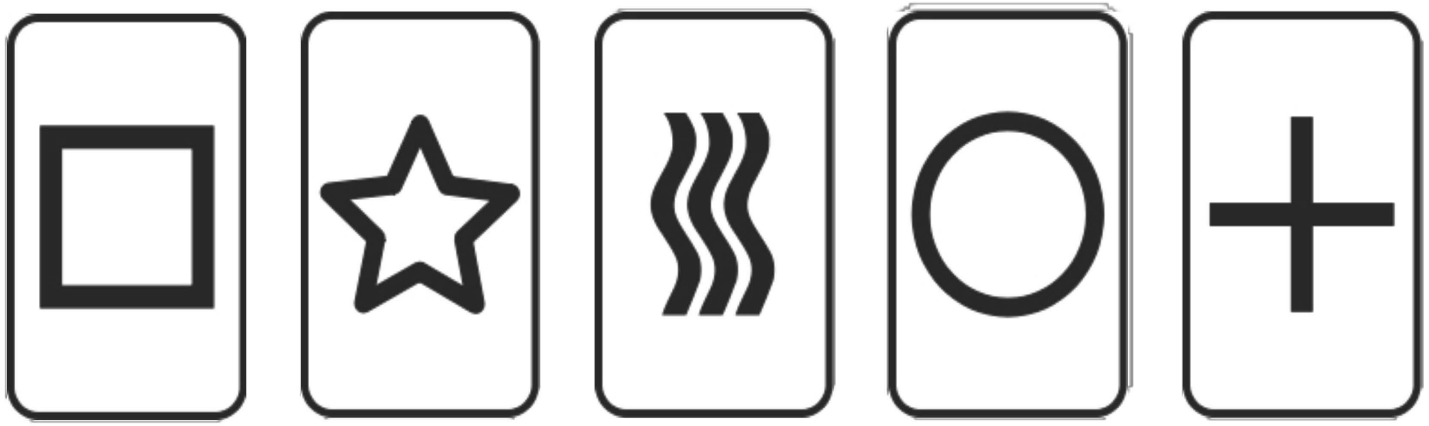

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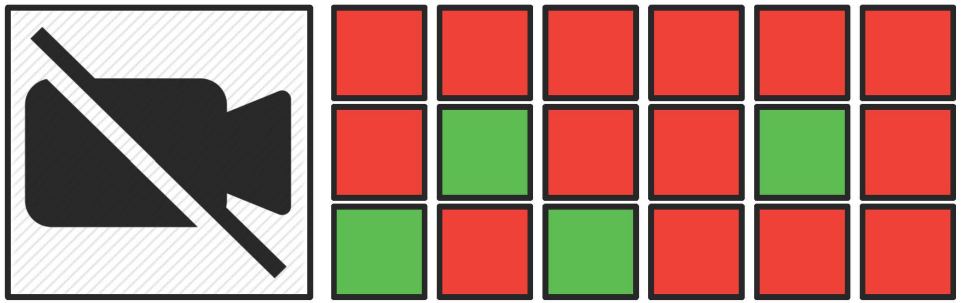

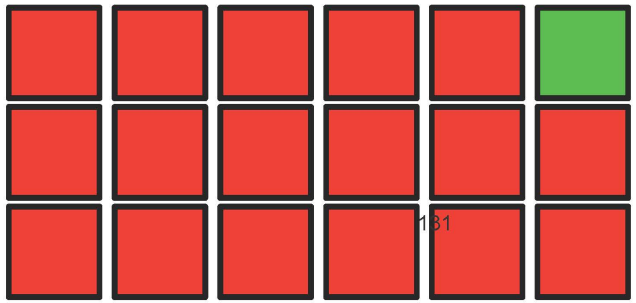

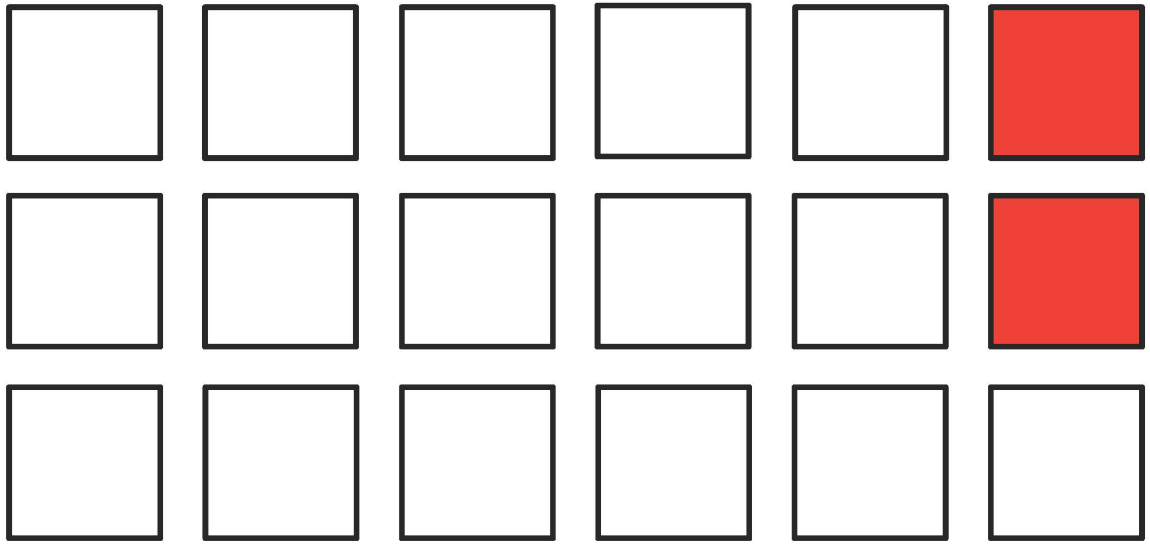

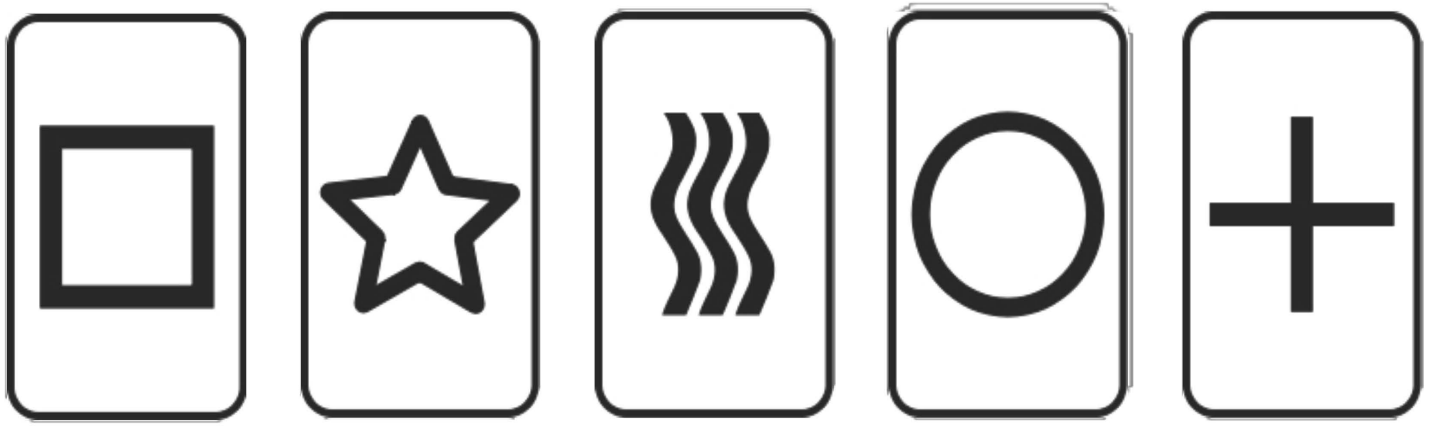

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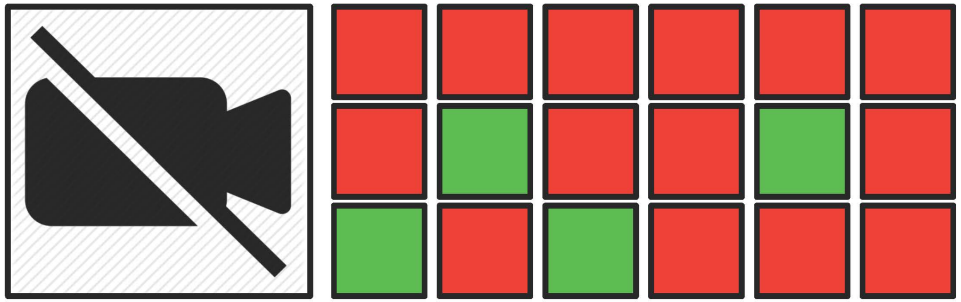

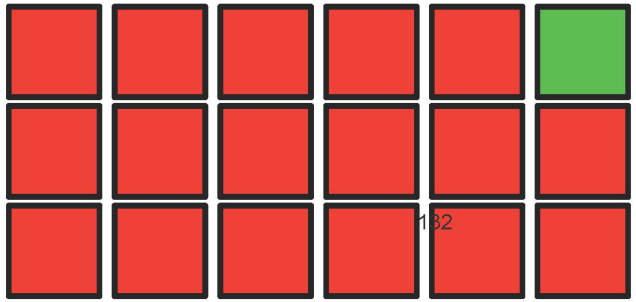

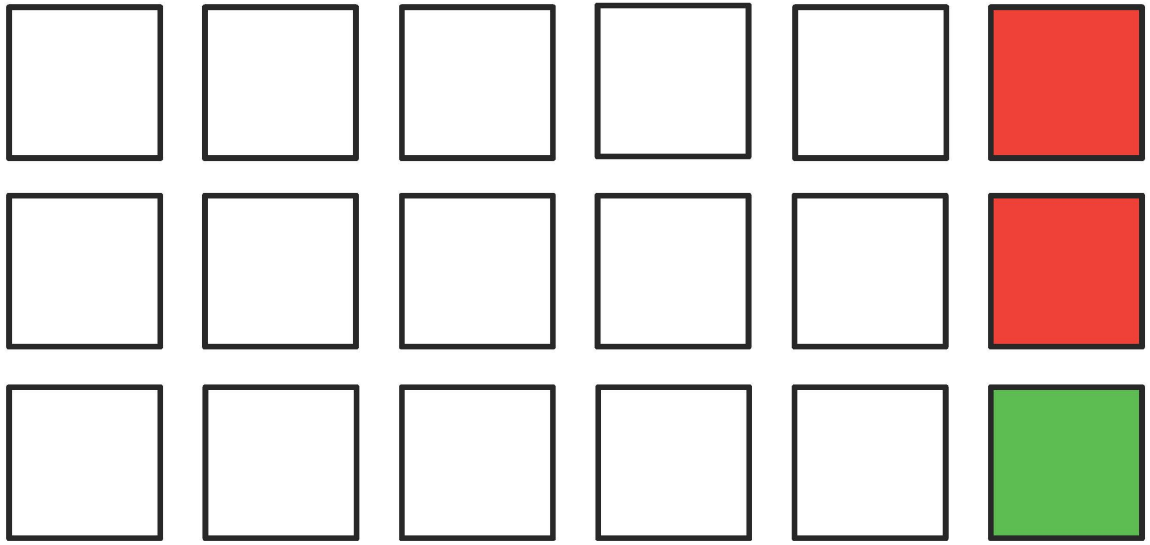

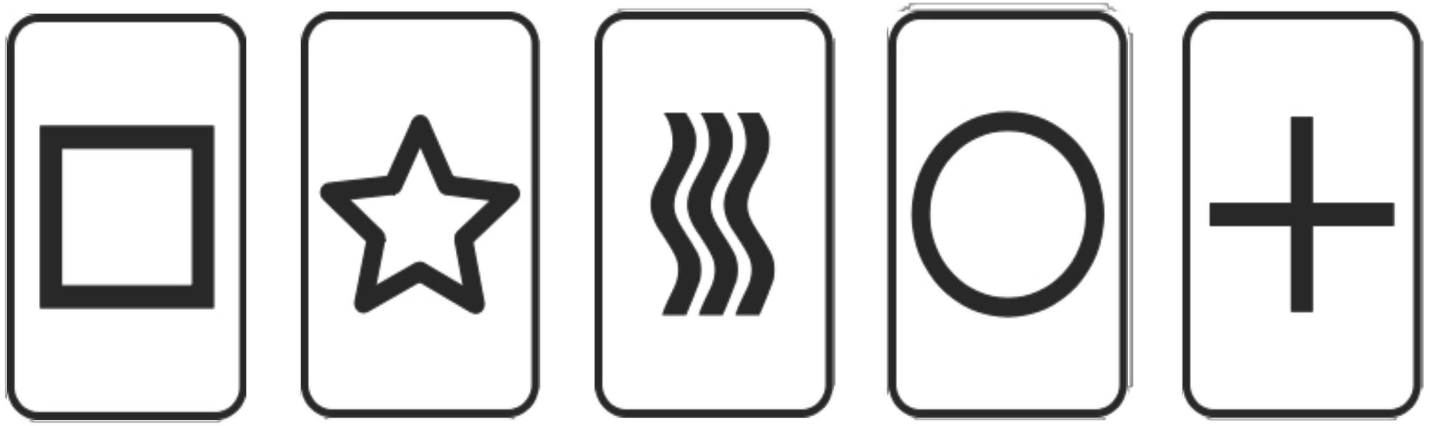

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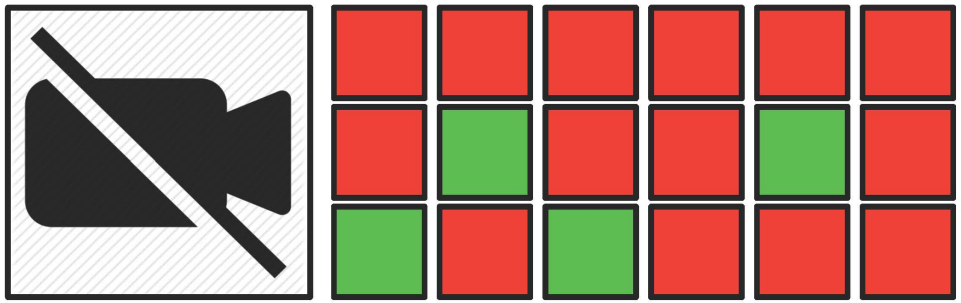

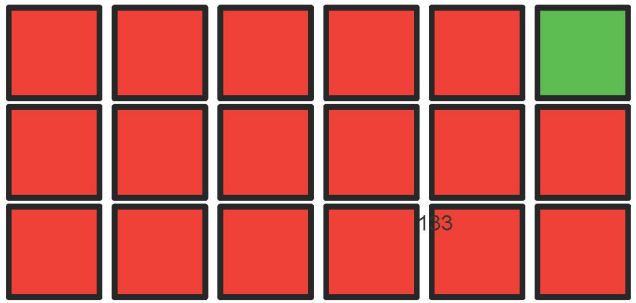

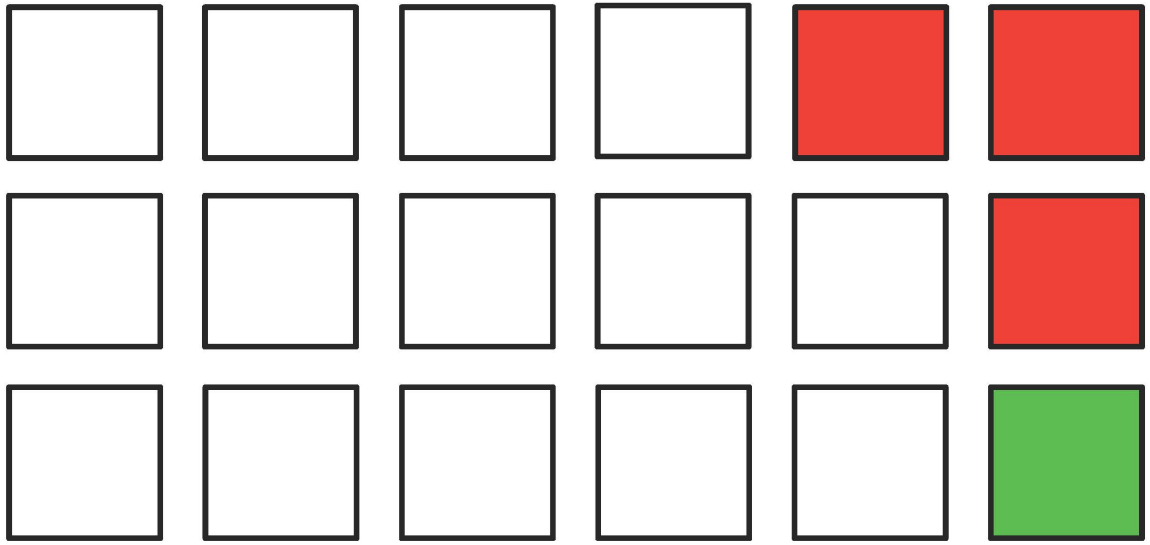

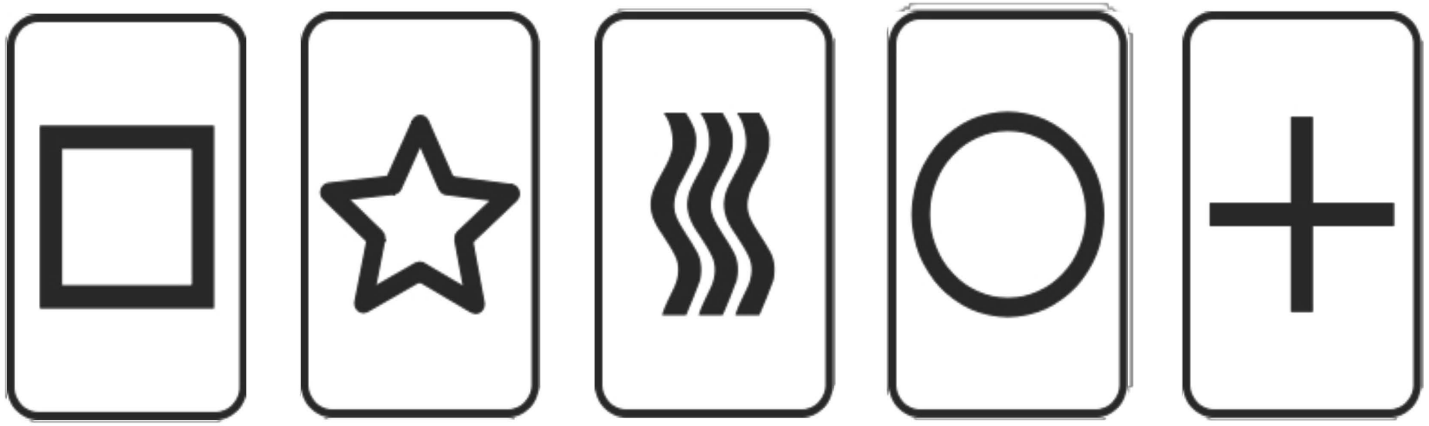

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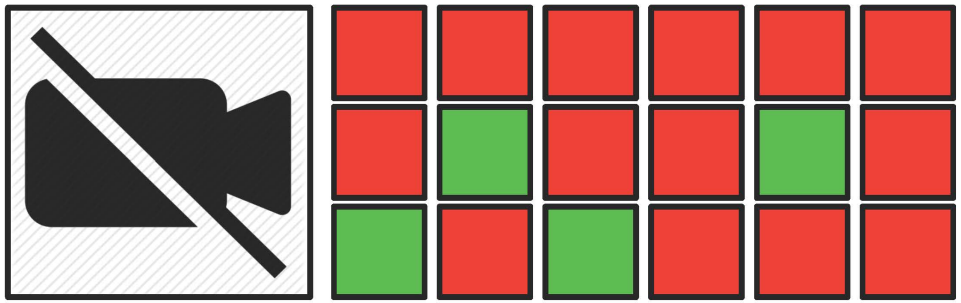

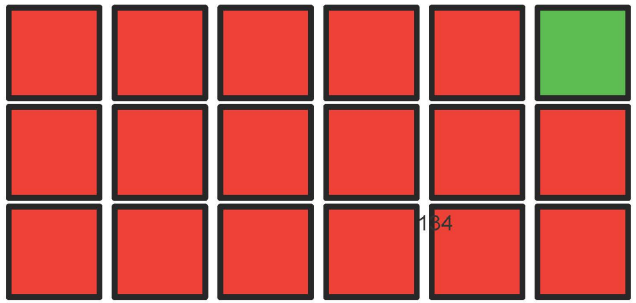

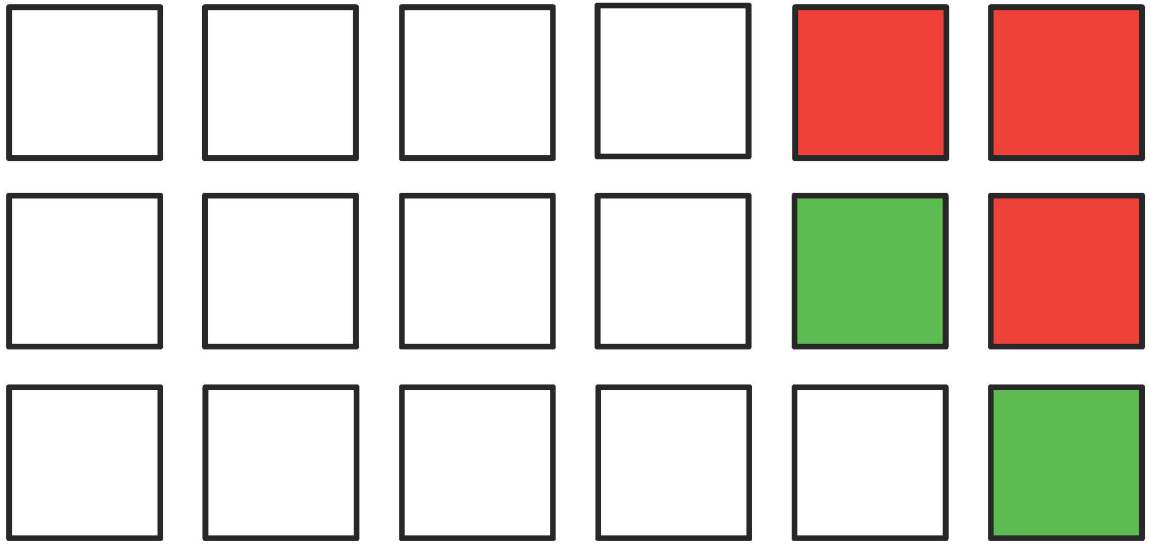

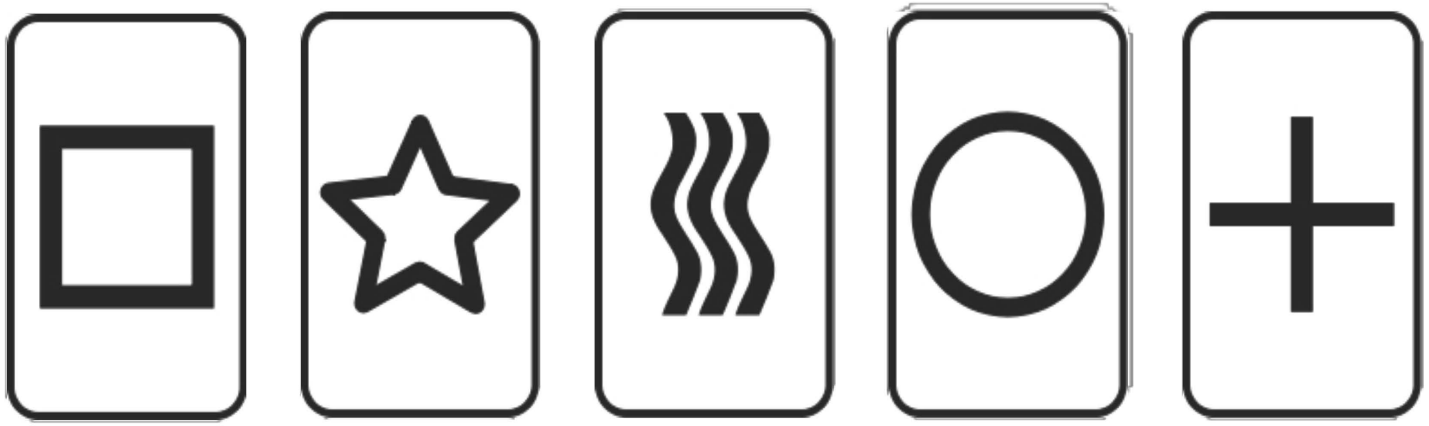

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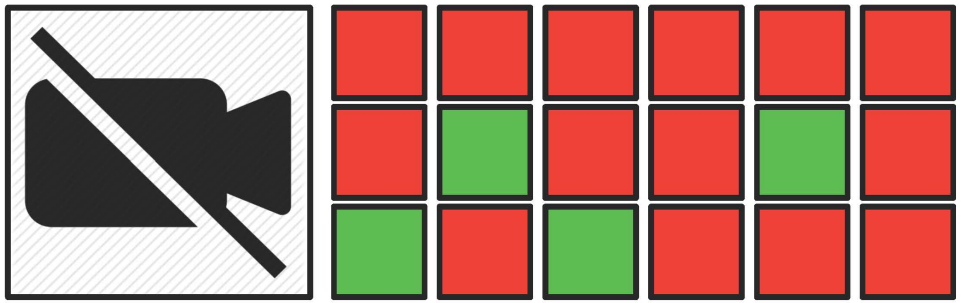

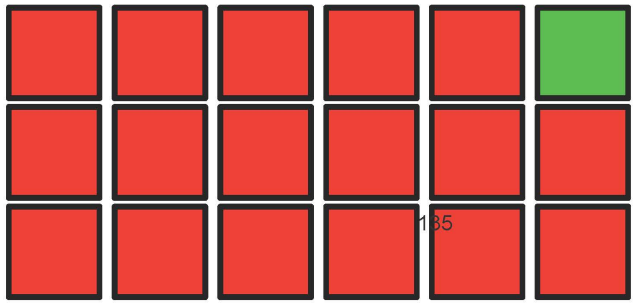

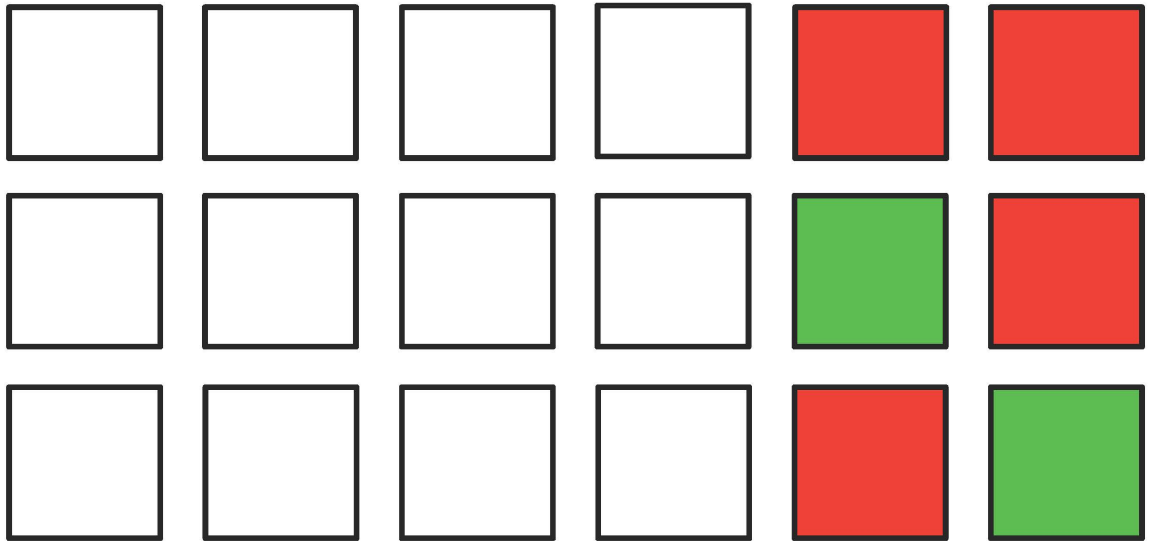

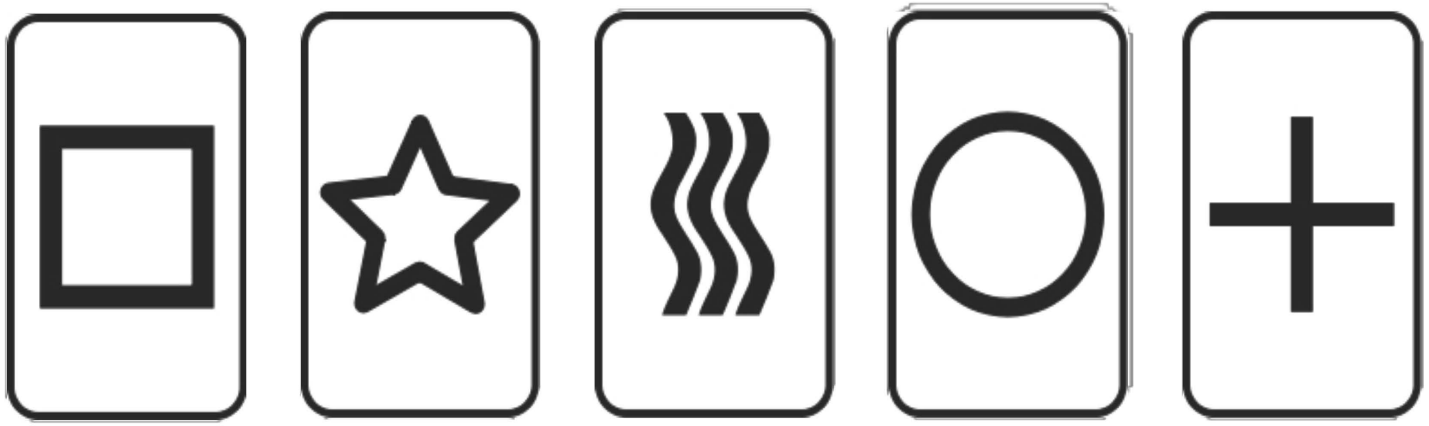

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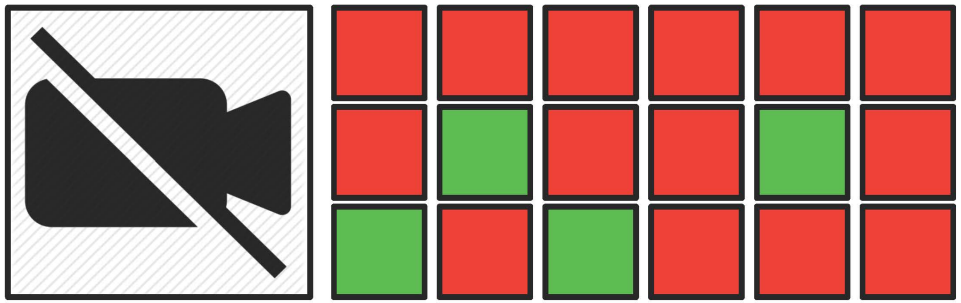

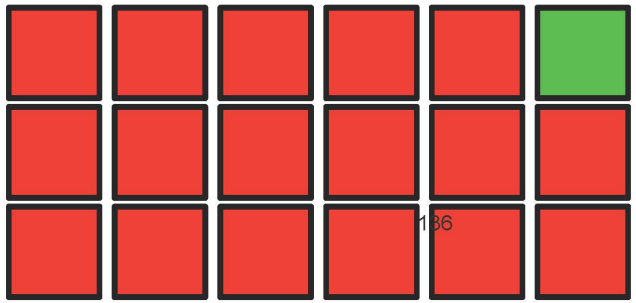

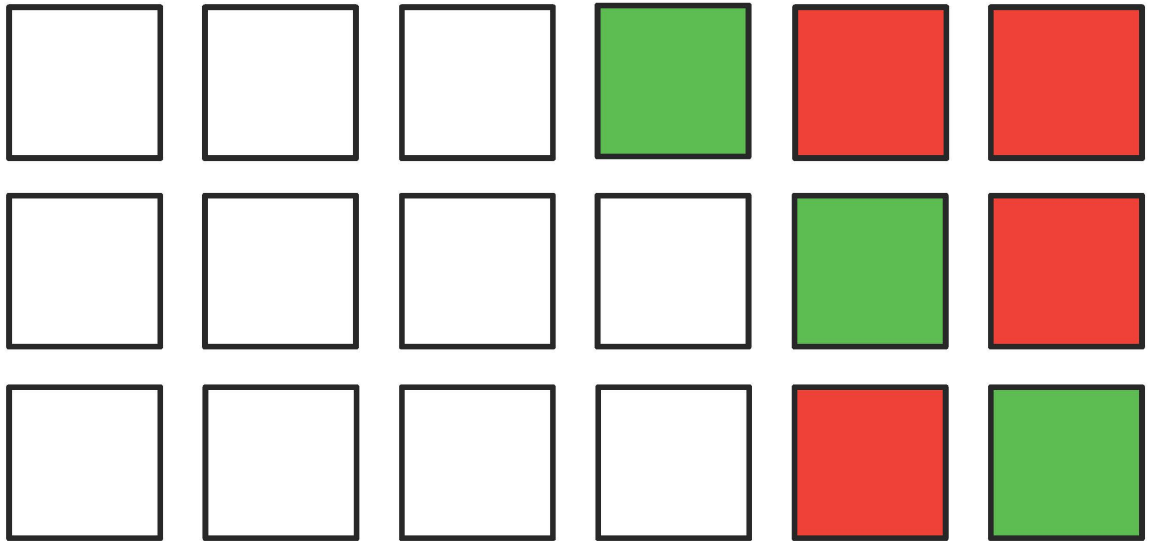

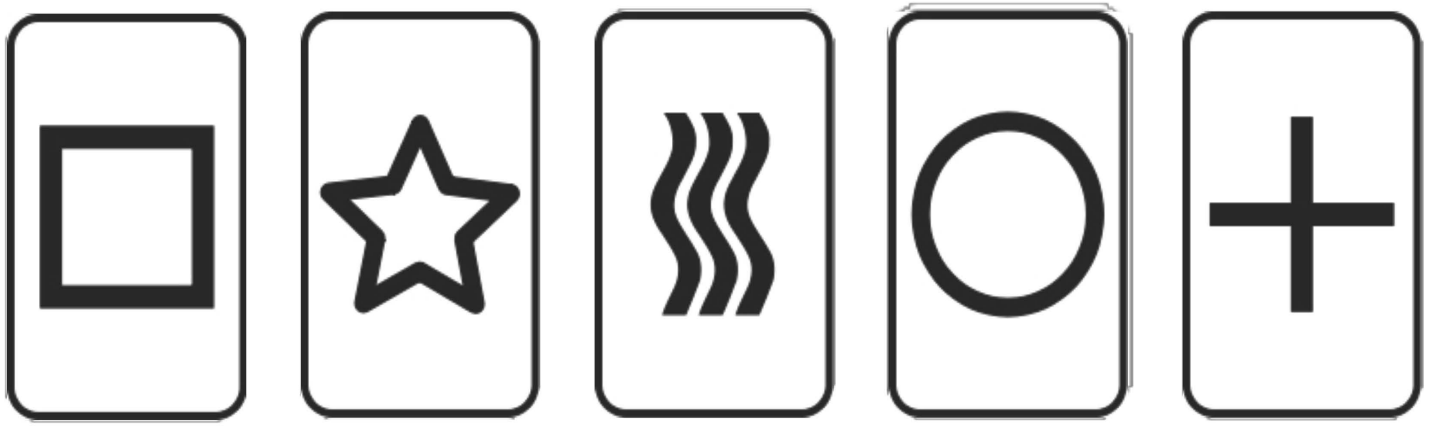

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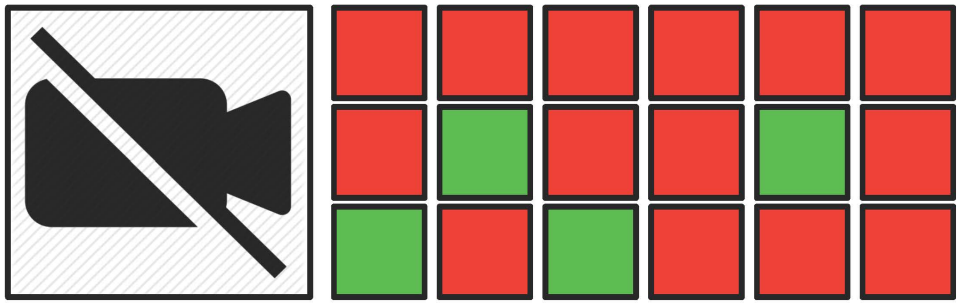

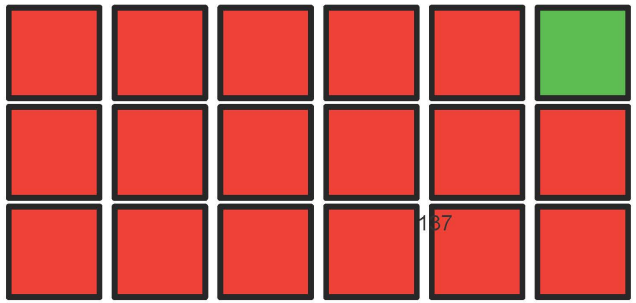

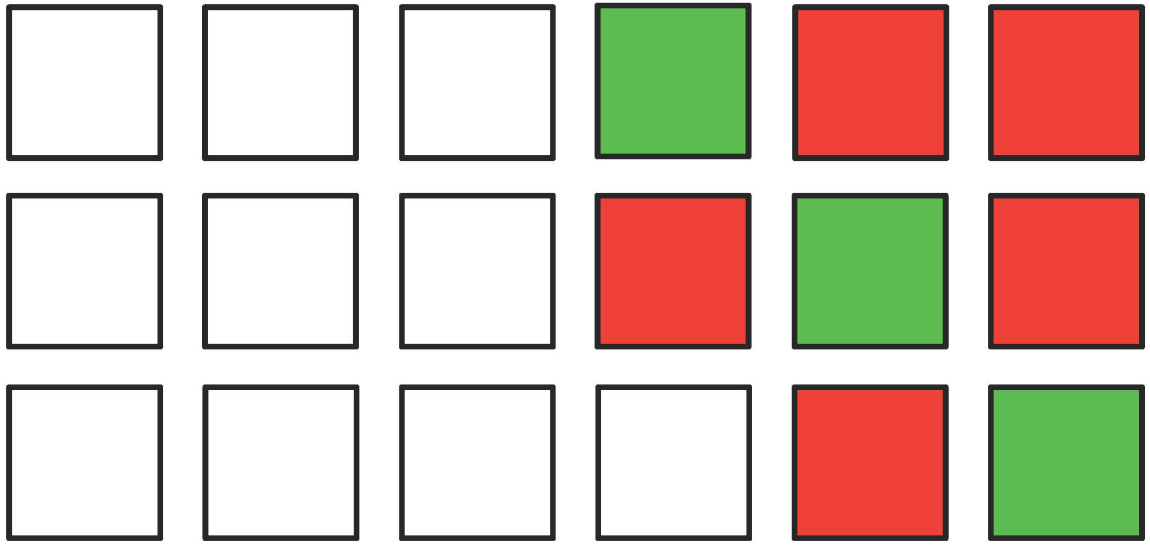

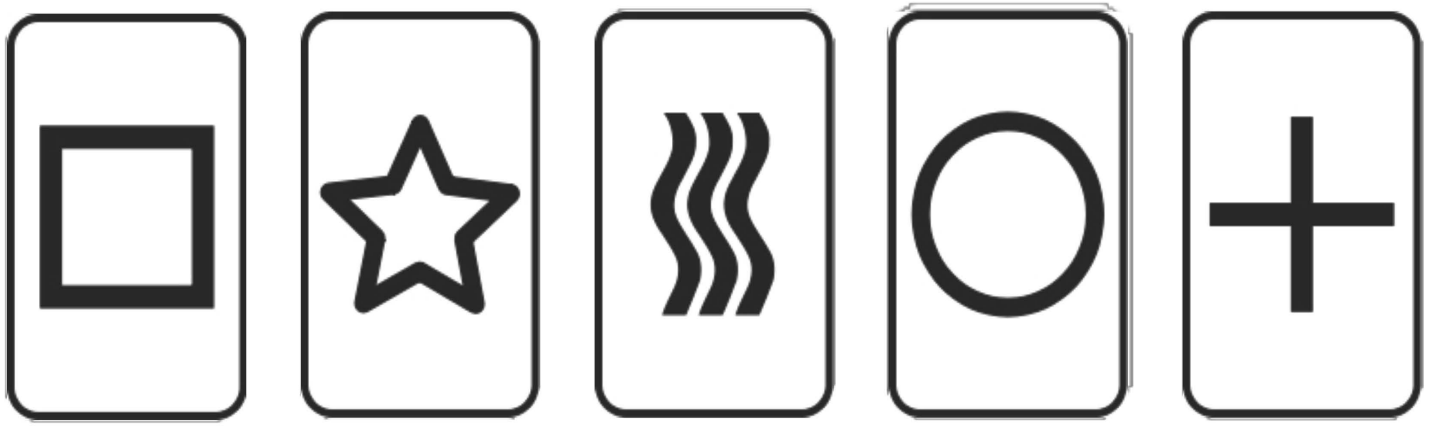

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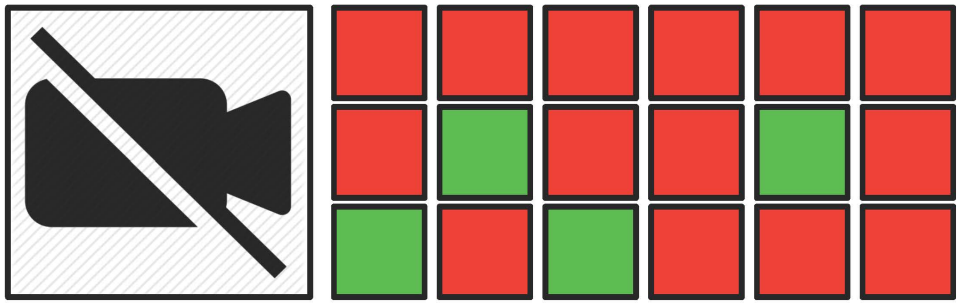

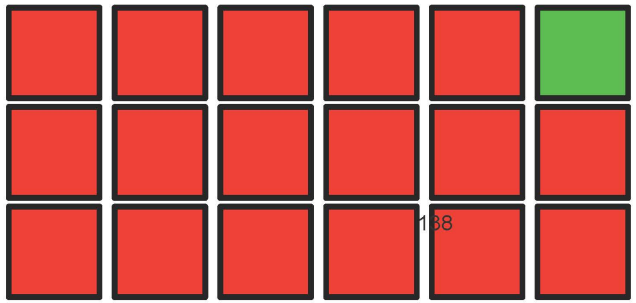

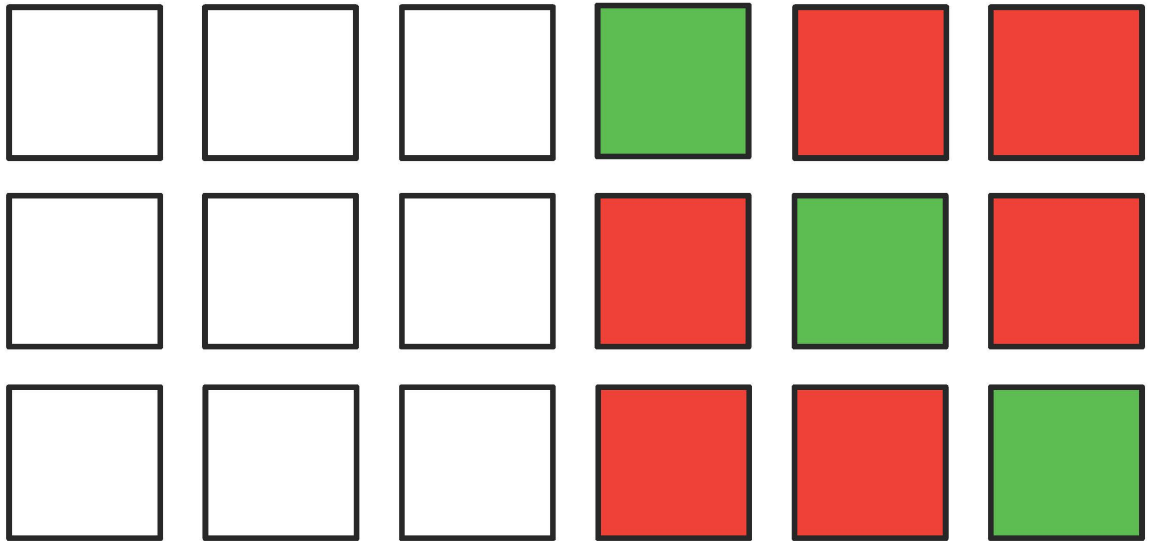

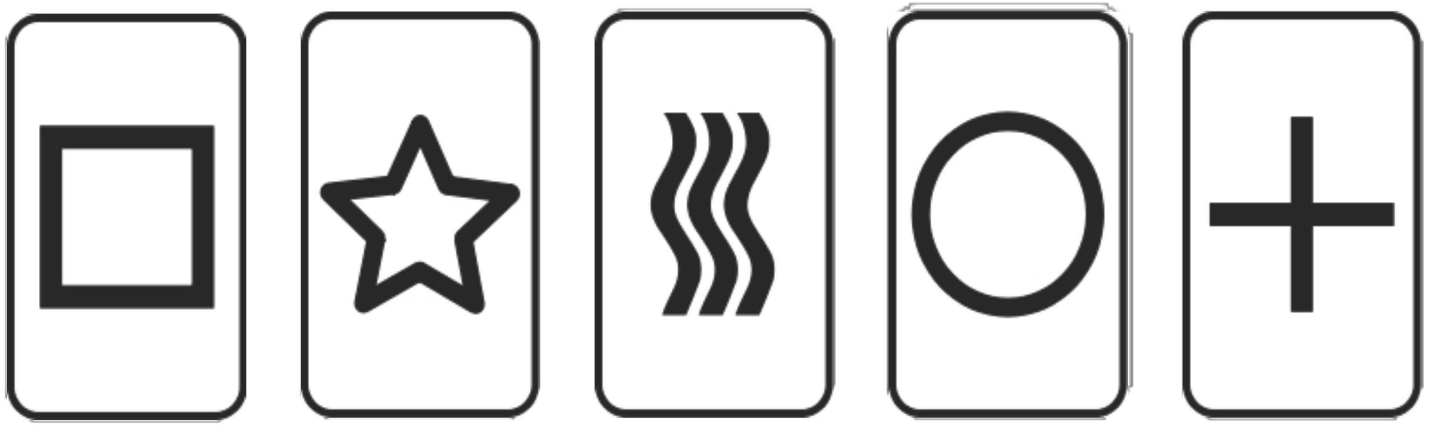

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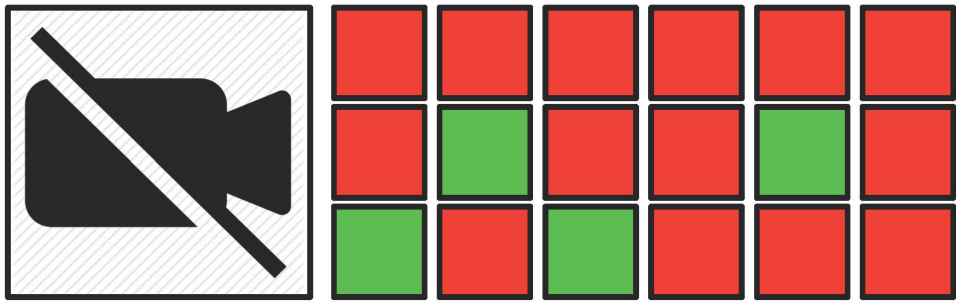

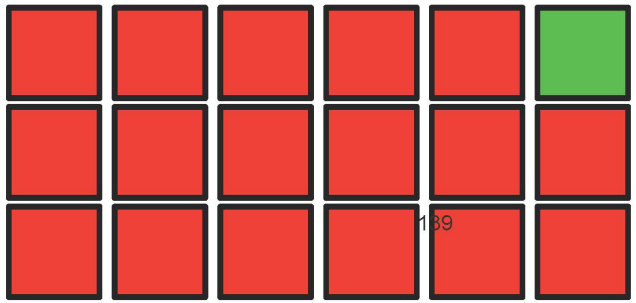

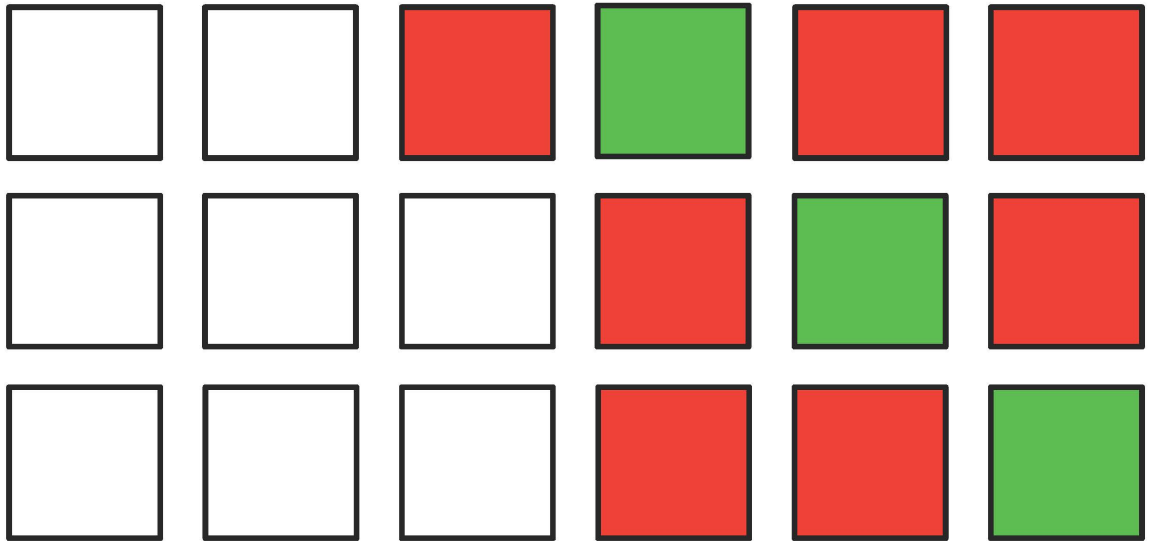

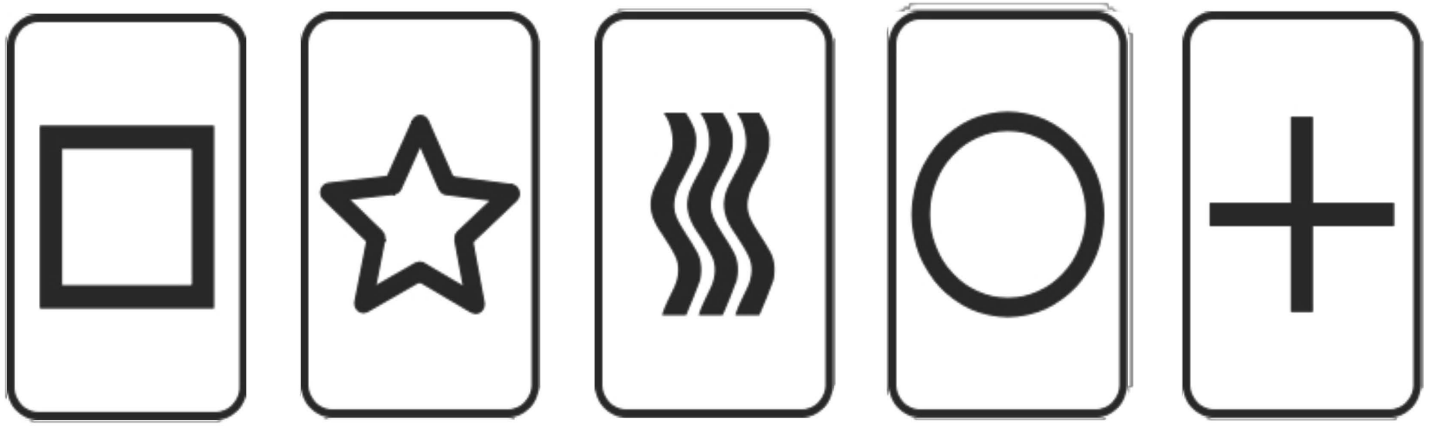

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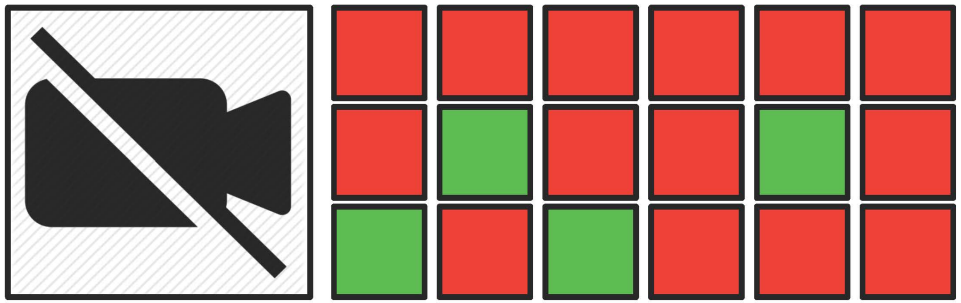

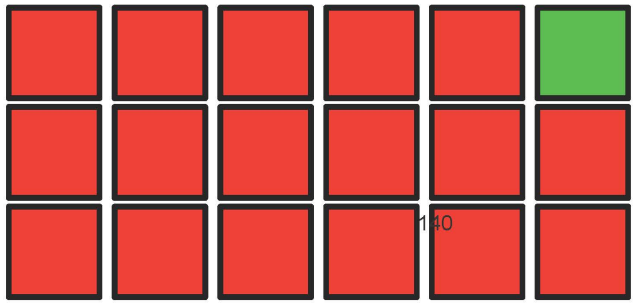

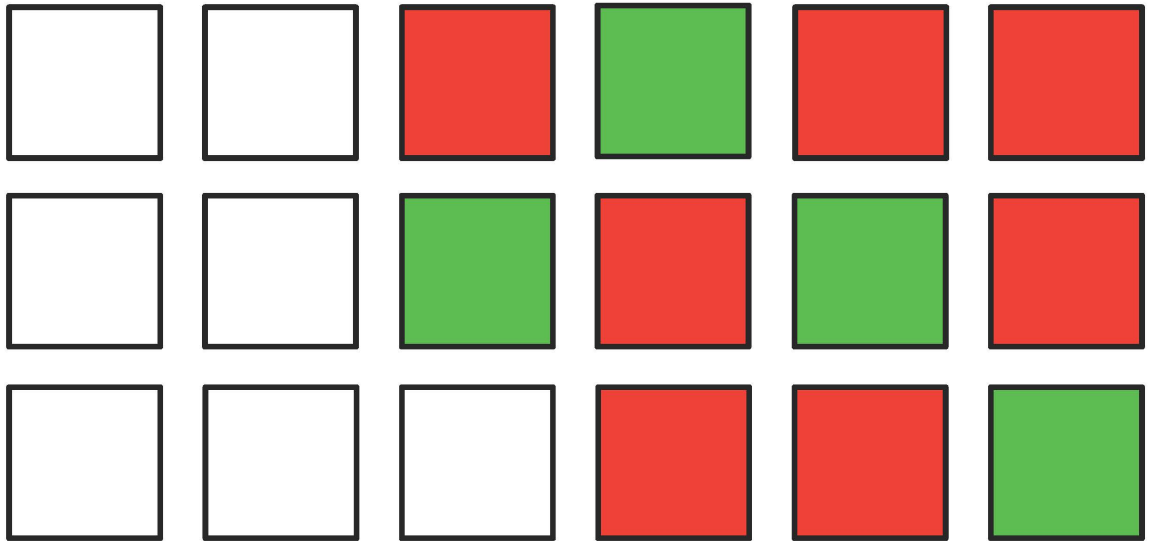

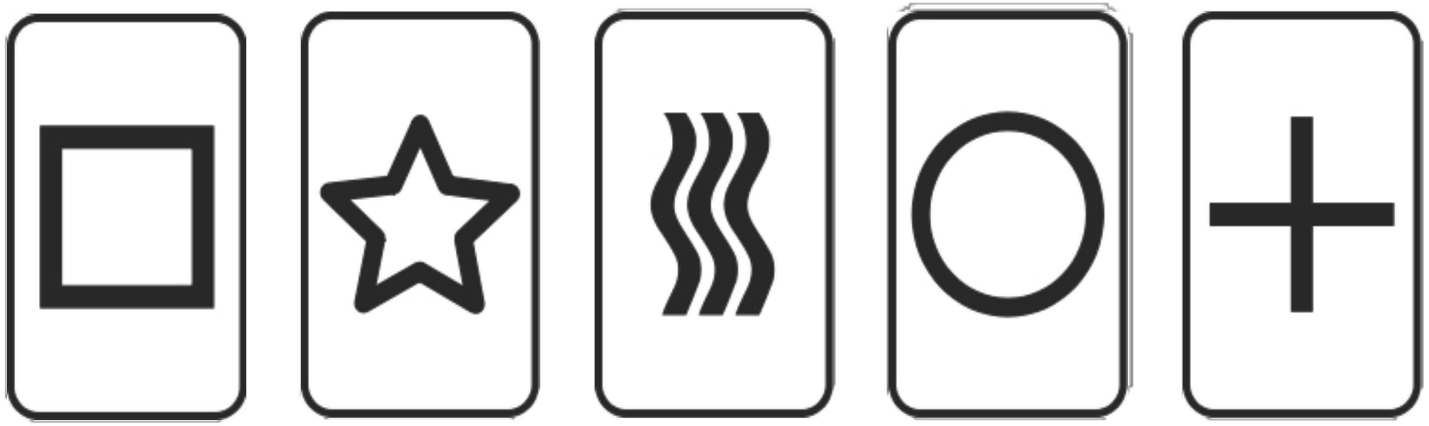

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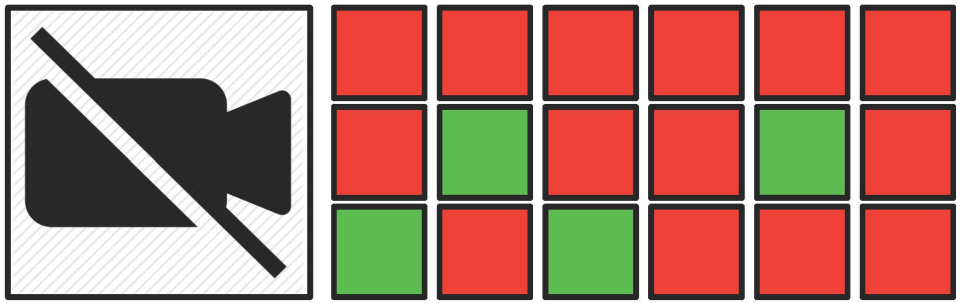

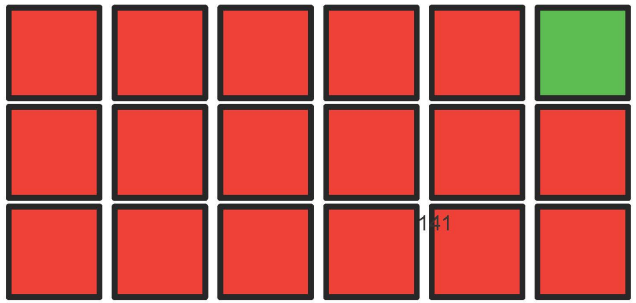

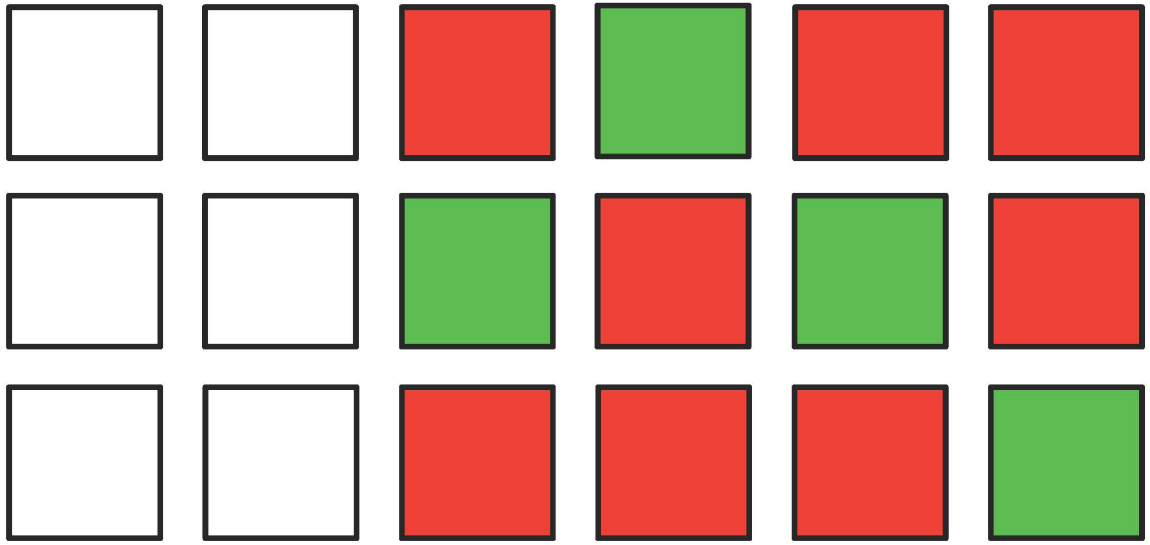

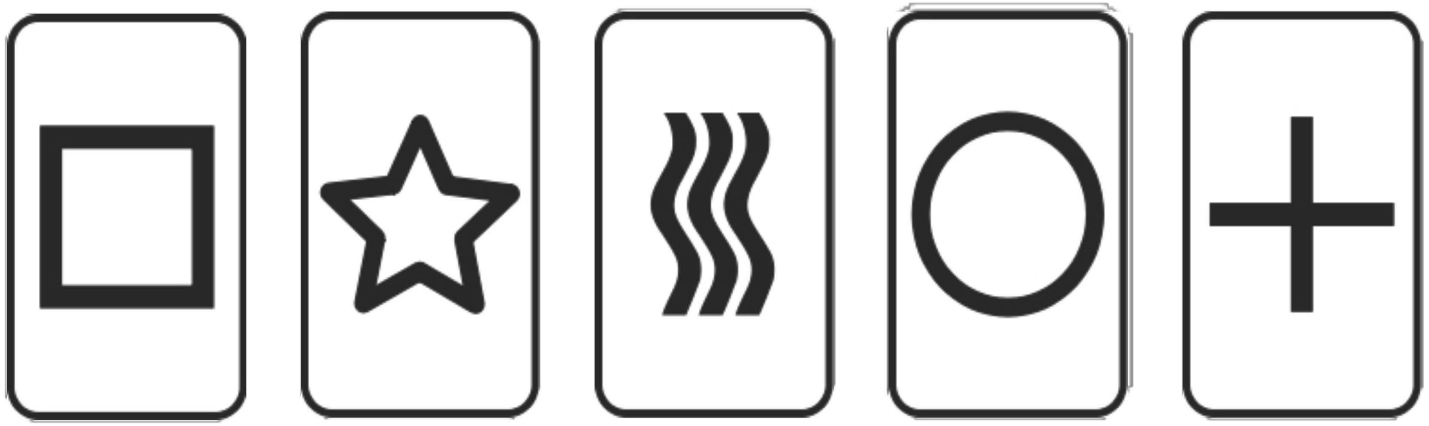

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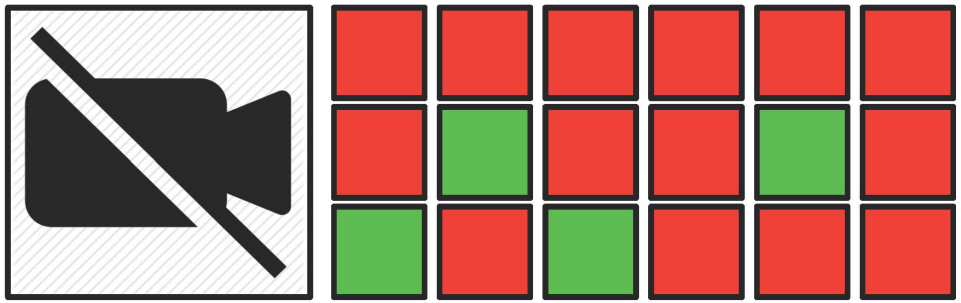

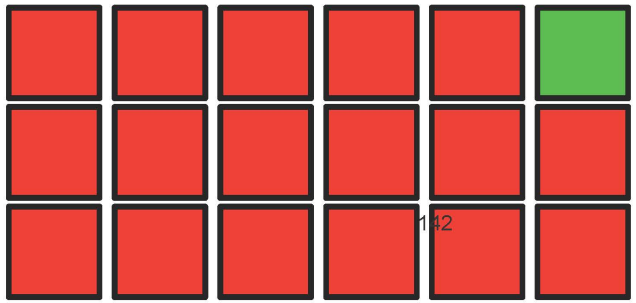

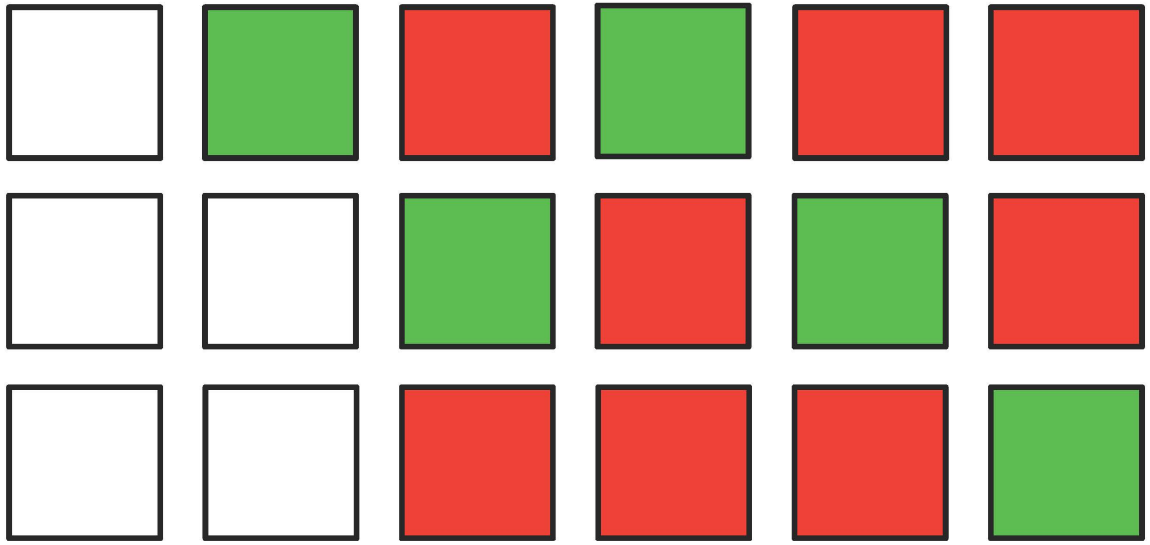

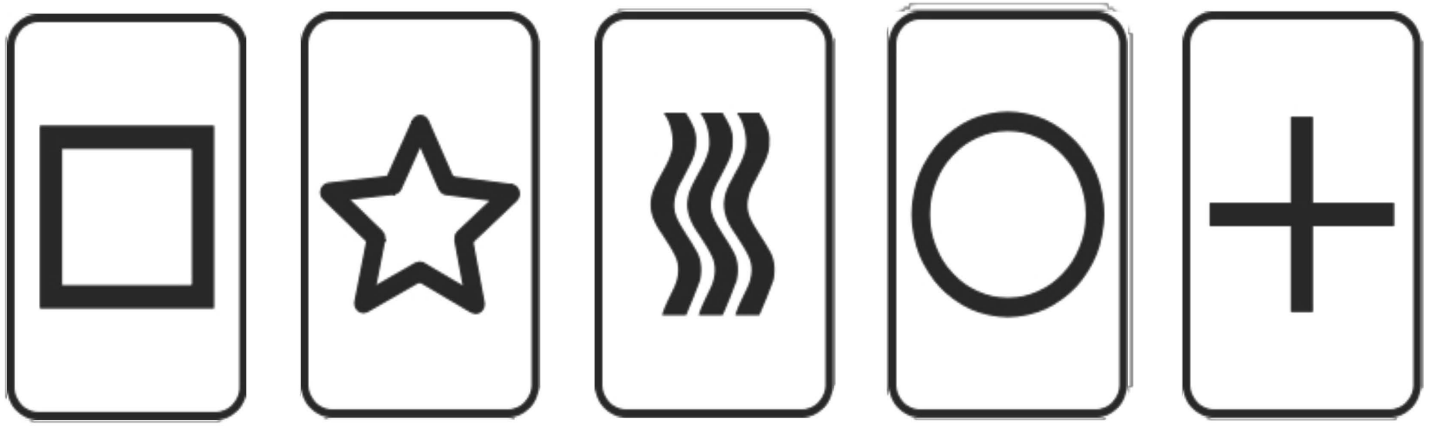

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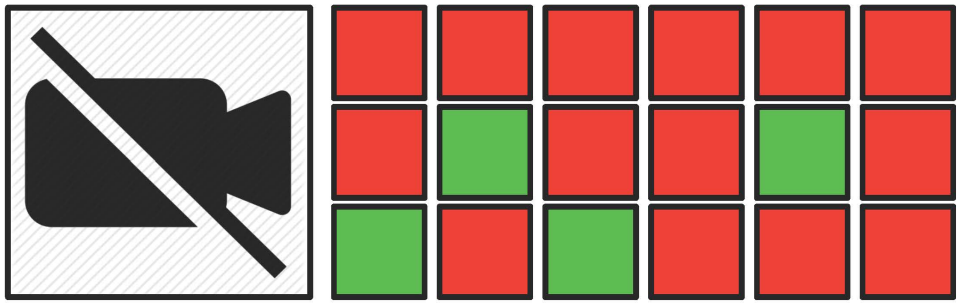

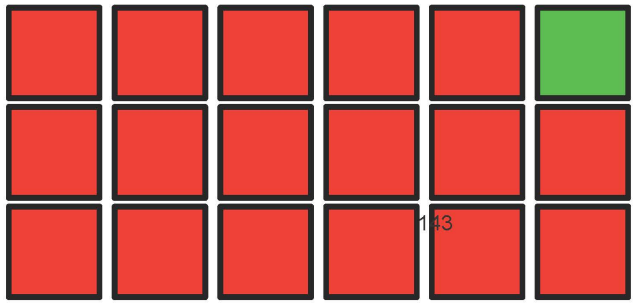

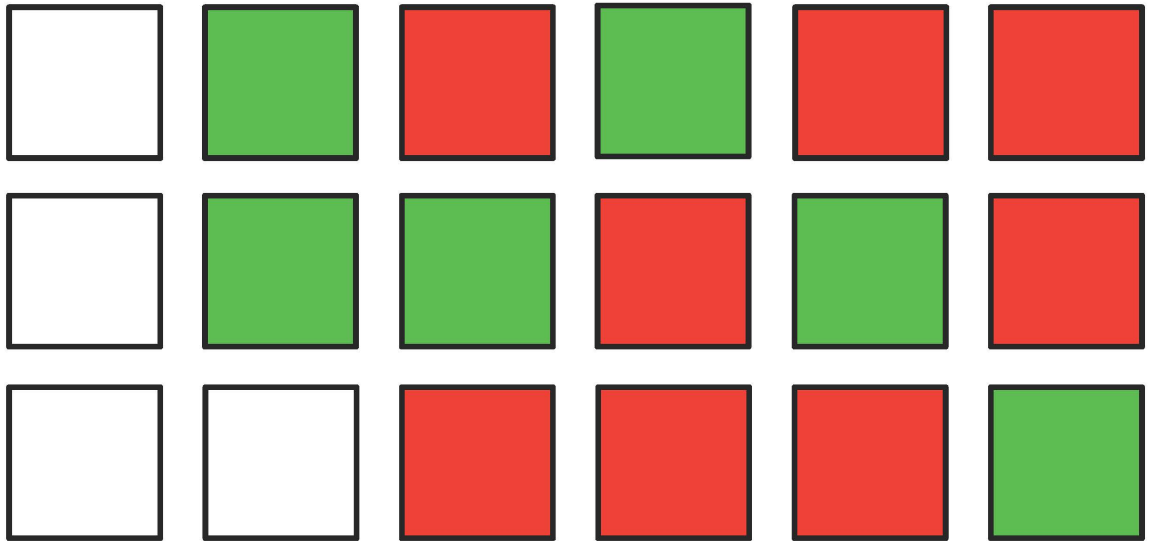

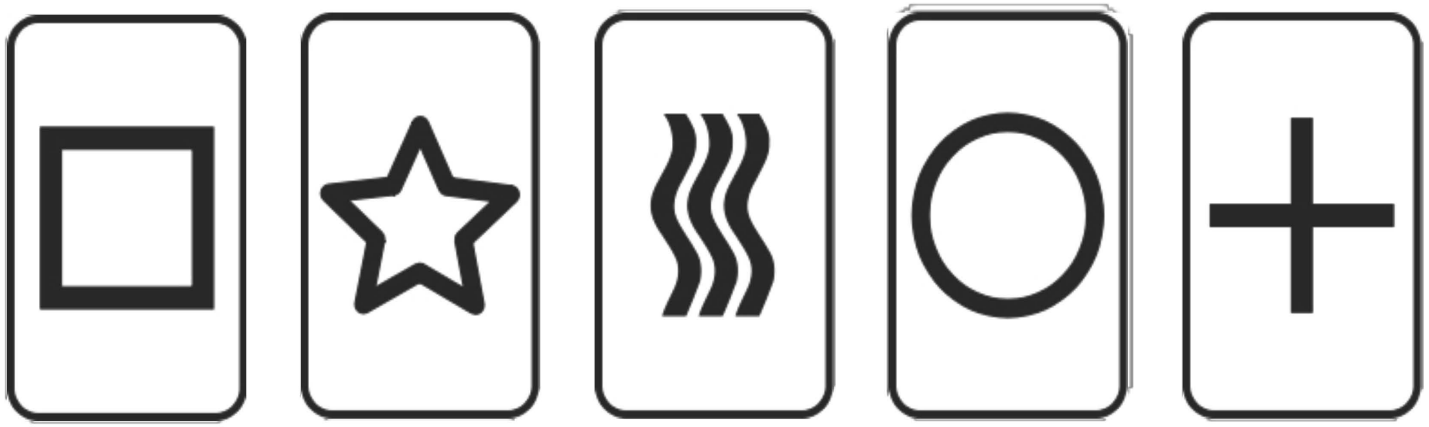

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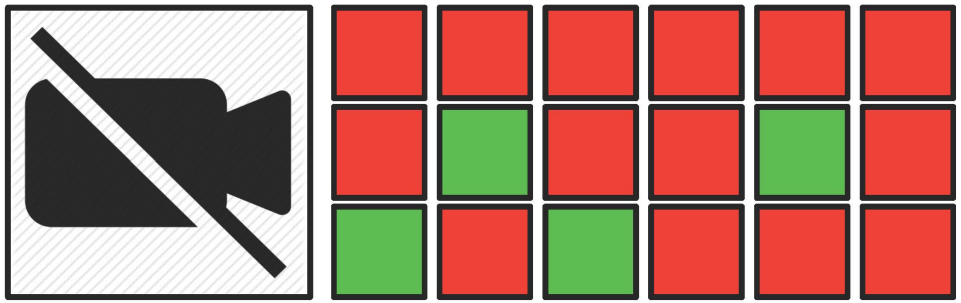

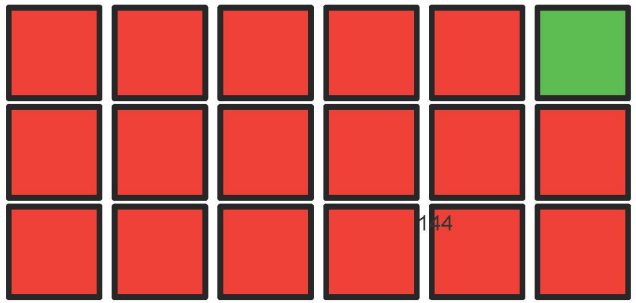

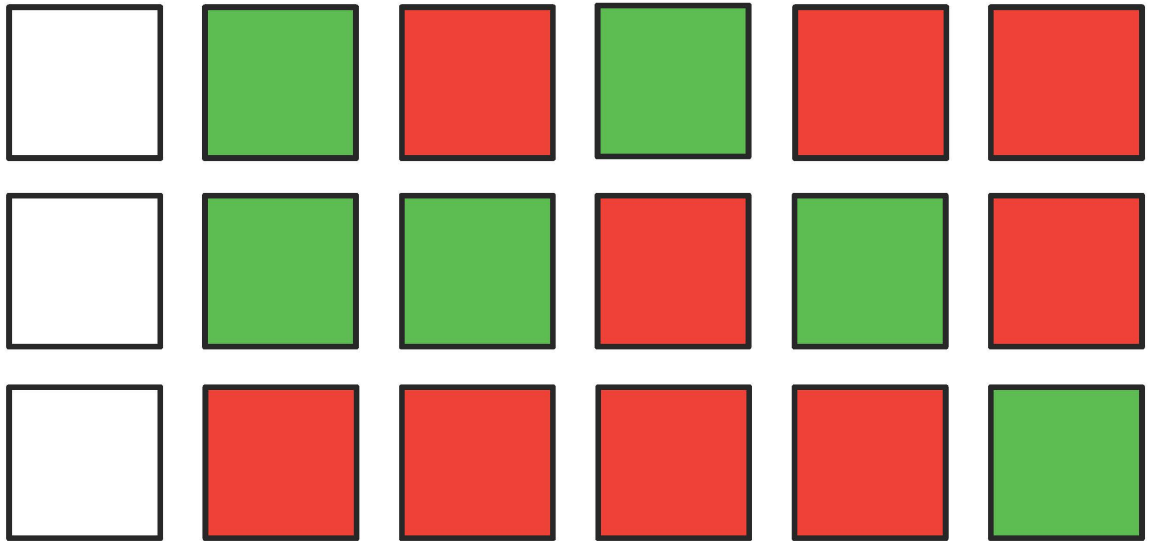

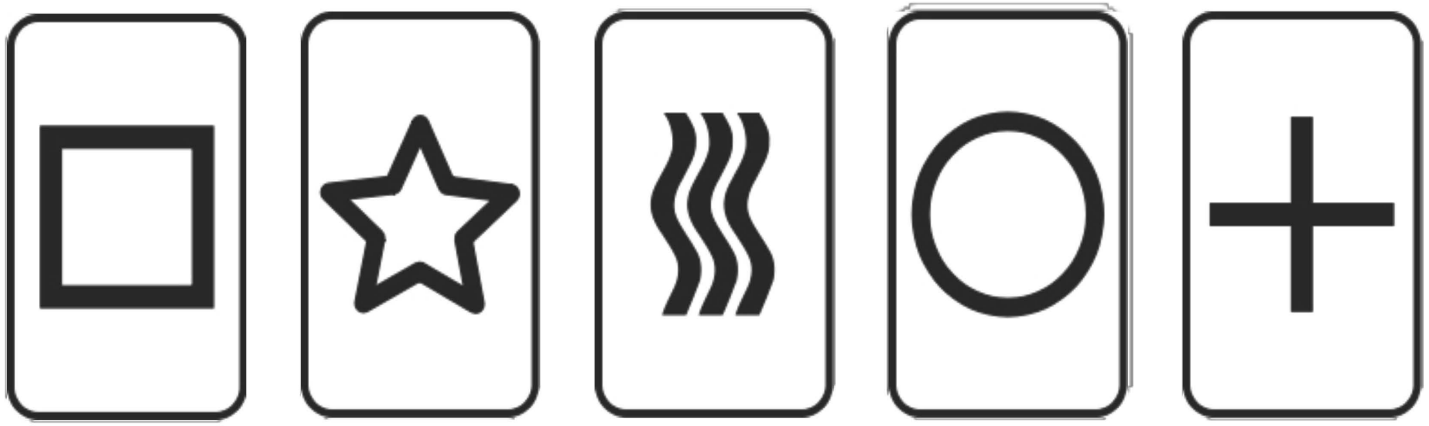

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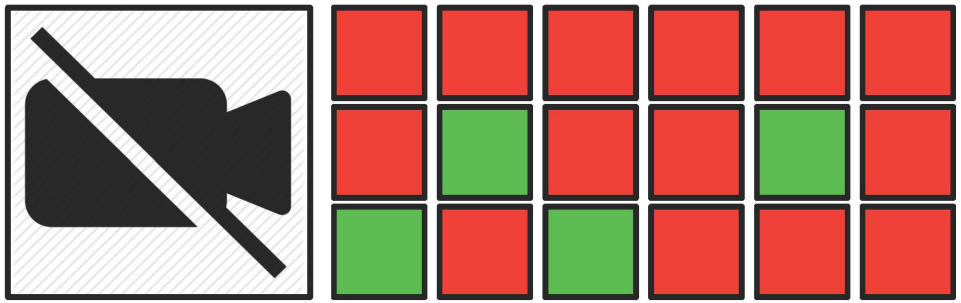

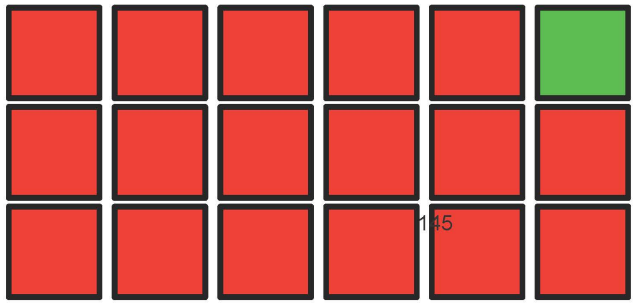

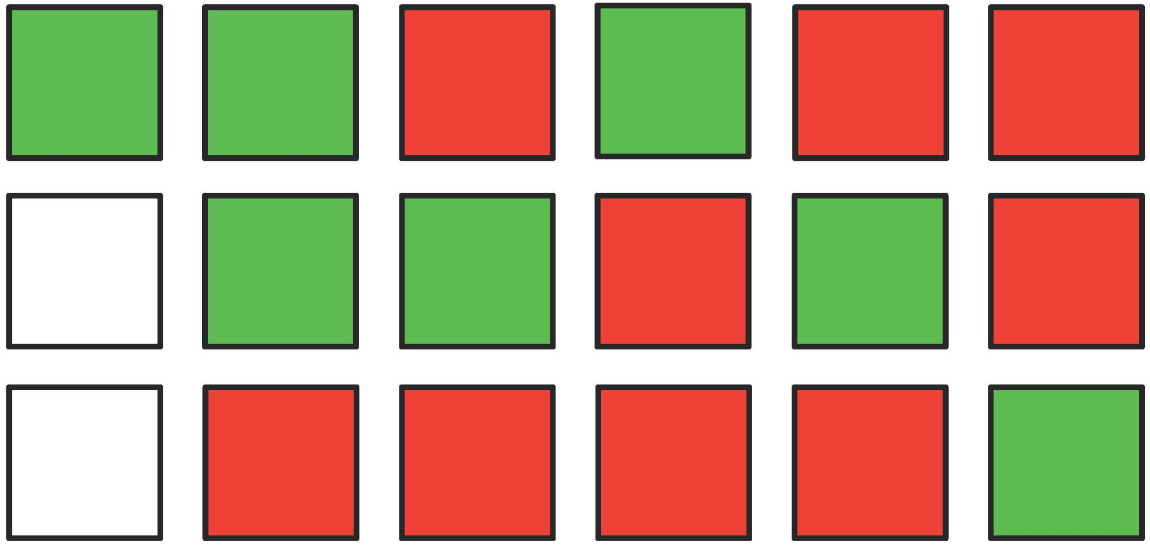

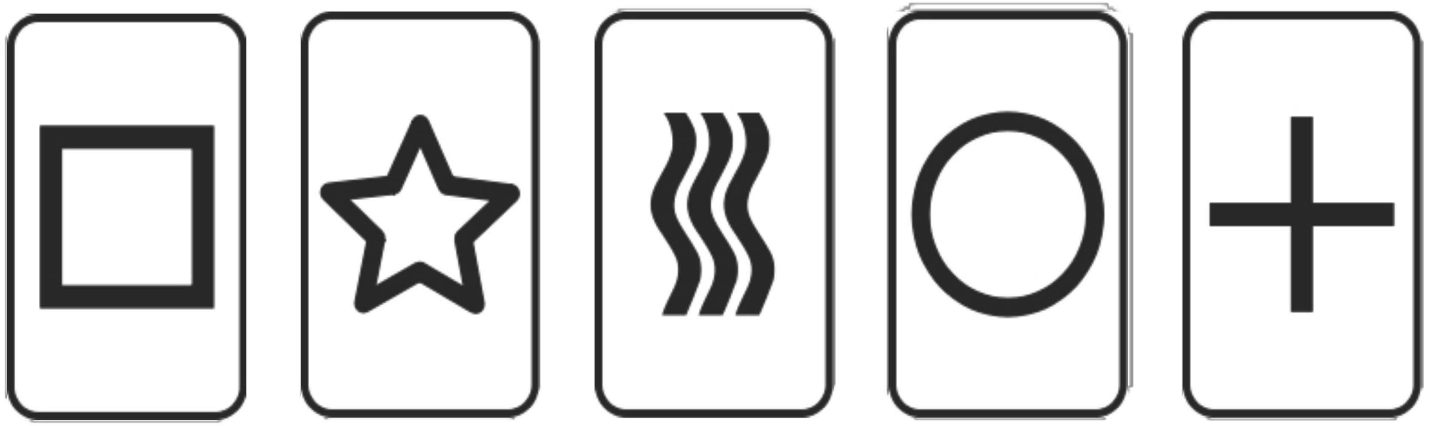

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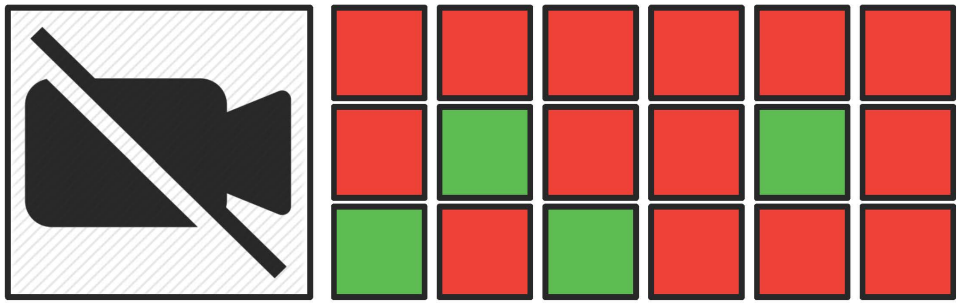

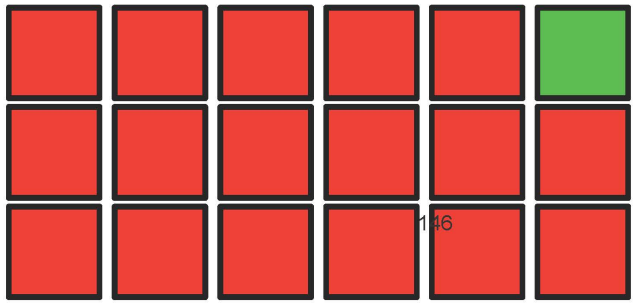

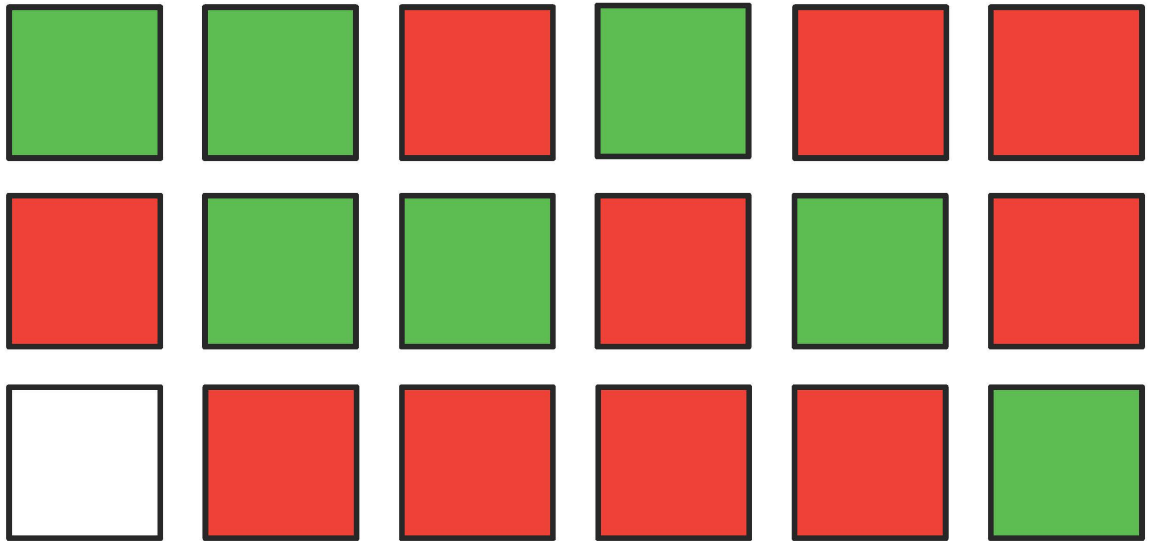

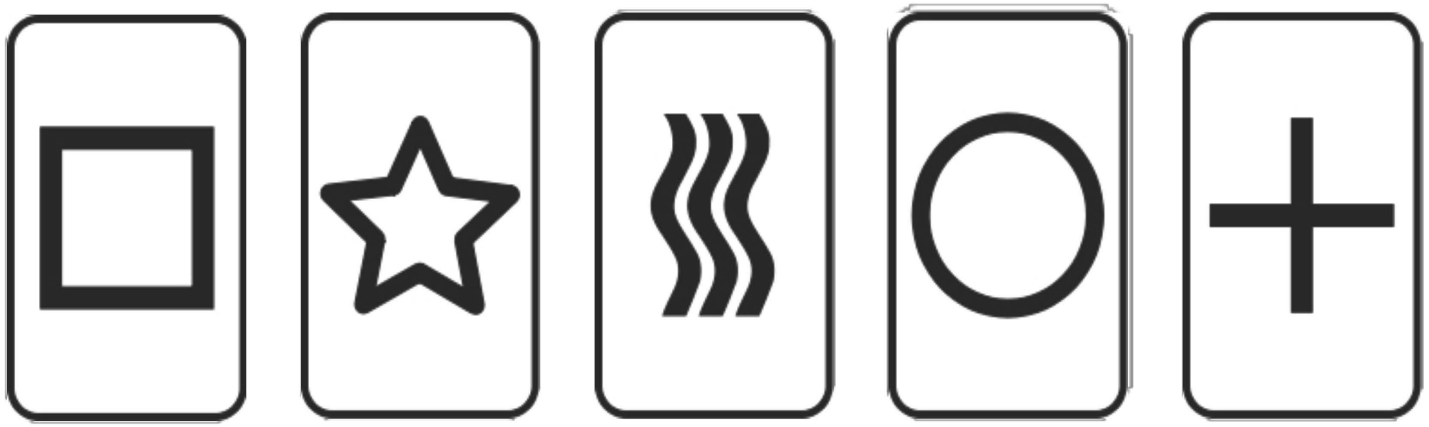

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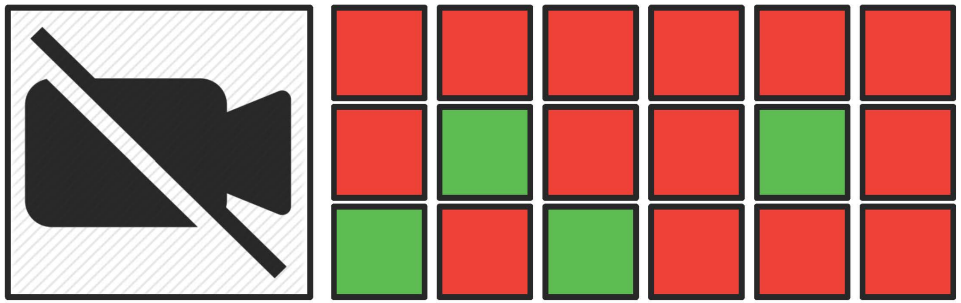

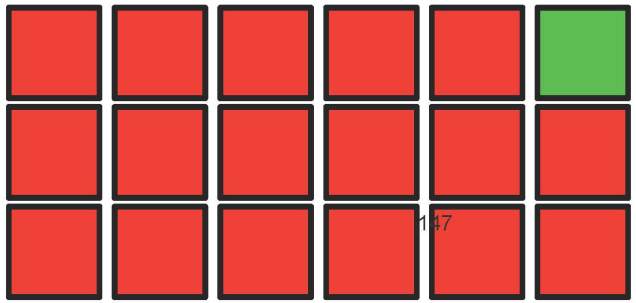

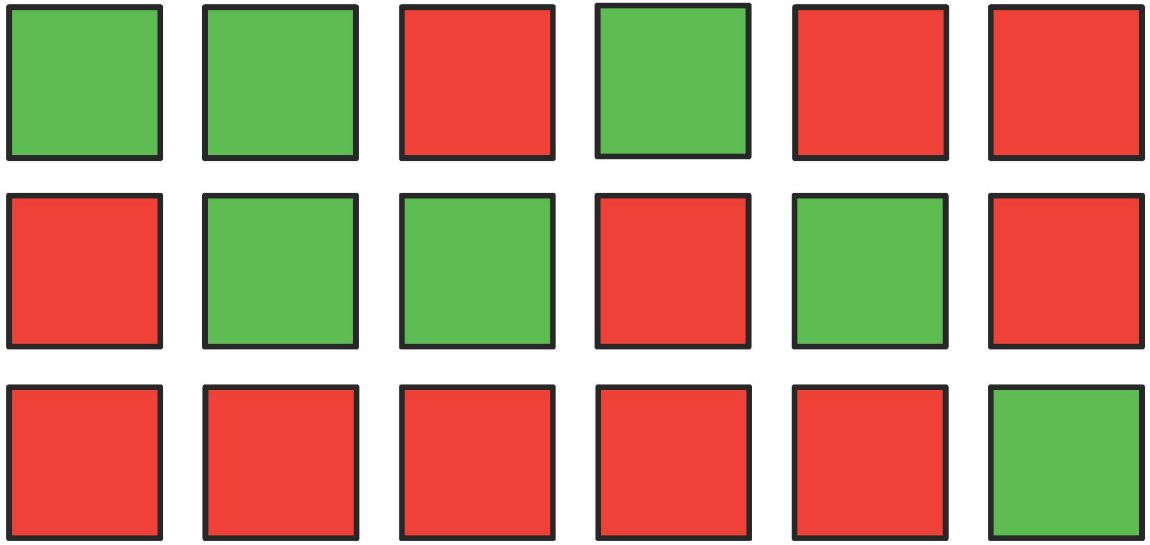

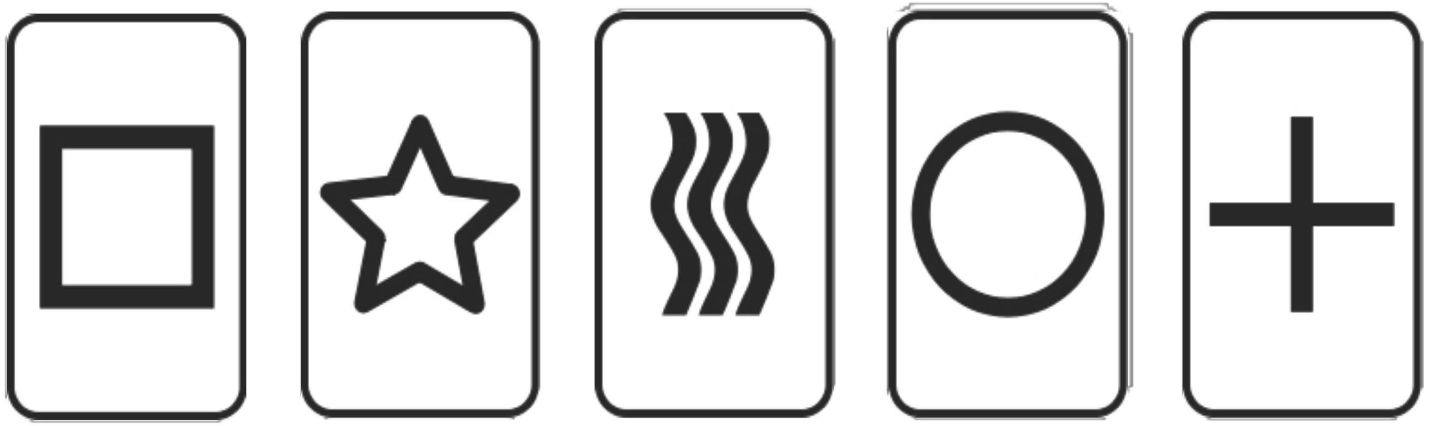

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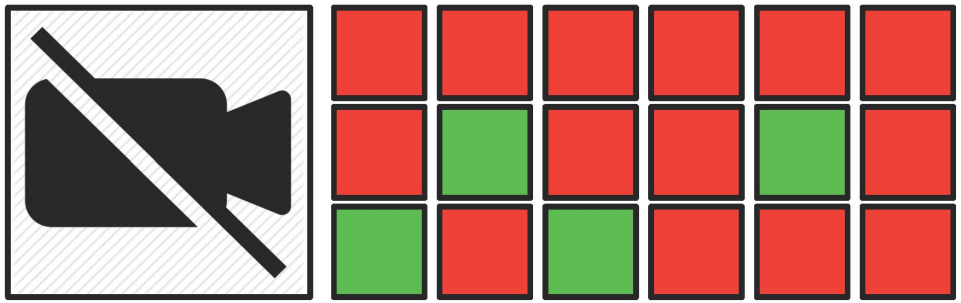
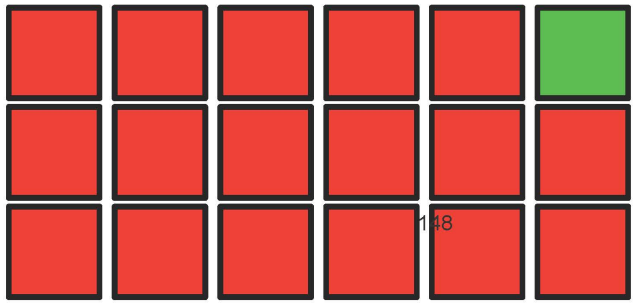


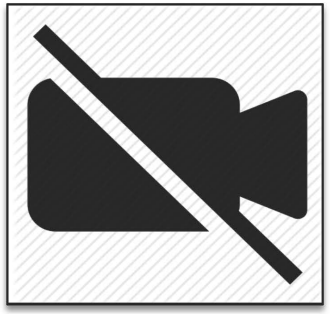


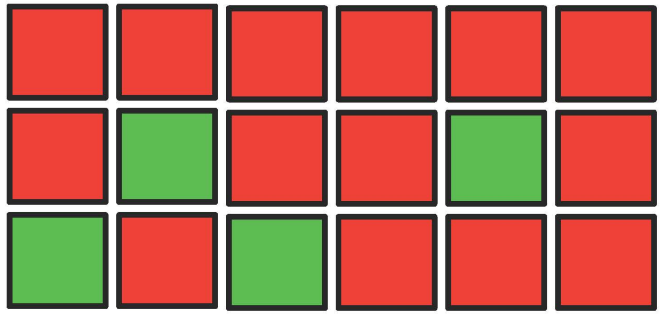
The next screen will display all of the players results.

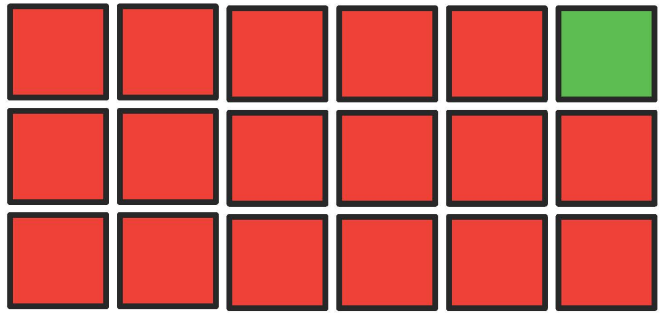
Please complete the questionnaire labeled *02.

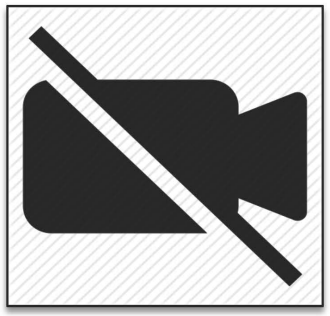
Take time to consider your answers and press continue when you have finished.

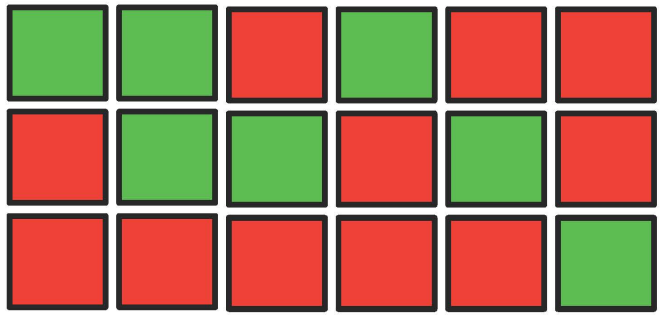
Continue











Please complete the questionnaire labeled *02.

Take time to consider your answers and press continue when you have finished.

Continue

Please complete the questionnaires labeled *03 and *04.

Take time to consider your answers and press continue when you have finished.

Continue

The study is now completed.

Thank you for your participation and engagement.
Your participation is vital to this research.

Please read and complete the debrief sheet provided by the operator.

Finish

Questionnaire *01 Date:_____

Participant *

Thank you for taking part in this study. Please enter your Participant Number in the space above.
Please take your time and answer all questions as accurately as you can.
Which players would you like to play with again?

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
Player 1	○	○	○	○	○	○	○
Player 2	○	○	○	○	○	○	○
Player 3	○	○	○	○	○	○	○

Please press continue on the results screen to carry on with the experiment.

Questionnaire *02 Date:_____

Participant *

Thank you for taking part in this study. Please enter your Participant Number in the space above.
Please take your time and answer all questions as accurately as you can.
Which players would you like to play with again?

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
Player 4	○	○	○	○	○	○	○
Player 5	○	○	○	○	○	○	○
Player 6	○	○	○	○	○	○	○

Please press continue on the results screen to carry on with the experiment.

Questionnaire *03 Date:_____
Participant *

Please enter your Participant Number in the space above.
Thank you for taking part in this study. Please take your time and answer all questions as accurately as you can.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
1. I think the best players results were random.	○	○	○	○	○	○	○
2. I think the worst player had bad luck.	○	○	○	○	○	○	○
3. I think that observing the players affected the results.	○	○	○	○	○	○	○
4. I think that if there had been more guesses, players would have improved.	○	○	○	○	○	○	○
5. I think that if the players could have seen me, it would have affected the results.	○	○	○	○	○	○	○
6. I think the game didn't allow players to do better or worse.	○	○	○	○	○	○	○
7. I think skill played a part in the results.	○	○	○	○	○	○	○

Questionnaire *03

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
8. I think that all of the results were arbitary.	○	○	○	○	○	○	○
9. I think the best player was cheating.	○	○	○	○	○	○	○
10. I think that if the worst player had prayed before the game, they would have performed better.	○	○	○	○	○	○	○
11. I think the game was rigged.	○	○	○	○	○	○	○
12. I think that body language affected the results.	○	○	○	○	○	○	○
13. I think the best player was blessed somehow.	○	○	○	○	○	○	○
14. I think that if the worst player had a lucky charm, it would have helped them perform better.	○	○	○	○	○	○	○
15. I think that the worst player could not have improved thier results, no matter what they did.	○	○	○	○	○	○	○

Questionnaire *03

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
16. I think that the best player had good luck.	○	○	○	○	○	○	○
17. I think that players that neither did well or or did badly didn't beleive are not religious.	○	○	○	○	○	○	○
18. I think that players that didn't perform well or poorly didn't believe in luck.	○	○	○	○	○	○	○
19. I think that observing the pattern of players results, affected the results.	○	○	○	○	○	○	○
20. I think that the best player believed was religious.	○	○	○	○	○	○	○

Please continue to Questionnaire *04.

Questionnaire *04 Date:_____
Participant *

Please enter your Participant Number in the space above.
Thank you for taking part in this study. Please take your time and answer all questions as accurately as you can.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
1. The soul continues to exist though the body may die.	○	○	○	○	○	○	○
2. Some individuals are able to levitate (lift) objects through mental forces.	○	○	○	○	○	○	○
3. Black magic really exists.	○	○	○	○	○	○	○
4. Black cats can bring bad luck.	○	○	○	○	○	○	○
5. Your mind or soul can leave your body and travel (astral projection).	○	○	○	○	○	○	○
6. The abominable snowman of Tibet exists.	○	○	○	○	○	○	○
7. Astrology can accurately predict the future.	○	○	○	○	○	○	○

Questionnaire *04

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
8. There is a devil.	○	○	○	○	○	○	○
9. Psychokinesis, the movement of objects through psychic powers, does exist.	○	○	○	○	○	○	○
10. Witches exist.	○	○	○	○	○	○	○
11. If you break a mirror, you will have bad luck.	○	○	○	○	○	○	○
12. During altered state, such as sleep or trances, the spirit can leave the body.	○	○	○	○	○	○	○
13. The Loch Ness monster of Scotland exists.	○	○	○	○	○	○	○
14. The horoscope accuratley tells a persons future.	○	○	○	○	○	○	○
15. I believe in God.	○	○	○	○	○	○	○

Questionnaire *04

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
16. A persons thoughts can influence the movement of a physical object.	○	○	○	○	○	○	○
17. Through the use of formulas and incantations, it is possible to cast spells on persons.	○	○	○	○	○	○	○
18. The number "13" is unlucky.	○	○	○	○	○	○	○
19. Reincarnation does occur.	○	○	○	○	○	○	○
20. There is life on other planets.	○	○	○	○	○	○	○
21. Psychics can accurately predict the future.	○	○	○	○	○	○	○
22. There is a Heaven and a Hell.	○	○	○	○	○	○	○
23. Mind reading is not possible.	○	○	○	○	○	○	○

Questionnaire *04

Participant *101

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Uncertain	Slightly Agree	Moderately Agree	Strongly Agree
24. There are actual cases of witchcraft.	○	○	○	○	○	○	○
25. It is possible to communicate with the dead.	○	○	○	○	○	○	○
26. Some people have an unexplained ability to predict the future.	○	○	○	○	○	○	○

Thank you for completing the questionnaire. Please press continue to carry on with the experiment.

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An Assessment of the Dimensionality and Factorial Structure of the Revised Paranormal Belief Scale

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Since its introduction, the Revised Paranormal Belief Scale (RPBS) has developed into a principal measure of belief in the paranormal. Accordingly, the RPBS regularly appears within parapsychological research. Despite common usage, academic debates continue to focus on the factorial structure of the RPBS and its psychometric integrity. Using an aggregated heterogeneous sample (N = 3,764), the present study tested the fit of 10 factorial models encompassing variants of the most commonly proposed solutions (seven, five, two, and one-factor) plus new bifactor alternatives. A comparison of competing models revealed a seven-factor bifactor solution possessed superior data-model fit (CFI = 0.945, TLI = 0.933, IFI = 0.945, SRMR = 0.046, RMSEA = 0.058), containing strong factor loadings for a general factor and weaker, albeit acceptable, factor loadings for seven subfactors. This indicated that belief in the paranormal, as measured by the RPBS, is best characterized as a single overarching construct, comprising several related, but conceptually independent subfactors. Furthermore, women reported significantly higher paranormal belief scores than men, and tests of invariance indicated that mean differences in gender are unlikely to reflect measurement bias. Results indicate that despite concerns about the content and psychometric integrity of the RPBS the measure functions well at both a global and seven-factor level. Indeed, the original seven-factors contaminate alternative solutions.

Keywords: belief in the paranormal, confirmatory factor analysis, bifactor model, revised paranormal belief scale, composite reliability

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INTRODUCTION

Opinion polls and surveys consistently report that belief in the paranormal is widespread within modern society. Specifically, they indicate that a substantial proportion of the general population believe in the existence of supernatural powers and forces. Illustratively, the 2005 Gallup survey (comprising 1,002 telephone interviews with American adults) found that 73% of Americans expressed belief in paranormal phenomenon (Moore, 2005). This was especially true of extrasensory perception (ESP) (41%) and haunting (37%). The overall figure was similar to an earlier 2001 Gallup survey (Newport and Strausberg, 2001), which reported that the majority of the American population (76%) endorsed at least one paranormal belief. Compared with the prior 1990 Gallup Poll (Gallup and Newport, 1990), the 2001 survey demonstrated an increase in belief of more than five percentage points for several paranormal phenomena (haunted houses, ghosts,

witches, communicating with the dead, psychic or spiritual healing, extra-terrestrial beings visiting earth and clairvoyance; the power of the mind to know the past and predict the future). Only belief in possession by the devil demonstrated a significant downturn.

MORI (Market and Opinion Research International) polls in Britain report comparable high levels of belief. The 2007 Survey on Beliefs (involving telephone interviews with a representative quota sample of 1,005 adults) found high endorsement of fate (62%), souls (62%) and premonitions (58%) (MORI, 2007). These figures were congruent with a previous 1998 MORI Paranormal Survey, which observed high endorsement of Premonitions/ESP (64%) (MORI, 1998). Collectively, Gallup and MORI polls evidence that belief in the paranormal is prevalent within contemporary society. This reflects the socially important nature and relevance of supernatural phenomena and explains/justifies sustained academic interest in the topic (Houran et al., 2001).

Alongside incidence of paranormal belief, researchers focus also on belief predictors. Hence, there is an established research tradition concerned with the study of correlates, which considers the psychological and socio-cultural foundations of paranormal belief (Lange et al., 2000). Correspondingly, articles referring to belief in the paranormal feature prominently within journals from a range of psychological sub-disciplines (e.g., personality, individual differences, cognitive, psychopathology, etc.). Whilst investigators have employed a range of measures to assess belief in the paranormal, the majority of work uses either the Revised Paranormal Belief Scale (RPBS) (Tobacyk, 2004), or the Australian Sheep-Goat Scale (ASGS) (Thalbourne and Delin, 1993; Wiseman and Watt, 2006). The RPBS because of its breadth, multidimensionality and preponderance in general psychological literature is the focus of the present paper. Indeed, the RPBS is the most widely used measure of paranormal belief (Goulding and Parker, 2001).

The ASGS in comparison possesses a narrower focus. It centers on traditional core paranormal concepts (extra-sensory perception, psychokinesis and life after death) and typically acts as a unitary, general index of paranormality (belief in psychic ability) (Thalbourne and Delin, 1993; Wiseman and Watt, 2006). The ASGS by virtue of emphasis and nature has historically featured more prominently within parapsychological literature.

The original Paranormal Belief Scale (PBS) (Tobacyk and Milford, 1983) arose from a factor analysis of a 61-item pool administered to 391 college students at Louisiana Tech University. Items sampled as wide a range of paranormal beliefs as possible and comprised questions modified from existing assessment instruments and newly devised statements. Conceptual coherence, in the absence of an agreed definition of the paranormal derived from implementation of three criteria (see Braude, 1978; Alcock, 1981); (a) current science and inexplicability of phenomena, (b) explicability requires major revision of the basic limiting principles of science (Broad, 1953), and (c) incompatibility with conventional notions of reality.

Factor analysis revealed seven independent factors (Traditional Religious Beliefs, Psi Beliefs, Witchcraft, Superstition, Spiritualism, Extraordinary Lifeforms and Precognition). All possessed clear, consistent structures and supported the notion that belief in the paranormal was a multidimensional construct. Prior to PBS construction, predetermined criteria specified clearest factor markers. Specifically, inclusion required that: (a) each marker possessed the largest loading on the relevant factor, and (b) the marker clearly reflected the factor theme. This process produced a 25-item scale derived from empirical investigation of belief via responses from a college sample, which represented separate paranormal dimensions. Further evaluation of the scale (Tobacyk and Milford, 1983), using 424 undergraduates, produced descriptive statistics and established the psychometric integrity of the PBS (convergent and discriminant properties).

Tobacyk reviewed the PBS (see Tobacyk, 1988, 2004) and developed the Revised Paranormal Belief Scale (RPBS). This involved contextualizing the nature of the RPBS, elucidating it as a measure of paranormal and religious beliefs, which facilitates examination of beliefs and their implications for spirituality. Adaptations to the PBS were: (1) implementation of a seven-point rather rating scale (PBS used a five-point scale); (2) development of a new Precognition subscale, item endorsement did not accurately reflect belief in precognition; and (3) modifications to the Witchcraft and Extraordinary Lifeforms subscales. Enhancements were designed to improve subscale reliability and validity (specifically, improve Western cross-cultural reliability) and lessen range restriction. Amendments resulted in the publication of the enhanced 26-item RPBS.

The scale has not been without criticism. Specifically, concerns and debate centered on the definition of paranormality employed to determine subject matter, item orthogonality (Tobacyk and Thomas, 1997), and factorial structure (Lawrence, 1995a,b; Tobacyk, 1995a,b; Lawrence and De Cicco, 1997; Lawrence et al., 1997, 1998). This discussion sits largely outside the remit of the present paper. However, the proposal of different factorial solutions, particularly the five and two-factor alternatives is important.

Particularly, Lawrence (1995a) demonstrated that an oblique five-factor model (Traditional Religious Belief, Psychic Beliefs, Superstition, Witchcraft and Anomalous Natural Phenomena) produced superior fit to the frequently cited Big Orthogonal Seven model (BOS) (see Lawrence et al., 1997). The value of the BOS is questionable because Tobacyk and Milford (1983) did not advance a mathematically based orthogonal model. They noted that subscales represented relatively independent dimensions (orthogonal), but were aware that cross-factor loadings factor did not advocate an uncorrelated subscale structure. Later, Tobacyk and Thomas (1997) suggested that a mixture of orthogonal and oblique relationships would most effectively represent the subfactors of the RPBS.

Following factor analysis of data from a sample of 560 Australian adults and removal of items showing pervasive differential item functioning, Lange et al. (2000) advocated a two-factor structure. This comprised New Age Philosophy (NAP; 11 items assessing largely psi, spiritualism and precognition) and Traditional Paranormal Beliefs (TPB; 5 items measuring traditional religious belief and witchcraft). These factors serve different functions. NAP instills a sense of control over external events at an *individual* level (Irwin, 1992), whilst TPB maintains

control over external events on a *social* level (Goode, 2000). Hence, personal experiences potentially reinforce NAP and culture TPB. The two-factor model has appeared in several papers, however, many researchers still use the RPBS as a general measure of belief in the paranormal, or the original subscales as independent measures.

Hartman (1999) using two statistical procedures (the minimum average partial and parallel analysis criteria) determined that the RPBS contained only four latent variables (Psi, Traditional Religion, Superstition, and Witchcraft) rather than the commonly used seven (Tobacyk and Milford, 1983) or five factors (Lawrence and De Cicco, 1997; Lawrence et al., 1997). Whilst, Hartman's approach offers useful insights into the factorial structure of the RPBS the four-factor model lacks conceptual clarity and has never been widely implemented. For instance, the third factor labeled Superstition comprises items measuring precognition (specifically astrology) and extraordinary life forms (belief in Abominable snowman of Tibet and the Loch Ness monster). For these reasons, Hartman's (1999) solution is only included within the present paper for the sake of completeness.

Since its development, the RPBS has featured in myriad papers as indexed by articles on the Web of Science. Publications span psychological domains (cognitive, individual differences, psychopathology, etc.). Within these studies, paranormal belief researchers have scored the RPBS in a variety of ways. Particularly, overall level of paranormal belief (e.g., Wolfradt, 1997; Hergovich, 2003; Aarnio and Lindeman, 2005; Darwin et al., 2011), the seven original factors (e.g., Peltzer, 2003) and the two-factor structure (e.g., Dagnall et al., 2017b,a). Whilst, correlations reveal close correspondence between the different solutions it is important to know which solution best fits data. This is vital because the models place different theoretical emphasis on belief. Specifically, adoption of single factor scores assumes that belief in the paranormal is a unitary construct and that the RPBS acts as an overall index of paranormal belief. Seven and five-factor solutions derive from the notion that belief in the paranormal is comprised of conceptually distinct, but related factors. Acceptance of the notion that belief in the paranormal is multidimensional has facilitated the criticism that the finite number of items contained within the RPBS cannot adequately sample the paranormal belief domain (Lawrence, 1995a; Hartman, 1999). This notion ignores the fact there are innumerable examples of scales with similar numbers of items that assess constructs and contain multiple related but independent factors (e.g., Self-Compassion Scale, Neff, 2003).

Contrastingly, the two-factor structure endorsed by Lange et al. (2000) focuses on belief function rather than content. It derived from the notion that measurement instruments in order to assess dimensionality must be free of differential item functioning (Lange et al., 2000). Hence, the RPBS was Rasch scaled to ensure that item responses reflected construct endorsement rather than characteristics, such as age or gender. Whilst, this is an important consideration many articles have continued to employ the conventional scoring methods, using the RPBS as a global measure of paranormal belief, and/or referred to the original seven-factor solution.

In addition to disagreement concerning the RPBS factorial composition, the dimensionality of the RPBS lacks confirmation. Tobacyk and Milford (1983) in their original analysis concluded that the RPBS was multidimensional. However, this supposition did not derive from confirmatory factor analysis (CFA). CFA is a powerful statistical technique that enables researchers to test the adequacy of theoretically plausible models via specification of underlying structure (see Bollen, 1989). Furthermore, subsequent work using CFA (e.g., Lawrence, 1995a; Lawrence et al., 1997) failed to test explicitly RPBS multidimensionality, and Irwin (2009) emphasizes that the notion of the RPBS being multidimensional requires further confirmatory evidence. This issue is problematic because numerous studies use RPBS total scores to assess belief in the paranormal (see Wolfradt, 1997; Hergovich, 2003; Aarnio and Lindeman, 2005; Darwin et al., 2011). A CFA-based test of multidimensionality vs. unidimensionality is achievable via bifactor modeling. Bifactor modeling determines subscale viability and indicates whether a measure represents a single dimension (Reise et al., 2010). Explicitly, after controlling for the influence of a general factor, bifactor modeling specifies item loading strength and subscale reliability. Strong item loadings and reliability coefficients for subscales relative to a general factor indicates that the data is likely to be multidimensional. Otherwise, subscales are unnecessary and a general factor underpins the measure.

The paranormal belief scale has also been adapted for use within different countries (e.g., China, Shiah et al., 2010; Spanish, Diaz-Vilela and Alvarez-Gonzalez, 2004; France, Bouvet et al., 2014). Analysis of modified versions has also produced alternative factorial structures. For instance, Utinans et al. (2015) produced a Latvian Version of the RPBS, which yielded a six-factor structure (Magical Abilities, Psychokinesis, Traditional Religious Belief, Superstition, Spirit Travel, and Extraordinary Life Forms). Additionally, a study using undergraduate students from the University of Zagreb, Croatia (Mikloušić et al., 2012), produced a previously unreported three-factor solution. This comprised General Paranormal Belief (mostly Psi and Spiritualism subscale items, with some Precognition, Witchcraft and Extraordinary Lifeforms items); Traditional Religious Belief (Traditional Religious Beliefs scale items); and Rituals and Practices (Superstition subscale items and the remaining Precognition, Witchcraft and Extraordinary Lifeforms subscale items).

Collectively, these studies support the notion that factor composition and item fit vary as a function of socio-cultural context (Tobacyk and Thomas, 1997; Bouvet et al., 2014). At the general level, cultural differences are evident. Illustratively, a cross-cultural comparison between university students from Finland and America revealed that American students scored generally higher across measures of paranormal belief (Traditional Religious Belief, Superstition, Witchcraft, and Extraordinary Lifeforms; Tobacyk and Pirttilä-Backman, 1992). At the item level, adaptation is required to ensure that items are relevant. For instance, Dag (1999) revised Extraordinary Lifeform items for use with a Turkish sample (e.g., Loch Ness monster of Scotland replaced by the Van Lake monster, and exchanged the snowman of Tibet with the wolfman).

The Present Study

The current study examined psychometric concerns about RPBS factor composition and dimensionality. Consideration of these issues was vital because conceptual stance and/or researcher preference determines RPBS scoring (i.e., total, seven-factor and two-factor), data analysis and interpretation. Thus, a comprehensive evaluation of RPBS latent structure was undertaken. This involved examination of several previously proposed models: two-factor model of Lange et al. (2000), one-factor solution (as a null model), five-factor and seven-factor solutions (Tobacyk and Milford, 1983; Lawrence, 1995a; Lawrence et al., 1997; Tobacyk and Thomas, 1997). Alongside these, bifactor variants of five-factor and seven-factor models were tested.

In summary, RPBS evaluation was necessary for several reasons. Firstly, to address how many subfactors best represent the RPBS and, in turn, to assess whether the RPBS functions as a multidimensional or general paranormal factor measure (Tobacyk and Milford, 1983; Irwin, 2009). Secondly, studies frequently employ total RPBS scores in conjunction with individual factors (e.g., Wolfradt, 1997; Hergovich, 2003; Aarnio and Lindeman, 2005; Darwin et al., 2011) and conceptualize belief in the paranormal as a latent factor (see Hergovich et al., 2008; Darwin et al., 2011). However, studies have failed to test the adequacy of these assumptions by including multidimensionality vs. unidimensionality within a single analysis. The inclusion of bifactor modeling determined whether scores from the RPBS best represented a single dimension or several specific factors. Since factors within bifactor models must not correlate, the technique allows an unambiguous assessment of scores on a general dimension without the influence of specific factors (Reise et al., 2007). Simultaneously, bifactor models determine whether specific facets exist after partialling out a general factor (Chen et al., 2012). In the context of the RPBS, bifactor modeling enabled an assessment of dimensionality and solution adequacy. Specifically, comparison of competing models clarified the latent structure of the RPBS.

METHODS

Participants

Several data sets containing completed RPBS measures were merged to produce a large heterogeneous sample (N = 3,764). These straddled the period between January 2008 and January 2017 (see ethics section). The aggregated sample comprised data from several published studies (e.g., Dagnall et al., 2016, 2017a) and new samples. This sampling approach was similar to that employed by Roets and Van Hiel (2011), who produced an amalgamated sample from previous studies in order to validate their Need for Closure Scale. Lange et al. (2000) in their top-down purification the RPBS also employed a similar approach; they used data from several studies collected over a 10 year period.

Consideration of the sample revealed 2,495 participants were students and 1,269 non-students. Of these, 1,069 (28%) respondents were male and 2,695 (72%) female. Within groups, 17% of students were male and 83% females, whilst 36% of non-students were male and 64% female. The mean age for males was 29.45 years (SD = 12.23, range of 18–79 years) and the mean age for females was 26.67 years (SD = 10.89, range of 18–78 years). The only exclusion criterion was that respondents had to be at least 18 years of age. To prevent multiple responses, instructions routinely ask respondents to indicate whether they have participated within similar studies.

Measure

The only measure analyzed within this study was the 26-item Revised Paranormal Belief Scale (RPBS). Within the RPBS, questions appear as statements (e.g., "There is a devil"; Tobacyk, 1988, 2004). Participants respond to each item via completion of a seven-point Likert scale (answers range from 1 = strongly disagree to 7 = strongly agree). Items index seven facets of belief: Precognition, Psi Belief, Traditional Religious Belief, Spiritualism, Witchcraft, Superstition and Extraordinary Lifeforms. Previous research reports that the RPBS possesses satisfactory reliability and adequate validity (Tobacyk, 2004). Hence, researchers generally regard the RPBS as a satisfactory measure of belief in the paranormal (Tobacyk, 2004). Some critics, however, question the psychometric properties of individual dimensions and forward alternative solutions (see introduction; Cardeña et al., 2015). Subsequently, Lange et al. (2000) purified the RPBS. This process identified a two-factor solution centered on belief function (individual vs. social). This includes New Age Philosophy (NAP) (11-items assesses belief in psi and survival of bodily death) and Traditional Paranormal Belief (TPB) (5-items measure belief in concepts, such as the devil, witchcraft, heaven and hell) (Cardeña et al., 2015). At the individual level, NAP imparts control over external events (Irwin, 1992), whilst TPB regulates social/cultural factors (Goode, 2000).

In the current study, Cronbach alpha reliability for the total scale was high (α = 0.93). For the seven subscales, alpha reliability was good for Traditional Religious Belief (α = 0.88), Witchcraft (α = 0.80), Psi Beliefs (α = 0.83), Superstition (α = 0.83), Spirituality (α = 0.83), and Precognition (α = 0.86). For Extraordinary Lifeforms, however, alpha was below the recommended threshold of 0.7 (α = 0.54). For the two subscales identified by Lange et al. (2000), alpha reliability was good, NAP (α = 0.86) and TPB (α = 0.81).

Procedure

Respondents within the studies underpinning the amalgamated data set undertook the same general procedure (these studies centered on anomalous beliefs, cognitive-perceptual personality factors and decision-making). Prior to participating potential respondents read the study background information, this stated the nature of the study and outlined ethical procedures. Respondents agreeing to participate indicated informed consent and received the materials booklet. Instructions asked respondents to carefully read questions, answer all questions, take their time and complete items in an open and honest manner. The order of questionnaires typically rotated across sections. Respondents provided also demographic information (preferred gender, age, etc.).

Ethics

The researchers obtained ethical approval for the studies as part of two successful grant proposals (September 2008 and 2010) and three unsuccessful bids (September 2012, 2014, and 2016). In the case of each application, The Director of the Research Institute for Health and Social Change (Faculty of Health, Psychology and Social Care) within Manchester Metropolitan University ratified the project (methodological and ethical). This is the necessary level of ethical clearance for projects rated as "routine." Furthermore, it is a university condition that research proposals are peer-reviewed by members of the Professoriate (or equivalent) prior to submission. This includes ethical scrutiny and gaining clearance in principal. Additionally, the Head of the Psychology Department must sanction research projects. Formal submission to a university ethics panel beyond this process is not an institutional requirement for routine studies.

Analysis

To examine comprehensively the latent structure of the RPBS confirmatory factor analysis (CFA) tested the adequacy of ten competing models using AMOS 24. **Table 1** provides a description of each model.

Consideration of a range of indices determined data-model fit. The chi-square (χ^2) statistic examines the difference between the observed and expected covariance matrix. A non-significant result denotes good fit. However, chi-square is sensitive to sample size and with large samples often over-rejects good models. The Comparative Fit Index (CFI), the Incremental Fit Index (IFI) and the Tucker-Lewis Index (TLI) compare a proposed model with a null model, where variables are uncorrelated (McDonald and Ho, 2002). Values above 0.90 specify adequate fit (Hu and Bentler, 1999). The Root-Mean-Square Error of Approximation (RMSEA) is a noncentrality-based index that identifies the quantity of variance-covariance data not effectively predicted by a hypothesized model. The Standardized Root-Mean-Square Residual (SRMR) is the square root of the misfit between a model covariance matrix and a sample covariance matrix. For RMSEA, the 90% confidence interval (CI) was included. Values below 0.08 for RMSEA and SRMR advocate reasonable fit (Hu and Bentler, 1999).

For each model, consideration of Modification Indices (MI) revealed the degree to which a model chi-square improved if constrained parameters were free to covary. High MI values (i.e., above 25; Torres-Harding et al., 2012) pertaining to subfactor items were investigated. Byrne (2010) recommends avoidance of covarying within-item errors unless reasonable justification is present. Instances where error covariance is justifiable include when the parameters in question are characterized by non-random measurement error (e.g., method effects resulting from similarities in item content). Error covariance across subfactors was, however, not permissible given the differences in item content (Byrne, 2010). Akaike's Information Criterion (AIC) and the Expected Cross-Validation Index (ECVI) facilitated model comparison, with lower values indicating better fit.

The superior factor structure was subjected to invariance testing in relation to gender at the configural, metric, and scalar level. Configural invariance tests require the same factor structure to hold across the tested groups. For metric invariance, it is necessary for the factor loadings to be the same (invariant) across groups. Scalar invariance requires the intercepts to be invariant across groups. Satisfaction of scalar invariance testing suggests that mean comparisons across groups are valid and are not symptomatic of measurement bias. To determine invariance, Cheung and Rensvold (2002) recommend in addition to satisfactory model fit, that CFI values should not change by more than 0.02 between models. Similarly, due to its sensitivity chi-square is not recommended as an index for invariance in samples of 1,000 or greater (Brown, 2006). Lastly, composite reliability of the superior factor solution assessed the reliability of the RPBS.

RESULTS

Prior to analysis, data screening occurred and resulted in the removal of 20 extreme scores. This left a final sample of 3,744. The RPBS mean was 80.86 (SD = 28.56). Skewness and kurtosis values were within the recommended interval of −2 to +2 (Byrne, 2010; see **Table 2**). A comparison of gender scores revealed that women (M = 85.43, SD = 27.18) scored significantly higher in paranormal beliefs than men (M = 69.84, SD = 28.81), $t(3{,}742) = 15.31$, $p < 0.001$, $d = 0.55$ (medium effect). Inter-correlations between the seven subscales outlined in the original RPBS (Tobacyk, 1988) and among scale items were significant. Furthermore, there were no instances of multicollinearity, all inter-correlations were below 0.9 (Tabachnick and Fidell, 2001). A correlation above 0.9 was evident between New Age Philosophy (NAP) and RPBS-Total (two-factor solution). However, this was unsurprising given that a high proportion of RPBS-Total items comprise NAP.

CFA fit indices for the two-factor oblique model indicated unacceptable fit on all indices, but SRMR: $\chi^2(103, N = 3{,}744) = 9{,}103.46, p < 0.001$, CFI = 0.764, TLI = 0.725, IFI = 0.764, SRMR = 0.078, RMSEA = 0.153 (CI of 0.150–0.155). Modification indices revealed the presence of high error covariance between items 2 and 16, 5 and 12, 7 and 14, 7 and 21, 9 and 16, 8 and 22, 12 and 19. Allowing these error terms to correlate significantly improved fit, χ^2 difference $(8, N = 3{,}744) = 5{,}607.53, p < 0.001$, resulting in acceptable fit on all indices, but TLI and RMSEA (see **Table 3**). Interestingly, all within-errors that were free to covary corresponded with the original RPBS factors.

The one-factor model reported poor fit: $\chi^2(299, N = 3{,}744) = 20{,}941.65$, $p < 0.001$, CFI = 0.663, TLI = 0.634, IFI = 0.663, SRMR = 0.089, RMSEA = 0.136 (CI of 0.134–0.137). High error covariance was present in more than 50% of the items. Consequently, the solution did not allow for correlation between item errors (Byrne, 2010). The five-factor oblique model (Lawrence, 1995a) suggested unacceptable data fit on all indices: $\chi^2(296, N = 3{,}744) = 12{,}979.34$, $p < 0.001$, CFI = 0.793, TLI = 0.773, IFI = 0.793, SRMR = 0.238, RMSEA = 0.107 (CI of 0.105–0.109). In comparison, the modified five-factor oblique model (Lawrence et al., 1997) demonstrated improved fit: $\chi^2(292, N = 3{,}744) = 9{,}984.33$, $p < 0.001$, CFI = 0.842, TLI = 0.824, IFI = 0.842, SRMR = 0.160, RMSEA = 0.094 (CI of 0.093 to 0.096). However, data-fit remained unacceptable across indices.

TABLE 1 | Competing factor models of the revised paranormal belief scale.

Model type	Description and item allocation
Two-factor oblique (Lange et al., 2000)	Two correlated factors: Traditional Paranormal Beliefs (items 8, 17, 22, 24, 26), and New Age Philosophy (items 2, 3, 5, 7, 9, 12, 14, 16, 19, 21, 23)
One-factor	All 26 RPBS items specified to load on a single factor
Five-factor oblique (Lawrence, 1995a)	Mixture of orthogonal and oblique relationships among five factors: Traditional Religious Belief (items 1, 8, 15, 22), Psychic Beliefs (items 2, 5, 9, 12, 16, 19, 21, 23, 25, 26), Superstition (items 4, 11, 18), Witchcraft (items 3, 10, 17, 24), and Anomalous Natural Phenomena (items 6, 7, 13, 14, 20)
Five-factor oblique (Lawrence et al., 1997)	Same as Lawrence (1995a), but with different factor correlations
Five-factor orthogonal (Lawrence et al., 1997)	Same factor composition as Lawrence (1995a), but with orthogonal relationships specified among factors
Five-factor bifactor	Six factors: Traditional Religious Belief (items 1, 8, 15, 22), Psychic Beliefs (items 2, 5, 9, 12, 16, 19, 21, 23, 25, 26), Superstition (items 4, 11, 18), Witchcraft (items 3, 10, 17, 24), Anomalous Natural Phenomena (items 6, 7, 13, 14, 20), and RPBS-Total (all scale items)
Seven-factor orthogonal (Tobacyk and Milford, 1983)	Seven orthogonal factors: Traditional Religious Belief (items 1, 8, 15, 22), Psi Beliefs (items 2, 9, 16, 23), Superstition (items 4, 11, 18), Witchcraft (items 3, 10, 17, 24), Spiritualism (items 5, 12, 19, 25), Precognition (items 7, 14, 21, 26), and Extraordinary Lifeforms (items 6, 13, 20)
Seven-factor mixed model (Tobacyk and Thomas, 1997)	Same as Tobacyk and Milford (1983), but with a mixture of orthogonal and oblique relationships among factors
Seven-factor oblique (Lawrence et al., 1997)	Same factor composition as Tobacyk and Milford (1983), but with oblique relationships specified among factors
Seven-factor bifactor	Eight factors: Traditional Religious Belief (items 1, 8, 15, 22), Psi Beliefs (items 2, 9, 16, 23), Superstition (items 4, 11, 18), Witchcraft (items 3, 10, 17, 24), Spiritualism (items 5, 12, 19, 25), Precognition (items 7, 14, 21, 26), Extraordinary Lifeforms (items 6, 13, 20), and RPBS-Total (all scale items)

In addition, it was not possible to conduct chi-square difference between the five-factor models because of the orthogonal nature of the Anomalous Natural Phenomena factor (see Lawrence, 1995a).

MI values for the Lawrence et al. (1997) solution reported high error covariance for several items (items 1 and 22, 10 and 24, 6 and 13, 12 and 5, 19 and 25, 25, 21 and 26, 2, 9, and 16). Data-model fit significantly improved by permitting correlations of these error terms: χ^2 difference (11, $N = 3{,}744$) = 4,433.95, $p < 0.001$, and resulted in acceptable fit on all indices but SRMR: $\chi^2(279, N = 3{,}744) = 5{,}550.38$, $p < 0.001$, CFI = 0.914, TLI = 0.901, IFI = 0.914, SRMR = 0.155, RMSEA = 0.071 (CI of 0.069–0.072). The five-factor orthogonal solution based on Lawrence et al. (1997) demonstrated poor fit on all indices: $\chi^2(299, N = 3{,}744) = 16{,}328.45$, $p < 0.001$, CFI = 0.739, TLI = 0.716, IFI = 0.739, SRMR = 0.303, RMSEA = 0.120 (CI of 0.118 to 0.121). Correlating error terms between items 1 and 15, 3, and 17, 6, and 13, 12, and 5, 19, and 25, 25, 21, and 16, 2, 9, and 16 significantly improved fit: χ^2 difference (11, $N = 3{,}744$) = 4,305.56, $p < 0.001$, but this remained unsatisfactory.

The five-factor bifactor model reported acceptable fit on all indices, but TLI: $\chi^2(273, N = 3{,}744) = 5627.63$, $p < 0.001$, CFI = 0.913, TLI = 0.896, IFI = 0.913, SRMR = 0.051, RMSEA = 0.072 (CI of 0.071 to 0.074). High error covariance was evident for items 1 and 15, 3 and 17, 12 and 5, 25 and 26. Model fit significantly improved by permitting correlations among error terms for these items: χ^2 difference (4, $N = 3{,}744$) = 767.15, $p < 0.001$. The orthogonal seven-factor model (Tobacyk and Milford, 1983) indicated unacceptable fit on all indices: $\chi^2(299, N = 3{,}744) = 18{,}722.39$, $p < 0.001$, CFI = 0.700, TLI = 0.673, IFI = 0.700, SRMR = 0.338, RMSEA = 0.128 (CI of 0.127–0.130). Allowing within-item errors between items 1 and 15, 3 and 17, 19 and 25, and 7 and 14 to correlate significantly improved fit: χ^2 difference (4, $N = 3{,}744$) = 1,522.60, $p < 0.001$. However, data-model fit remained unsatisfactory.

To determine which subfactors should correlate (oblique vs. orthogonal) for the mixed seven-factor model (Tobacyk and Thomas, 1997), a two-stage process was applied. Firstly, an assessment of inter-item correlations was undertaken; all possessed significant relationships (i.e., $p < 0.05$). Next, based on subscales an examination of inter-correlations occurred (see **Table 2**). Where moderate relationships existed between subfactors (i.e., inter-correlations greater than 0.4; Evans, 1996) these were correlated in CFA. Accordingly, Traditional Religious Belief correlated with Witchcraft, Precognition, and Spiritualism. Superstition correlated with Precognition and Spiritualism. Witchcraft correlated with all subfactors, but Superstition. Precognition and Spiritualism correlated with all subfactors. Extraordinary Lifeforms and Psi Beliefs correlated with one another, Witchcraft, Precognition, and Spiritualism. Results suggested unacceptable fit on all indices: $\chi^2(283, N = 3{,}744) = 7{,}624.62$, $p < 0.001$, CFI = 0.880, TLI = 0.862, IFI = 0.880, SRMR = 0.165, RMSEA = 0.083 (CI of 0.082 to 0.085). Allowing within-item error correlations between items 1 and 22, 10 and 24, 5 and 12, 7 and 14, and 21 and 26 significantly improved fit, χ^2 difference (5, $N = 3{,}744$) = 1,878.61, $p < 0.001$, and fit was satisfactory on all indices, but TLI and SRMR. The seven-factor oblique solution reported acceptable fit on all indices, but TLI: $\chi^2(278, N = 3{,}744) = 6{,}077.63$, $p < 0.001$, CFI = 0.905, TLI = 0.889, IFI = 0.905, SRMR = 0.062, RMSEA = 0.075 (CI of 0.073–0.076). Model fit significantly improved by permitting within-item errors between items 1 and 22, 10 and 24, 5 and 12, 7 and 14, 21 and 26 to correlate: χ^2 difference (5, $N = 3{,}744$) = 1,923.13, $p < 0.001$.

TABLE 2 | Descriptive statistics and intercorrelations for RPBS-Total and subscales ($N = 3,744$).

Variable	Mean	*SD*	Skew	Kurtosis	1	2	3	4	5	6	7	8	9	10
1. RPBS-total	80.86	28.56	0.12	−0.71		0.70**	0.62**	0.81**	0.84**	0.57**	0.78**	0.87**	0.89**	0.93**
2. Traditional religious belief	14.93	7.21	0.14	−0.97			0.36**	0.49**	0.44**	0.23**	0.40**	0.51**	0.82**	0.52**
3. Superstition	6.93	4.18	0.90	0.01				0.37**	0.55**	0.32**	0.40**	0.44*	0.46**	0.51**
4. Witchcraft	12.57	6.60	0.32	−0.86					0.60**	0.42**	0.64**	0.63*	0.83**	0.74**
5. Precognition	11.60	5.79	0.31	−0.85						0.43**	0.70**	0.75**	0.70**	0.87**
6. Extraordinary lifeforms	9.72	3.34	0.25	−0.19							0.45**	0.46**	0.40**	0.50**
7. Psi beliefs	11.80	5.67	0.44	−0.49								0.72**	0.63**	0.90**
8. Spirituality	13.02	6.55	0.74	0.47									0.68**	0.90**
9. Traditional paranormal beliefs	16.31	7.35	0.15	−0.81										0.76**
10. New age philosophy	32.63	14.48	0.39	0.01										

**$p < 0.001$.

The seven-factor bifactor model reported acceptable data-model fit on all indices: $\chi^2(273, N = 3,744) = 4,371.34$, $p < 0.001$, CFI = 0.933, TLI = 0.920, IFI = 0.933, SRMR = 0.048, RMSEA = 0.063 (CI of 0.062–0.065). Allowing within-item errors between items 1 and 15, 3 and 17, and 21 and 26 to correlate significantly improved fit: χ^2 difference (3, $N = 3,744$) = 701.53, $p < 0.001$. Overall, the seven-factor bifactor model demonstrated superior fit in comparison with the other factor models, as evidenced by superior fit and lower AIC and ECVI statistics[1] (see **Table 3**). Parameter estimates for the seven-factor bifactor solution further support the appropriateness of this model, as all factor loadings for RPBS-Total were statistically signissficant and exceeded the minimum threshold of 0.32 (Tabachnick and Fidell, 2001), with the exception of item 20 (loading of 0.22) (see **Figure 1**). The relative strength of the factor loadings for the subscale factors and the general factor provide important information in relation to the appropriateness of including subscales when scoring the RPBS. Specifically, when items load more highly on subscales than a general factor, this suggests that a measure comprises distinct subscales. When items load more highly on a general factor, this indicates that total scores are valid and that an underlying construct underpins the measure (Reise et al., 2010). In terms of the subscales, some item loadings were non-significant (items 23 and 26). However, the majority of items loaded higher than 0.32. These results provide tentative support for a general paranormal belief dimension and the existence of separate subscales.

Tests for invariance were subsequently performed in relation to gender. The configural invariance test revealed satisfactory fit, CFI = 0.925, TLI = 0.911, IFI = 0.925, SRMR = 0.048, RMSEA = 0.047 (CI of 0.046 to 0.048). A test for metric invariance also indicated satisfactory fit, CFI = 0.926, TLI = 0.919, IFI = 0.927, SRMR = 0.055, RMSEA = 0.045 (CI of 0.044–0.046), with a CFI difference less than the threshold of 0.02, confirming invariance at configural and metric stages across gender. The scalar invariance test reported acceptable fit, CFI = 0.917, TLI = 0.912, IFI = 0.917, SRMR = 0.055, RMSEA = 0.047 (CI of 0.046–0.048), with a CFI difference <0.02, supporting strong factorial invariance.

Many researchers regard internal reliability as a critical factor for determining a measure's suitability. Composite reliability, which provides an appropriate index within a latent modeling context, assessed the internal consistency of the seven-factor bifactor model (Raykov, 1998). Results of 0.60 and greater are considered acceptable (Diamantopoulos and Siguaw, 2000). The RPBS-Total demonstrated excellent internal consistency ($\rho c = 0.96$). Considering the subscales, the Traditional Religious Belief ($\rho c = 0.84$), Psi Belief ($\rho c = 0.71$), Witchcraft ($\rho c = 0.78$), Superstition ($\rho c = 0.77$), Spirituality ($\rho c = 0.65$), and Precognition ($\rho c = 0.72$) possessed satisfactory to good internal consistency. Composite reliability for Extraordinary Lifeforms was, however, lower than the threshold of 0.60 ($\rho c = 0.46$).

[1]AIC and ECVI for the two-factor oblique models were not compared with the other factor solutions due to possessing less RPBS items.

TABLE 3 | Fit indices for competing RPBS factor solutions.

Model	$\chi 2$	*df*	CFI	TLI	IFI	SRMR	RMSEA (90% CI)	AIC	ECVI
Two-factor oblique (Lange et al., 2000)	9,103.46**	103	0.764	0.725	0.764	0.078	0.153 (0.150–0.155)	9,201.46	2.45
Two-factor oblique (CE) (Lange et al., 2000)	3,495.93**	95	0.911	0.887	0.911	0.047	0.098 (0.095–0.101)	3,609.93	0.96
One-factor	20,941.65**	299	0.663	0.634	0.663	0.089	0.136 (0.134–0.137)	21,097.65	5.63
Five-factor oblique (Lawrence, 1995a)	12,979.34**	296	0.793	0.773	0.793	0.238	0.107 (0.105–0.109)	13,141.34	3.51
Five-factor oblique (Lawrence et al., 1997)	9,984.33**	292	0.842	0.824	0.842	0.160	0.094 (0.093–0.096)	10,154.33	2.71
Five-factor oblique (Lawrence et al., 1997) (CE)	5,550.38**	281	0.914	0.901	0.914	0.155	0.071 (0.069–0.072)	5,742.38	1.53
Five-factor orthogonal (Lawrence et al., 1997)	16,328.45**	299	0.739	0.716	0.739	0.303	0.120 (0.118–0.121)	16,484.45	4.40
Five-factor orthogonal (CE) (Lawrence et al., 1997)	12,022.89**	288	0.809	0.784	0.809	0.302	0.104 (0.103–0.106)	12,200.89	3.26
Five-factor bifactor	5,627.63**	273	0.913	0.896	0.913	0.051	0.072 (0.071–0.074)	5,835.63	1.55
Five-factor bifactor (CE)	4,860.48**	269	0.925	0.910	0.925	0.050	0.068 (0.066–0.069)	5,076.48	1.35
Seven-factor orthogonal (Tobacyk and Milford, 1983)	18,722.39**	299	0.700	0.673	0.700	0.338	0.128 (0.127–0.130)	18,878.39	5.04
Seven-factor orthogonal (CE) (Tobacyk and Milford, 1983)	17,199.78**	295	0.724	0.696	0.724	0.337	0.124 (0.122–0.125)	17,363.78	4.63
Seven-factor mixed (Tobacyk and Thomas, 1997)	7,624.62**	283	0.880	0.862	0.880	0.165	0.083 (0.082–0.085)	7,812.62	2.08
Seven-factor mixed (CE) (Tobacyk and Thomas, 1997)	5,746.01**	278	0.911	0.896	0.911	0.162	0.072 (0.071–0.074)	5,944.01	1.58
Seven-factor oblique (Lawrence et al., 1997)	6,077.63**	278	0.905	0.889	0.906	0.062	0.075 (0.073–0.076)	6,275.63	1.67
Seven-factor oblique (CE) (Lawrence et al., 1997)	4,154.49**	273	0.937	0.925	0.937	0.055	0.062 (0.060–0.063)	4,362.49	1.16
Seven-factor bifactor	4,371.34**	273	0.933	0.920	0.933	0.048	0.063 (0.062–0.065)	4,579.34	1.22
Seven-factor bifactor (CE)	3,669.80**	270	0.945	0.933	0.945	0.046	0.058 (0.056–0.060)	3,883.80	1.03

*CE, correlated errors; $\chi 2$, chi-square goodness-of-fit statistic; df, degrees of freedom; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; IFI, Incremental Fit Index; SRMR, Standardized Root-Mean-Square Residual; RMSEA, Root-Mean-Square Error of Approximation; AIC, Akaike Information Criterion; ECVI, Expected Cross-Validation Index; **$\chi 2$ significant at $p < 0.001$.*

DISCUSSION

A comparison of 10 competing models of the RPBS found superior fit for a seven-factor bifactor solution. This solution comprised a general factor of paranormal belief alongside seven subfactors originally proposed by Tobacyk (1988). The factor loadings for all items but item 20 on the general factor were in the moderate to high range. In comparison, factor loadings were generally weaker for the seven subscales, but the majority of items loaded to an acceptable degree. This indicated that belief in the paranormal, as measured by the RPBS, is best characterized as a single overarching construct, comprising several related, but conceptually independent subfactors. This position is reassuring for previous work that has used the RPBS as a general (e.g., Dagnall et al., 2007) and/or multidimensional (e.g., Darwin et al., 2011) measure because it supports the notion that scores at both measurement levels are valid. Furthermore, although RPBS subscales contain only few items (three or four per factor) they possessed psychometric integrity and appeared theoretically consistent with their factor designation. The one exception being the Extraordinary Lifeforms factor, which demonstrated poor internal reliability (further discussion of this issue appears later).

At a factorial level, this study produced several important findings. Firstly, seven-factor solutions (Tobacyk and Milford, 1983; Tobacyk and Thomas, 1997) more appropriately represented RPBS content than five-factor iterations (Lawrence, 1995a; Lawrence and De Cicco, 1997; Lawrence et al., 1997). This outcome provides support for Tobacyk and Milford's (1983) original categorization of the RPBS and perhaps reflects greater similarities in phrasing among the items of the initial seven subfactors; a line of reasoning highlighted by the greater amount of error covariance required for the five-factor relative to the seven-factor solutions to achieve acceptable model fit. Secondly, oblique (Lawrence et al., 1997) solutions provided a better data-fit than orthogonal models (Tobacyk and Milford, 1983), suggesting that the specification of correlations between factors leads to meaningful improvements in model fit regardless of how many subfactors are incorporated.

Thirdly, bifactor models demonstrated superior fit for both five-factor and seven-factor solutions, supporting the existence of a general dimension of paranormal belief. This finding ran contrary to Tobacyk and Milford (1983), who concluded that rather than being a single dimension of belief in the paranormal there were several relatively independent paranormal dimensions. Studies that have used both the RPBS and the ASGS provide support for the notion that the RPBS adequately samples the paranormal belief domain; the two measures share approximately 60% shared variance (Drinkwater et al., 2012; Dagnall et al., 2014). This indicates that the RPBS as well as possessing construct breadth indexes the core aspects of the paranormal belief assessed by the ASGS (extrasensory perception, life after death and psychokinesis). Collectively, these results support a hierarchical conceptualization of paranormal belief, whereby a general paranormal belief factor relates to several specific belief dimensions. These data support this conceptualization, which represents a novel adjunct to the existing literature. Furthermore, women reported significantly higher levels of paranormal belief than men, which is a consistent finding in relation to previous research (e.g., Wolfradt, 1997). Support for invariance of the RPBS across gender indicates that mean differences in paranormal belief are unlikely to be artifacts of measurement bias, and rather suggest true mean differences.

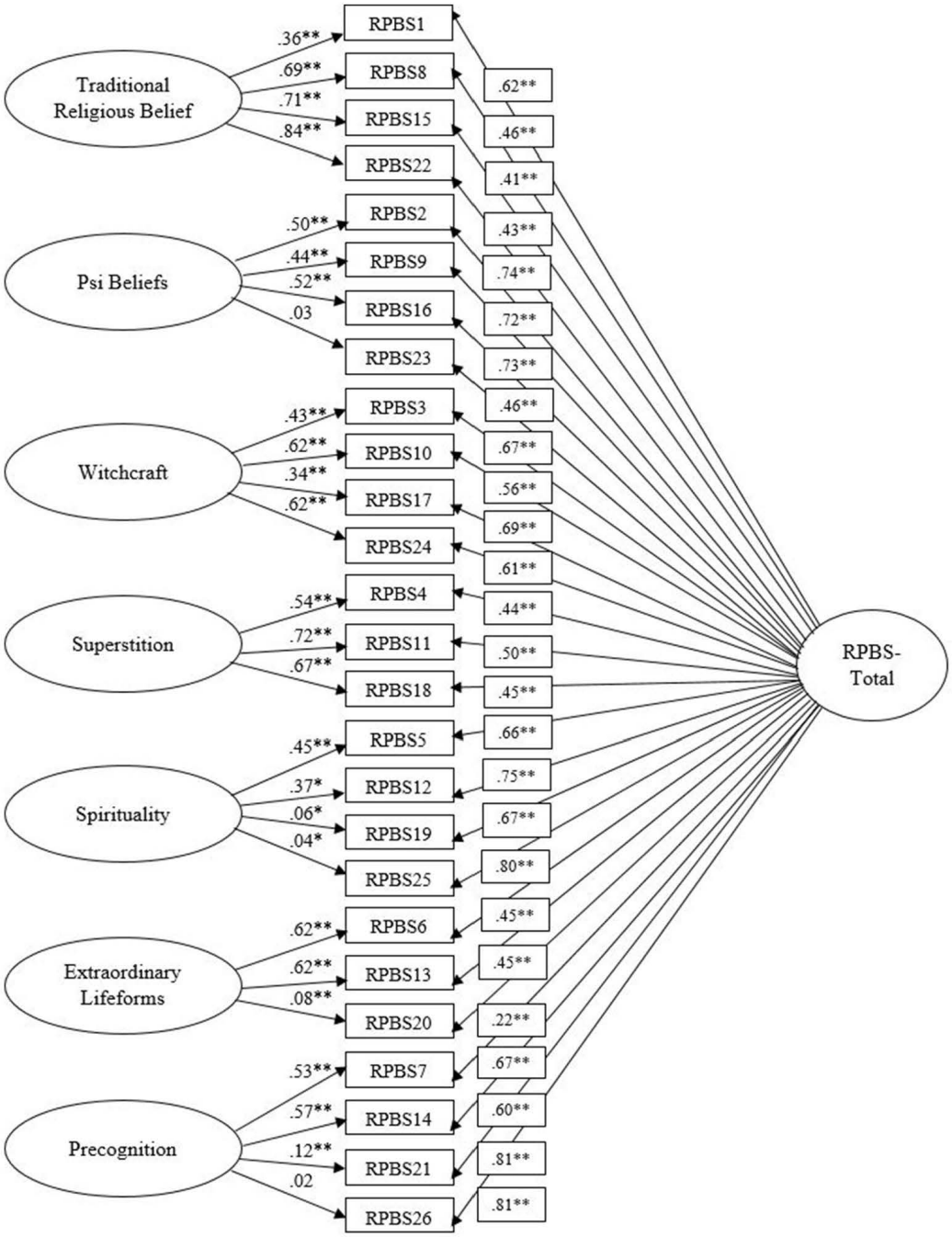

FIGURE 1 | Seven-factor bifactor RPBS model. Latent variables are represented by ellipses; measured variables are represented by rectangles; error is not shown, but was specified for all variables. Error covariances between RPBS1 and RPBS15, RPBS3 and RPBS17, RPBS21 and RPBS26 are not shown but were included in the analysis. $^{*}p < 0.05$; $^{**}p < 0.001$.

Regarding the two-factor model, analysis revealed that the original seven subscales have contaminated RPBS purification. To illustrate this point, New Age Philosophy (NAP) derives almost exclusively from three original RPBS factors, Psi, Spirituality and Precognition, whilst Traditional Paranormal belief (TPB) consists of Traditional Religious Belief, Witchcraft and a single Psi item. In this context, it is clear that correlations present within the original seven-factor measure manifest within the two-factor model. This conclusion is consistent with Dagnall et al. (2017b), who found that it was necessary to covary errors among items belonging to the initial seven subscales to achieve satisfactory fit for both NAP and TPB. Other recent work utilizing

the two-factor model has produced similar findings (e.g., Dagnall et al., 2017a).

At a conceptual level, the analysis supports previously expressed concerns about the Extraordinary Lifeforms (ELF) subscale and the use of a reversed item (question 23) to assess Psi. Considering these issues in turn, the authors are aware that critics contend that the inclusion of ELF is questionable because it is it is unclear whether belief in creatures, such as the Loch Ness monster, abominable snowman and extraterrestrials represent a paranormal dimension (Lawrence, 1995a; Dagnall et al., 2010). Rather than being beyond nature the existence of creatures, such as the Loch Ness monster and abominable snowman are improbable and elusive rather than supernatural. That is of course unless believers link them to paranormal powers or forces. To illustrate this point, researchers regularly discover new animal species (e.g., Ninja Lanternshark, Vásquez et al., 2015; Dusky Snout Catshark, Ebert and Clerkin, 2015).

Whilst, "paranormality" is an important concern the issue with the ELF scale was the relatively high endorsement rate of item 20, "There is life on other planets" ($M = 4.88$, $SD = 1.61$); this value indicates that respondents demonstrate moderate levels of agreement with this item. In comparison, respondents generally disagree with item 6, "The abominable snowman of Tibet exists" ($M = 2.45$, $SD = 1.49$) and item 13, "The Loch Ness monster of Scotland exists" ($M = 2.39$, $SD = 1.52$). Clearly, regardless of whether ELF items are paranormal, subscale content requires revision because it demonstrates poor internal reliability. This finding is consistent with the criticism that the extraterrestrial item is "useless" because most people regardless of general level of paranormal belief would agree with the statement that there is some form of life on other planets (Lawrence, 1995a). The authors do not support abandonment of the ELF subscale (see Lawrence et al., 1997), but instead recommend revision to ELF-item phrasing.

Concerning the Psi subscale, item 23 ("Mind reading is *not* possible") loaded poorly on the factor. Scrutiny of the Psi means revealed that endorsement of the statement was high in comparison to other items ($M = 3.87$, $SD = 1.90$), which fell within a narrow range ($M = 2.50$, $SD = 1.67$ to $M = 2.89$, $SD = 1.79$). This finding was consistent with previous work, which reports that reversed items display lower reliability and weaker item-to-total correlations than positive-worded counterparts (Cronbach, 1942; Peabody, 1966; Benson and Hocevar, 1985). In addition to this, reversed items often prove difficult to accommodate within factorial models and frequently load on a separate factor (Benson and Hocevar, 1985; Pilotte and Gable, 1990; Herche and Engelland, 1996).

The current commonly used measures of paranormal belief (e.g., RPBS and ASGS) lack negatively keyed (reversed) items. Hence, within the RPBS, with the exception of item 23, endorsement of statements typically indicates belief in the paranormal. A frequently cited criticism of measures composed of predominantly positively framed items is that they incline respondents to answer in ways that do not reflect their actual view. Response bias is a major concern for scale developers because it can seriously compromise the validity of self-report scales (Van Sonderen et al., 2013). For example, clusters of unidirectional items will increase the tendency to agree or disagree to statements regardless of their content. Paradoxically, in the case of RPBS item 23 respondents often fail to notice the reversed wording of the statement as evidenced by the items poor psychometric performance.

Noting problems associated with response bias, scale developers recommend that scales comprise a balance of positively worded and reversed items (Baumgartner and Steenkamp, 2001). In the case of the assessment of belief in the paranormal generally and the RPBS specifically, the present study suggests that the use of reversed items may cause additional issues. Particularly, respondents often struggle to comprehend statements. Additionally, not believing in a specific instance/situation (mind reading) does not invalidate belief in ESP or telepathy. The question tells the researcher little about general belief in ESP; it is possible that respondents could believe that people have visions of the future, that people can communicate telepathically, see things remotely, but that they do not believe that information is transmitted via mental processes.

The RPBS despite being hierarchical and possessing construct breadth fails to reference important paranormal phenomena, such as ghost and poltergeists (Dagnall et al., 2010). These are important because both phenomena link closely to the survival hypothesis (e.g., life after death and spirits), which is a key paranormal concept. Additionally, belief in ghosts is high within contemporary society reflecting the significance of the topic (Gallup and Newport, 1990; Newport and Strausberg, 2001). Consequently, future scale developments and studies need to include items assessing belief in ghost and poltergeists (Dagnall et al., 2010).

Referencing the two-factor Rasch scaled model of Lange et al. (2000), it is important to note that this derived from a sample comprised of Australian adults. It would prove interesting to examine whether the gender and age biases observed within that population two-three decades ago apply to contemporary samples of other cultures, e.g., North American, British. This is an important point to consider for future research because beliefs and social attitudes evolve and change over time (Gergen, 1996). In addition, the current study did not perform further tests of reliability and validity including test-retest reliability and convergent validity. However, preceding research has supported temporal stability of the scale across a 4-week interval (Tobacyk, 2004). Future work, while assessing the latent structure of the RPBS, could also incorporate comparable measures of paranormal belief (e.g., the ASGS). This would provide a useful index of convergent validity.

Finally, it is worth noting that differences in sample size and composition may have contributed to the breadth of factorial solutions recommended previously. For example, several studies with relatively low respondent numbers drew exclusively on undergraduate student populations (Tobacyk and Milford, 1983; Lawrence et al., 1997). Clearly, future work would benefit from the use of larger more heterogeneous samples and the delineation of agreed expected sampling conventions and parameters. In conclusion, the current study indicates that a hierarchical latent structure, consisting of a general dimension of paranormal belief and seven conceptually independent subfactors best represents the RPBS. Strong factor loadings for a general factor and weaker, albeit acceptable, factor loadings for the subfactors supports

the use of total RPBS scores and, to a lesser degree, subfactor scores within research. Findings also indicate that a seven-factor bifactor solution provides a robust conceptualization of the RPBS, evident by high reliability (alpha and composite) for all factors but Extraordinary Lifeforms.

AUTHOR CONTRIBUTIONS

KD: theoretical focus and analysis; design, background and data collection. AD: theoretical focus and analysis; analysis and model testing. ND: theoretical focus and analysis; contributed to and supported all sessions. AP: commented on drafts—provided theoretical background and draft feedback.

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