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Associative learning and perceptual style: Are associated events perceived analytically or as a whole?

Elias Tsakanikos *

Institute of Psychiatry, King's College London, ESTIA Centre, 66 Snowfields, London SE1 3SS, UK

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Abstract

The present study examined whether the formation of associations is affected by individual differences in perceptual style (analytic vs. holistic). Ninety undergraduate students were tested on their ability to associate concurrent events (i.e. word—colour) and were assessed on measures of field dependence and intelligence. The analysis revealed that analytic perceptual style (field independence) was associated with better performance on associative learning, and that this relationship was retained after controlling for differences in intelligence, age, and gender. The obtained results lent support to elemental theories of associative learning suggesting that concurrent stimuli tend to be perceived as separate units.

Keywords: Field dependence/independence; Individual differences in associative learning; Perceptual style

1. Introduction

The ability to associate two or more events that systematically occur together has a unique adaptive value as it facilitates adjustment to imminent biologically and/or socially significant events. Detailed knowledge of the principles regulating the formation of basic associations has shed light on more complex forms of behaviour and cognition, ranging from substance abuse (Siegel, 1989) to development of communication in infancy (Silvén, 2002).

* Tel.: +44 20 7378 3221; fax: +44 20 7378 3222.
E-mail address: e.tsakanikos@iop.kcl.ac.uk

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Although the theoretical basis of elementary associative phenomena remains largely equivocal (Reed & Tsakanikos, 2002) a rich body of evidence on the empirical laws of associative learning has been accumulated (Wasserman & Miller, 1997). The experimental parameters that modulate the formation of associations have been extensively investigated, however the role of individual differences in associative learning remains largely under-researched, mainly limited to the contribution of cognitive abilities (Kyllonen & Woltz, 1989; Rogers, Fisk, & Hertzog, 1994), retrieval strategies (Ackerman & Woltz, 1994) and age-related memory differences (Kausler, 1994). It remains unclear, for example, whether associating learning is influenced by perceptual differences, such as the systematic tendency to perceive events either analytically (e.g. two associated stimuli ⇒ two separate units) or as a whole (e.g. two associated stimuli ⇒ one single unit). Such a line of enquiry has been neglected in the research of associative learning despite the current interest in procedures such as latent inhibition (e.g., Braunstein-Bercovitz, 2003; Carson, Peterson, & Higgins, 2003; Tsakanikos, 2004).

Insight into perceptual differences can be gained by testing the ability to identify simple shapes hidden in complex configurations (Witkin, 1964). Field independent (FI) individuals are characterised by an analytical perceptual style as they tend to separate visual events from the surrounding context, and, therefore, they can easily locate a hidden shape in a complex configuration. As a result, FI individuals are inclined to perceive concurrent visual stimuli as separate entities, rather than as a whole. On the contrary, field dependent (FD) individuals tend to perceive concurrent visual stimuli as a whole, rather than as separate entities. Being prone to a holistic/global perceptual processing, FD individuals find it difficult to isolate a single event from its context.

The bipolar construct of field-dependence/independence (FD/FI), which is though to be only part of a general cognitive style (Riding, 1997; Witkin, 1964), is *value differentiated* rather than *value directional* as each pole has adaptive properties emerging under differences circumstances (Witkin & Goodenough, 1981). FD participants seem to outperform FI participants in tasks where a holistic/global processing strategy is advantageous, while FI participants tend to outperform FD participants in tasks that require a more analytic strategy (e.g., Johnson, Prior, & Artuso, 2000; O'Donnell, Dansereau, & Rocklin, 1991; Rickards, Fajen, Sullivan, & Gillespie, 1997).

What are the perceptual prerequisites for the successful formation of elementary associations? Are two or more co-occurring events experienced analytically, as separate units, or holistically, as a single unit? Relevant to this question is whether associations are *elemental* or *configural*. Elemental theories (Mackintosh, 1975; Wagner & Rescorla, 1972) share the core assumption that when two (or more) stimuli are presented at the same time, they tend to be represented as separate units. In contrast, configural theories (Friedman & Gelfand, 1964; Pearce, 1994) share the assumption that simultaneous presentation of two (or more) stimuli results in a representation of these stimuli as a compound (i.e. a single unit). Attempts to test experimentally these opposing theories have failed to produce consistent evidence: some studies have lent support to configural theories (Aydin & Pearce, 1997; Nakajima & Urushihara, 1999), whereas other studies have lent support to elemental theories (Rescorla, 1997, 1999).[1]

[1] The controversy surrounding the nature of the learned associations (i.e. elemental versus configural) is not purely theoretical. A similar debate appears to underlie different instructional strategies on skill acquisition, such as learning to write, given that opposing methods (phonic/syllabic or analytic versus global) may co-exist within the same educational system (Boscolo & Cisotto, 1999).

The aim of the present study was to test two opposing predictions, as derived from different theoretical accounts of associative learning. In an experimental paradigm of associative learning, the participants were tested on their ability to form associations between concurrent events across successive blocks of trials. They were also assessed on their perceptual style, as indexed by their ability to identify simple shapes hidden in complex configurations.

If two associated events tended to be represented as a single unit, i.e. holistically (configural theories), then participants with an analytic perceptual style (FI) would be in a disadvantageous position during associative learning. As a result, performance for FI participants would be less likely to improve across trials, although it would be still expected to improve for FD participants (FI < FD). On the contrary, if simultaneously presented events were represented as separate units, i.e. analytically (elemental theories), the opposite pattern would be expected (FI > FD).

2. Method

2.1. Participants

Ninety first-year psychology students (16 males and 74 females) took part in this study as a part of a course requirement. Their age ranged from 18 to 38 years (mean = 19.2, SD = 2.7).

2.2. Associative learning

The employed paradigm was a variant of a visual associative learning task (Tsakanikos & Reed, 2004; Tsakanikos, 2004). Each participant received 32 trials as continuous, short animated sequences. The trials were presented in a fixed random order. Each trial depicted a display of four three-dimensional rings, each one located in each quadrant of a computer screen. The screen background was black. The rings were coloured, identical in size to one another, and appeared to move simultaneously towards the observer. In each moving ring, there was either a non-word or a real word. Yellow rings (target colour) always contained a real word; rings of any other colour (non-targets) always contained non-words. Baby blue, light orange, light green, dark blue, and magenta were used as non-target colours. Each trial contained one target and three non-targets colours (i.e. one word ring and three non-words rings).

The animations produced an impression of motion, such as the four-ring configuration appeared to loom from distance towards the observer, while increasing in size. Each animation was composed of 74 frames, and was presented at a rate of nine frames per second. Based on pilot studies, the speed of the moving frames made word identification possible only at one or two rings per trial, providing a substantial level of difficulty. The word stimuli were five-letter concrete nouns: 'BRAIN', 'BREAD', 'BRICK', 'DRAIN', 'ELBOW', 'GLOVE', 'GRAIN', 'HONEY', 'LABEL', 'MOVIE', 'PILOT', 'PLATE', 'SHIRT', 'SKIRT', 'THIGH', and 'TOOTH'. The non-word stimuli were meaningless strings of letters: 'ASDFG', 'FJHGK', 'GHZXF', 'HGSKC', 'JTWDL', 'KVBMR', 'LFSDX', 'MNQCP', 'NCVTP', 'RDNBG', 'RTPSD', 'QWBNF', 'VMNXC', 'WXFZT', 'YWRQS', and 'ZCPLQ'. The participants were instructed to ignore the non-words and focus on the real words. They were also asked to write down any real word they could see at the end of each trial before the next trial commenced. The number of correctly identified words was the dependent variable.

The participants were not aware about the fact that only one particular colour (yellow) would be associated with real words. It was expected that those participants who would form an association between the target (CS) and the presence of a real word (US) would produce an increased number of correct responses across successive trials, as compared to participants who would fail to form such a CS–US association.

2.3. Cognitive tasks

Hidden Figures Test. The Hidden Figures Test (Ekstrom, French, Harman, & Dermen, 1976) is an often-employed measure of field-dependence/independence (e.g. Noppe, 1985; Schmidt & Stephans, 1991; Tsakanikos & Reed, 2003). In this test, each participant is presented with five simple figures, which are available throughout the task, and thirty-two complex figures. The participants have to identify which one of the five simple figures is hidden in a given complex figure. The test is divided in two sections, each of which consists of sixteen problems, the difficulty level of which remains the same within and across the sections. The time available to complete the task was 20 min.

Raven's Progressive Matrices. The Raven's Standard Progressive Matrices (Raven, Court, & Raven, 1977) is a non-verbal, culturally free measure of the general ability to solve novel problems and adapt to new situations (fluid intelligence). This test has been shown to have acceptable validity and reliability (Carroll, 1993). The test consists of sixty items, grouped into five sets of twelve (A–E) with the level of difficulty gradually increasing across sets. The time available to complete the task was 45 min.

3. Results

Three participants were eliminated from the analysis, as they produced zero correct responses on the associative learning task. The rest of the participants were assigned either to the field-dependent (FD) or to the field-independent (FI) group on the basis of their scores on the Hidden Figures Test (mean = 11.3, median = 10, SD = 3.5). Participants with scores lower or equal to the median were classified as FD (mean = 5.9, median = 6, SD = 2.1), while participants with scores higher than the median were assigned as FI (mean = 16.6, median = 16, SD = 3.7).

Fig. 1 presents performance on the associative learning task as a function of perceptual style (FI versus FD) and block of successive trials (four-trial blocks). Inspection of the data suggests that performance for the FI participants was improved across trials. In addition, performance for FI participants was elevated across trials as compared to their FD counterparts, and this difference appeared more pronounced in the last block of trials.

To examine the above observations, the data were analysed by a mixed analysis of variance (ANOVA) with Perceptual Style (FD versus FI group) as a between-subject factor, and Block of trials (1–4) as a within-subject factor. The analysis revealed that the effect of Perceptual style did not reach statistically significance, $F_{(1,85)} = 3.02$, $p = .09$. However, there was a statistically significant effect of Block, $F_{(3,225)} = 8.17$, $p < .001$, and a statistically significant Perceptual

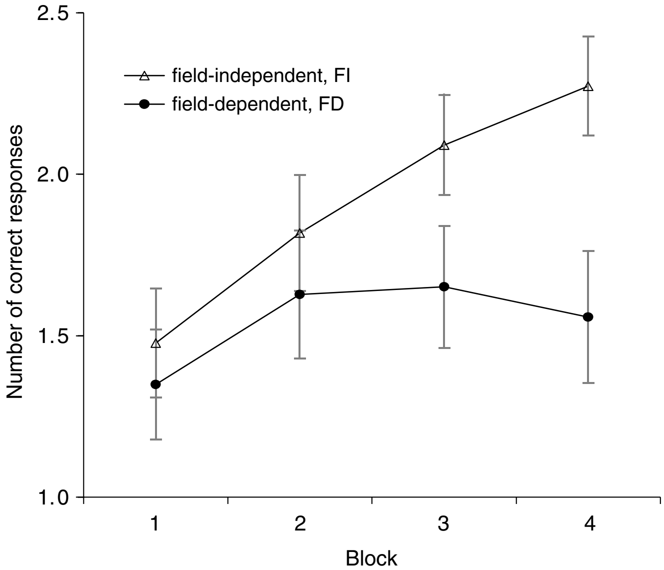

Fig. 1. Performance on the associative learning task as a function of perceptual style (FI vs FD) and block of trials.

style × Block interaction, $F_{(3,225)} = 2.81$, $p < .05$. To examine this interaction further, repeated-measures ANOVAs with Block as a factor were performed separately for FD and FI participants. These analyses revealed that the effect of Block was statistically significant for the FI group, $F_{(3,129)} = 9.27$, $p < .001$, but not for the FD group, $F < 1$.

The above analyses suggested that performance was improved across successive blocks of trials for FI but not for FD students, although the overall effect of perceptual style on performance was statistically not significant. Consequently, the obtained data supported the hypothesis that associative learning, as indexed by gradually improving performance across successive blocks of trials, is facilitated by a tendency to perceive events in an analytical way (FI).

Nevertheless, a conclusion that perceptual style modulates associative learning would not be warranted without assessing statistically the possible contribution of other relevant variables. For example, the relationship between perceptual style and associative learning could be mediated by differences in terms of general ability (McKenna, 1984) or other variables, such as age (Kausler, 1994) and gender (Chipman & Kimura, 1998). Pearson's correlation coefficients were used to evaluate associations between gender, age, perceptual style, as assessed by the Hidden Figures Test, general ability, as assessed by the Raven Progressive Matrices, and performance on the associative learning task. Table 1 presents the inter-correlations between the above variables.

Inspection of Table 1 shows that performance on associative learning correlated positively with perceptual style, general ability, and gender (males outperformed females). In addition, perceptual style was positively correlated with general ability. In order to assess the individual contribution of the above variables to associative learning performance, while controlling for the existing inter-correlations, a hierarchical multiple regression analysis (method: enter; SPSS 11.1) was performed at three successive steps.

Table 1
Inter-correlation matrix

Variables	1	2	3	4	5
1. Associative learning	–				
2. Hidden figures test	.30**	–			
3. Raven progressive matrices	.31**	.25*	–		
4. Gender	.34**	.06	.16	–	
5. Age	−.16	.11	.13	−.09	–

* $p < 0.05$.
** $p < 0.01$ (two-tailed).

Table 2
Predictor variables for the number of correct responses on the associative learning task

Predictor variable	*B*	SEB	Beta	*t*
Hidden figures test	.05	.02	.26	2.73**
Raven progressive matrices	.05	.02	.22	2.27*
Gender	−.98	.30	−.31	−3.26**
Age	−.06	.02	−.24	−2.61*
(Constant)	2.11	1.31		

* $p < 0.05$.
** $p < 0.01$ (two-tailed).

At a first step, the scores on Hidden Figures Test were entered as a first predictor variable. The total number of correct responses on the associative learning task was the dependent variable. The regression equation was statistically significant, $F_{(1,85)} = 8.68$, $p < .01$, accounting for 8.2% of the variance (adjusted R^2). At a second step, the scores on the Raven Progressive Matrices were entered as a second predictor variable. The equation remained statistically significant, $F_{(2,84)} = 7.42$, $p = .001$, and accounted for 13% of the variance (adjusted R^2). At a final step, 'gender' and 'age' were entered as third and forth predictor variables respectively. The overall equation was statistically significant, $F_{(4,79)} = 8.48$, $p < .001$, accounting for 26.5% of the variance (adjusted R^2). The regression coefficients of the final model are presented in Table 2.

The above analyses suggest that participant variables (age, gender, IQ) were independently associated with performance on the associative learning task, replicating previous findings (Chipman & Kimura, 1998; Kausler, 1994; McKenna, 1984). In addition, perceptual style was a significant independent predictor of performance on the associative task, suggesting that FI participants were more likely to form CS–US associations. This latter result is a novel finding of particular theoretical interest in terms of the perceptual requirements of associative learning.

4. Discussion

The reported study investigated the role of perceptual style in associative learning in order to test opposing theoretical views on the nature of perceived associations. The obtained results suggested that participants with an analytical (field independent) perceptual style were more likely to associate a target-colour (CS) with the presence of an anticipated event/word (US) than participants with a more holistic (field dependent) perceptual style. The previously reported gender, age and cognitive ability differences (Chipman & Kimura, 1998; Kausler, 1994; McKenna, 1984) were also replicated in the present study. However, the analysis revealed that the relationship between field-dependence/independence and associative learning was above and beyond the contribution of such differences.

The finding that the tendency to perceive events in an analytical way was beneficial to the formation of associations cannot be accommodated by *configural theories* of associative learning (Friedman & Gelfand, 1964; Pearce, 1994): if two associated events were perceived as a single compound (i.e. as a whole), then participants who tend to perceive events holistically (field dependent) would be better at the forming associations between two paired stimuli than participants who tend to perceive events analytically (field independence). However, the obtained results are better explained in terms of *elemental theories* (Mackintosh, 1975; Wagner & Rescorla, 1972) that co-occurring events are represented as separate units (see also Introduction).

In conclusion, the obtained evidence suggests that learning of concurrent events is enhanced by a tendency to perceive events as single units (analytically) rather than in a holistic way. Further understanding of the perceptual prerequisites for the formation of elementary associations is important, as analytical instructional approaches, when the to-be-learned units are presented as separate entities (e.g. learning to write in a syllabic way), might provide the optimum conditions for the acquisition of complex skills such as reading and writing.

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