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The Effect of Cognitive Ability on Training and Transfer Performance
인지 능력이 훈련 및 전이 수행에 미치는 효과

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Abstract This study examined the effect of cognitive ability levels on skill acquisition and transfer as a function of training difficulty. Participants were classified into three groups based on the result of cognitive ability tests. They were trained with difficult or easy tasks and then transferred to novel difficult tasks. Results suggest that cognitive ability levels influenced training performance, though the effect of training difficulty on transfer performance varied with cognitive ability. The training difficulty was most effective for those who have the medium level of cognitive ability. These results were discussed with respect to individual differences and skill transfer performance

Keywords Cognitive ability, Individual differences, Training, Transfer

요 약 이 논문은 훈련의 난이도가 인지 기술의 습득과 전이에 미치는 효과가 인지 능력 수준의 개인차에 따라 어떻게 다른지를 실험을 통해 분석하였다. 인지 능력 측정 도구를 사용하여 실험 참가자들을 각기 다른 수준의 인지 능력을 갖는 세 집단으로 분류하였다. 각 집단의 실험 참가자들 중 반은 난이도가 높은 과제를, 나머지 반은 난이도가 낮은 과제를 수행하는 훈련을 받은 후, 모든 실험 참가자들이 훈련 과정에서 경험하지 않은 새로운 전이 과제를 수행하였다. 실험 결과를 볼 때, 인지 능력 수준이 훈련 수행에 영향을 주었으며, 또한 훈련의 난이도가 전이 수행에 미치는 효과도 인지 능력 수준에 따라 차이가 났다. 세 수준의 인지 능력 집단들 중 중간 수준의 집단이 훈련의 난이도에 따라 훈련 및 전이 수행에 가장 큰 영향을 받는 것으로 나타났다. 이 실험 결과들이 개인차와 기술 전이 수행의 관점에서 논의되었다.

주제어 인지능력, 개인차, 훈련, 전이

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Training theorists (e.g., Brown & Carr, 1993; Logan, 1988; Meyers & Fisk, 1987; Schneider & Shiffrin, 1977) have postulated that learning takes place through repeated exposure to specific stimuli and that what is learned is stimulus-specific skill. However, they also postulate that an additional form of skill is acquired that is not tied to the specific stimuli experienced (e.g., Anderson, 1982; Brown & Kane, 1988; Doane, Alderton, Sohn, & Pellegrino, 1996; Doane, Sohn, & Schreiber, 1999; Haider & Frensch, 1996, 1999a, 1999b; Pellegrino, Doane, Fischer, & Alderton, 1991; Strayer & Kramer, 1994). These theorists suggest that processing particular stimuli leads to the acquisition of strategic skills that can be transferred to novel stimuli.

The concept of strategic aspects of skill has a long history in the learning literature (e.g., Battig, 1979). In addition, there is a renewed interest in incorporating strategic skills into theories of skill acquisition and transfer (e.g., Anderson, Fincham, & Douglass, 1997; Carlson & Yaure, 1990; Clawson, Healy, Ericsson, & Bourne, 2001; Cross, Doane, Sohn, Alderton, & Pringle, 2004; Czerwinski, Lightfoot, & Shiffrin, 1992; Doane et al., 1996, 1999; Pellegrino et al., 1991; Schmidt & Bjork, 1992; Speelman & Kirsner, 1997). Research in this area emphasizes both stimulus-specific and strategic aspects of skill acquisition, with a particular emphasis on the impact learning context has on the nature of strategic skills acquired during training and their transfer. In general, there is agreement both that strategic skills serve to minimize redundant information processing and that they are largely stimulus independent (e.g., Brown & Kane, 1988; Judd, 1908).

Evidence for strategic skills has come from studies of performance on visual comparison tasks (Cross et al., 2004; Doane et al., 1996, 1999; Pellegrino et al., 1991). In studies conducted by Doane and her colleagues, participants trained to make visual comparisons of either similar (difficult training) or dissimilar (easy training) polygon pairs were then transferred to comparisons of novel similar polygon pairs. Transfer performance was superior for participants exposed to difficult training. Since transfer polygons were novel and identical for both training groups, between-group performance differences are not readily explained by stimulus-specific skills acquired during training trials.

Rather, the performance differences are explained by strategic skills acquired for processing polygons differed with training difficulty (Cross et al., 2004; Doane et al., 1996, 1999; Pellegrino et al., 1991). Specifically, participants trained on similar comparisons acquired strategic skills that were positively transferred to making similar comparisons of completely novel polygons. The acquired strategies are clearly developed from processing specific polygons during training. However, the ability to transfer these processing strategies to novel polygons indicates that they are not stimulus-specific. Taken together, previous research suggests that skill acquisition involves the development of strategic processing skills that may be transferred to novel stimuli and that these skills differ as a function of initial training difficulty.

The previous research on visual comparison (e.g., Cross et al., 2004; Doane et al., 1996, 1999; Pellegrino et al., 1991) has addressed questions about the acquisition and transfer of strategic skills and the nature of strategies that develop with practice. Yet, understanding of individual differences in cognitive or spatial processing abilities might be just as important in most training contexts (e.g., Ackerman, 1987, 1988, 1990, 1992; Bell, Gardner, & Woltz, 1997; Cross & Doane, 2002; Fleishman, 1972; Goska & Ackerman, 1996; Lajoie, 2003; Law, Morrin, & Pellegrino, 1995; Sullivan, 1964; Woltz, Garder, & Gyll, 2000; Woltz & Shute, 1993). The previous researchers concerned with the effect of training context on skill acquisition and transfer have ignored individual differences in abilities to learn, apply, and modify strategic skills. Past studies are limited by the fact that they use normative methods to evaluate differences at the treatment level. Unfortunately, aggregation of individual performances often results in a performance profile not representative of any individual aptitude characteristics (Pellegrino & Kail, 1982).

Understanding individual differences in strategic skill acquisition and transfer would improve our understanding of skill learning mechanisms underlying performance differences as well as yield important information necessary to select individuals for effective training in changing environmental situations. The goal of the present research was to relate individual differences in cognitive ability to training and transfer performance as a function of training difficulty. Of particular interest were the changes in processing associated with cognitive ability and practice and the modifiability of processing skills.

Present Research

For this research, participants were asked to compare polygon pairs that varied in similarity for numerous training trials using a same-different judgment task (cf. Posner & Keele, 1968). On each trial, a polygon was either paired with itself or with one of six distractors that systematically varied in their average rated similarity to the target. Training difficulty was manipulated by asking half the participants to compare very similar stimulus pairs and the other half to compare very dissimilar pairs. Participants were trained at their respective difficulty levels for numerous trials and then transferred to comparing novel polygon pairs not seen during training. We ruled out the possibility of explanation of differential transfer performance based solely on stimulus-specific skills by transferring participants to a completely novel stimulus set.

Given the importance of strategic skills to training and transfer performance, a process-analytic approach was used to examine differences in observed performance with regard to the strategies used by individuals on spatial processing tasks (e.g., Bethell-Fox, Lohman, & Snow, 1984; Cooper, 1975; Kyllonen, Lohman, & Snow, 1984; Kyllonen, Lohman, & Woltz, 1985; Pellegrino & Kail, 1982; Shepard & Metzler, 1971). Past research has shown that participants develop optimal feature comparison strategies such that with practice, individuals learn a sequence of feature comparisons between stimulus pairs that minimize the average number of requisite comparisons (Cross et al., 2004; Doane et al., 1996, 1999; Fisher & Tanner, 1992; Fisher & Young, 1987). In addition, the nature of optimal strategies varies with the learning difficulty (Cross et al., 2004; Doane et al., 1996, 1999).

For example, the initial search in a same-different judgment task involved comparing features of a polygon pair one by one until a featural mismatch was found (i.e., the polygons are judged as different) or until there were no more features left to compare (i.e., the polygons are judged as same). For those trained on very similar comparisons, many matches would be encountered prior to finding a mismatch because of the many similar features shared by the polygons compared. This would result in a very precise comparison strategy that develops after careful and complete examination of all points in comparison stimuli. In contrast, those trained to compare very dissimilar polygons should encounter a mismatch very early in their search process. This would result in a less precise strategy that does not include comparing all features for stimuli.

An important aspect of this kind of research was to examine differences in observed performance with regard to the strategies at transfer to novel stimuli. The specific sequence of optimal comparison features learned for the training stimuli is not relevant for transfer stimuli. However, the skill of how to process stimuli such that an optimal feature sequence is acquired is applied to novel stimuli. If transfer stimuli require a precise comparison strategy, then an individual who has had practice developing this type of strategy would have superior transfer performance over an individual who has not. A precise strategy can be effectively applied even to stimuli that do not require a precise strategy.

Research Objective

The present research incorporated individual differences in cognitive ability into the strategic skill acquisition and transfer process. To restate, the major question addressed in this research was how individual differences in cognitive ability impact on acquisition and transfer of strategic comparison skills as a function of practice difficulty. Specifically we examined changes in training and transfer performance on a visual comparison task for individuals with high, medium, and low levels of cognitive ability in the context of difficult and easy practice, respectively. Of particular interest were differences in acquisition and transfer of strategic skills among individuals varying with cognitive ability. High and low levels of cognitive ability might facilitate and inhibit strategy development and the effectiveness of acquired strategy might be enhanced and limited by the ability levels, respectively. Conversely, strategy development might not be related to the levels of cognitive ability.

Experimental Design

To accomplish this research objective, the present study consisted of two phases of experiment, the first containing a cognitive ability test battery and the second containing a visual comparison task. The visual comparison task consisted of three sessions of trials varying with difficulty and type of stimulus set (see Table 1). Participants trained with either difficult (i.e., similar) or easy (i.e., dissimilar) comparisons in the first session were transferred to difficult comparisons of novel stimuli in the second session. That is, participants who received difficult comparisons in Session 1 (i.e., 'difficult-first' training group) received the same level of difficult comparisons from a novel stimulus set in Session 2, whereas participants who received easy comparisons in Session 1 (i.e., 'easy-first' training group) were switched to difficult comparisons from a novel stimulus set in Session 2. In the third and final session, participants made the full range of comparisons(i.e., from very similar to very dissimilar) on the stimulus set they viewed at the second session. The only difference between these two groups was whether they initially learned to make difficult or easy comparisons during their first session. From the beginning of Session 2, both groups were matched in terms of the difficulty, order and frequency of the stimuli shown.

Method

Participants

Forty-nine undergraduate students participated in this 5-day experiment. They completed computerized cognitive ability tests in their first 2 days and visual comparison trials during their last 3 days. All participants were given identical cognitive ability tests, but were assigned to one of two comparison training conditions: difficult-first training (25 participants) and easy-first training (24 participants).

Apparatus and Materials

Cognitive ability battery

The test battery included Raven's Standard Progressive Matrices (SPM; Raven, 1938), Revised Minnesota Paper Form Board (MPFB; Likert &

<Table 1> Visual Comparison Experimental Design

	Session 1: Training		Session 2: Training or Transfer		Session 3: Transfer	
Condition	Set	Difficulty	Set	Difficulty	Set	Difficulty
Difficult A/difficult B/all B	A	D1-D3	B	D1-D3	B	D1-D6
Easy A/difficult B/all B	A	D4-D6	B	D1-D3	B	D1-D6

Note. The order of exposure to stimulus sets 1 and 2 was counterbalanced (see Figures 1-2). A and Bin the table can refer to either stimulus set (i.e., set 1 or 2). A change from A to B from Session 1 to 2 indicates a change in stimulus set.

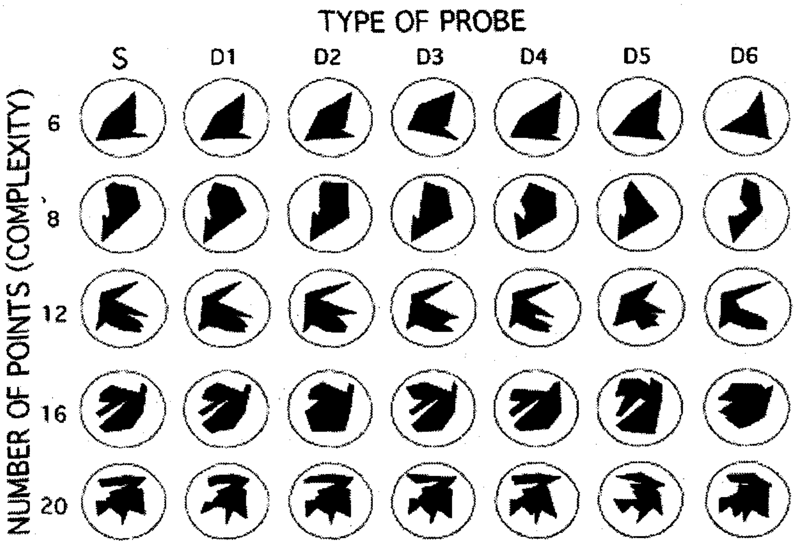


Figure 1. Cooper and Podgorny (1976) polygon figures.

Quasha, 1970), Thurstone's Perceptual Speed (TPS; Thurstone, 1938), Alderton's Integrating Details (AID; Alderton, 1989), and Nelson-Denny Vocabulary (Voc; Brown, Bennett, & Hanna, 1981) to measure a wide range of cognitive abilities such as general reasoning, spatial visualization, perceptual speed,

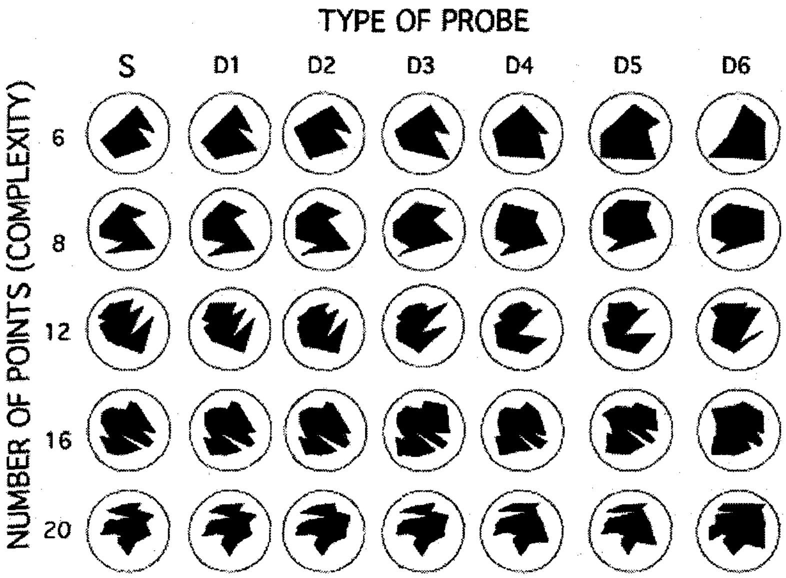


Figure 2. Doane, Alderto, Sohn, and Pellegrino (1996) polygon figures.

spatial problem solving, and verbal comprehension, respectively.

Visual comparison task

Participants made visual comparisons of polygon pairs that varied in similarity. Within each stimulus pair, the polygon on the left was always a standard (S) and the polygon on the right was either the identical standard or one of the D1-D6 polygons for that standard.

Two sets of polygon stimuli were used for this part of this experiment (see Figures 1 and 2). The stimulus sets were made up of five standard or same polygons varying by the number of points (6, 8, 12, 16, or 20) that formed the shape of each polygon, as well as six different (D1-D6) polygons for each standard, for a total of 35 polygons (details are described in Cooper & Podgorny, 1976). The different polygons differed in their average rated similarity to their respective standards, with D1 being most similar and D6 being most dissimilar. In each session, stimuli were arranged into 8 blocks presented in four random orders to which, participants were randomly assigned. Each of 24 blocks of polygon comparisons consisted of 120 trials with 60 same judgments and 60 different judgments, and each session consisted of 960 trails. The 60 same judgments consisted of12 presentations of each standard polygon at each of the five stimulus-complexity levels. The 60 different judgments consisted of four presentations of each different polygon (of D1-D3 for difficult comparisons and of D4-D6 for easy comparisons) in Sessions 1 and 2, and two presentations of each different polygon (of D1-D6) in Session 3 at each of the five stimulus-complexity levels.

Procedure

Participants completed two sessions of cognitive ability test battery and three sessions of visual comparison task over a five-day period. Sessions were scheduled such that approximately 24-48 hours were intervened between sessions, each session taking place in about 1-hour period. Participants were administered the five tests of the battery for the first two-day period. They completed SPM (Raven, 1938), MPFB (Likert & Quasha, 1970) and TPS (Thurstone, 1938) on Day 1, and AID (Alderton, 1989) and Voc (Brown, Bennett, & Hanna, 1981) on Day 2.

For the remaining three days, participants completed visual comparison trials. They read instructions that indicated both speed and accuracy were important, before they completed a set of practice trials and commenced the experimental trials. During each trial, participants viewed a pair of horizontally aligned polygons on a computer screen and determined whether the two polygons were the same ("S" key) or different ("L" key). Each same-different judgment was self-paced such that pressing either key ended the current trial, and the next trial began.

In Session 1 of visual comparisons (Day 3), participants were randomly assigned to one of two training groups: difficult-first training (the standard polygon compared with itself for a "same" judgment or one of the D1-D3 polygons for a "different" judgment) or easy-first training (the standard polygon compared with itself for a "same" judgment or one of the D4-D6 polygons for a "different" judgment). In Session2 (Day 4), both groups were transferred to difficult comparisons of polygons from a novel stimulus set (see Table 1 and Figures 1-2). In Session 3 (Day 5), participants were presented with polygons from each level of difficulty (the standard compared with itself or D1-D6) from the stimulus set viewed in Session 2. Response time and accuracy were recorded for each participant.

Results and Discussion

Of interest was the effect of cognitive ability levels on training and transfer performance as a function of initial training difficulty. We examined response latency and accuracy as indices of visual comparison performance. For the purpose of analysis, participants were divided into one of three levels of cognitive ability. The results of participant grouping based on the cognitive test battery are first presented, followed by the visual comparison latency and accuracy results for the three groups varying with cognitive ability.

Cognitive Ability

Data from the five cognitive ability tests were submitted to a factor analysis (varimax rotation) to classify participants into three ability groups based on resulting factors. The analysis produced one factor with an eigen value greater than 1 accounting for 52% of the variance in the data. Then, we conducted a cluster analysis on the basis of the factor to classify participants into three groups. As a result of the analysis, participants were classified into 12 high-ability (6 difficult-training and 6 easy-training), 23 medium-ability (11 difficult-training and 12 easy-training), and 14 low-ability(8 difficult-training and 6 easy-training) participants. Two-tailed *t* tests resulted in no significant difference between difficult- and

<Table 2> Mean Cognitive Ability Scores in Difficult and Easy Training Conditions for three Abilities levels

	High Ability				Medium Ability				Low Ability			
	Difficult Training		Easy Training		Difficult Training		Easy Training		Difficult Training		Easy Training	
Measure	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
SPM	52.7	2.0	52.7	2.7	47.7	3.6	48.0	3.7	38.6	8.5	39.0	5.1
MPFB	51.1	4.2	49.2	4.8	38.1	7.2	40.8	8.9	31.3	10.2	28.2	9.4
TPS	85.4	11.1	88.6	19.3	75.0	16.4	73.3	17.5	55.3	21.4	61.9	10.8
AID	46.8	4.2	47.2	4.3	40.4	4.1	41.9	6.1	33.5	4.5	36.0	4.9
Voc	69.4	6.4	67.1	12.1	57.1	8.6	52.7	12.3	50.0	15.0	44.2	7.0

easy-training conditions for each cognitive ability group (*p*s $>$ .3), which suggests that participants in both training conditions were comparable in cognitive ability. Cognitive ability profiles are presented in Table 2.

Visual Comparison

The focus of our analyses was on the differences in performance on training and transfer accounted for by cognitive ability and initial training difficulty.

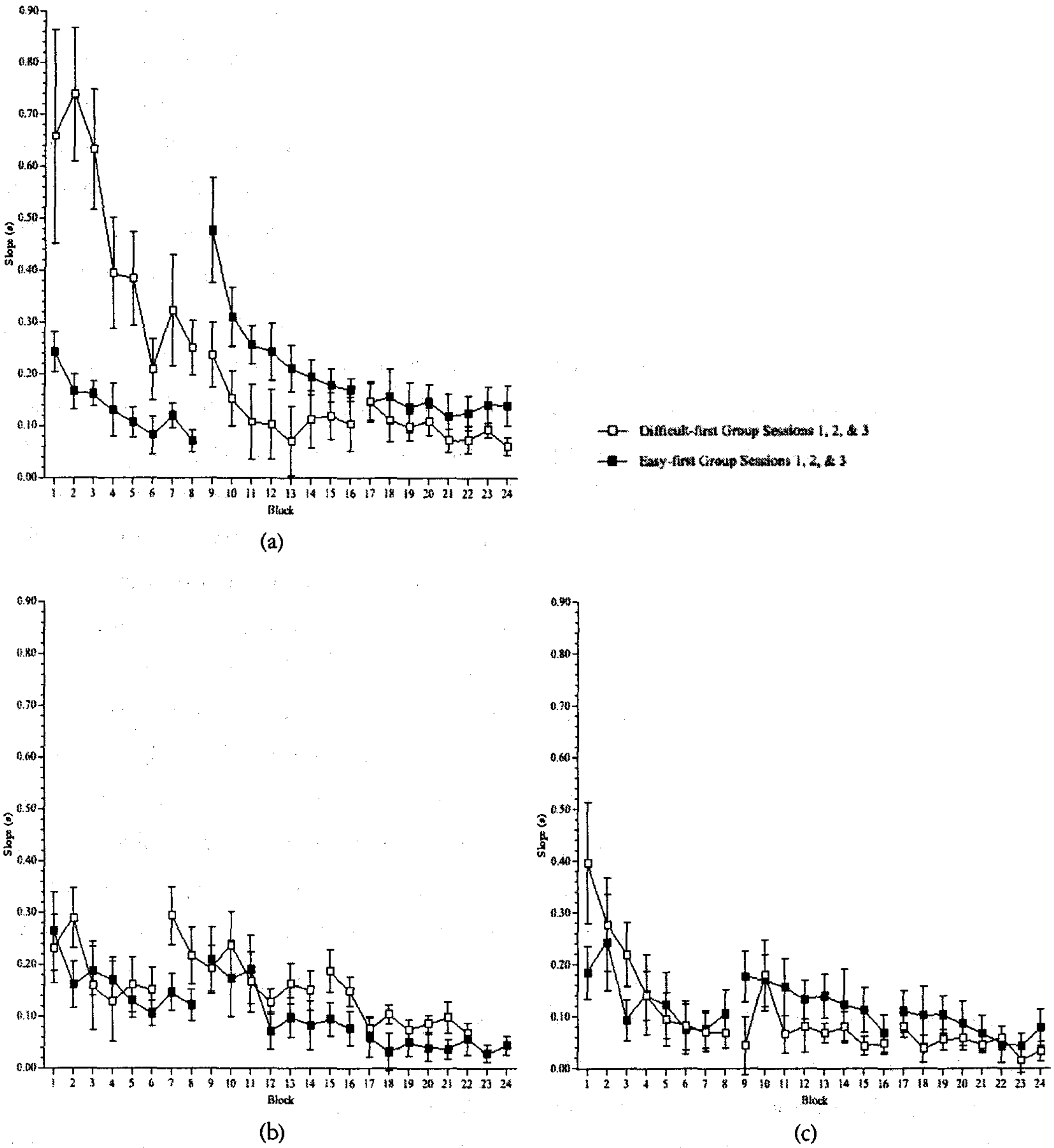
Latency Complexity Slope

Figures 3a-3c show an analysis of the differential latency patterns exhibited by difficult- and easy-first training conditions over same judgments for each level of cognitive ability. Slopes of the linear function relating latency to stimulus complexity were derived for each training condition at each block of practice. Of most interest were the changes in complexity effects for the high cognitive ability group, shown in Figure 3a. Their complexity effects were initially very high and then attenuated with practice for the difficult-first condition and the complexity effects increased abruptly at the beginning of Session 2 for the easy-first condition. These results suggest that the high cognitive ability group in the difficult training condition developed an exhaustive featural comparison strategy that evolved with practice into a constrained comparison of features that are diagnostic for comparisons. In contrast, the high cognitive ability group in the easy training condition developed an initial strategy requiring minimal processing, but they realized that their initially acquired strategy was not effective to process difficult stimuli on transferring to novel stimuli in Session 2 and they developed an exhaustive featural comparison strategy. This pattern of results was not prominent for the other lower cognitive ability groups.

Also, of interest was the complex effect in the difficult-first training condition for the medium cognitive ability group as compared with that for the low cognitive ability group. As shown in Figures 3b and 3c, the medium cognitive ability group showed an increased and high complexity effect at the beginning of Session 2 when transferred to novel stimuli, while the low cognitive ability group did not, although both groups showed similar complexity effects in Session 1. These results suggest that the medium cognitive ability group was able to develop effective strategic processing skills through their initial difficult training and successfully apply them to novel stimuli, but the low cognitive ability group was not.

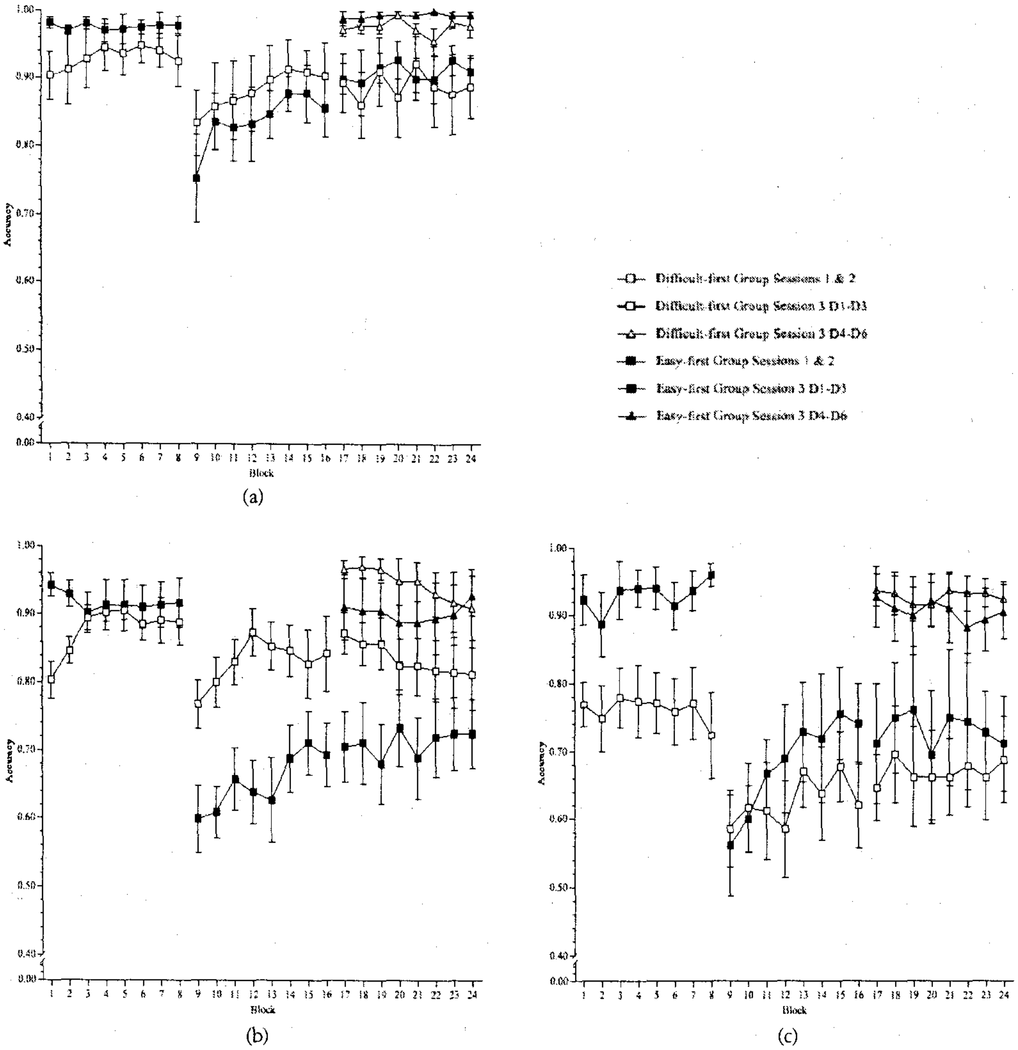
Accuracy

We examined same- and different-judgment accuracies. However, no significant effects of cognitive ability, training difficulty, or practice, or their interactions existed, all *F*s $<$ 2, for same-judgment accuracies. Thus, same-judgment accuracies will not be discussed further, and the focus of our discussion will be on different-judgment accuracies.



(Figures 3) Mean latency complexity slopes for same comparison judgments as a function of block for (a) high, (b) medium, and (c) low cognitive ability groups.

Figures 4a-4c show the mean correct different-judgment accuracies for difficult-first and easy-first comparison conditions as a function of block. An ANOVA was performed on the different-judgment accuracies for Sessions 1 and 2 with cognitive ability (high, medium, low), *training difficulty* (difficult- vs. easy-first), session (1-2), and block (1-8) as variables. Overall, as the cognitive ability



(Figures 4) Mean accuracy for different comparison judgments as a function of block for (a) high, (b) medium, and (c) low cognitive ability groups

increased, the accuracy increased, F (2, 43) = 7.86, MSE = 0.16, p < .01, and the accuracy differences between the difficult- and easy-first training conditions decreased, F (2, 43) = 3.49, MSE = 0.16, p < .04. The accuracy decreased when participants were exposed to novel difficult stimuli in Session 2, F (1, 43) = 77.90, MSE = 0.05, p< .01, though the decrease was greater for those in the easy-first training condition, F (1, 43) = 17.74, MSE = 0.05, p < .01.

To specifically examine if there were significant accuracy differences between the two initial training conditions for each level of cognitive ability in Sessions 1 and 2, separate ANOVAs were performed on the different-judgment accuracies for Sessions 1 and 2 for high, medium, and low cognitive-ability groups respectively, with training difficulty (difficult- vs. easy-first), session (1-2), and block (1-8) as variables. The analyses resulted in no significant training difficulty effect, or training difficulty session or block interactions, all $ps > .05$, for low and high cognitive ability groups. However, the medium cognitive ability group in the difficult-first training condition started with less accurate performance than those in the easy-first training condition in Session 1, but this result was reversed in Session 2, when those in the difficult-first training condition was much more accurate, $F(1, 21) = 24.65$, $MSE = 0.04$, $p < .01$. The practice effects were different between the two training conditions in Session 1 but not in Session 2, $F(7, 147) = 3.98$, $MSE = 0.002$, $p < .01$. These results indicate that initial difficult training was effective and positively transferred to novel difficult stimuli only for the medium cognitive ability group.

An additional ANOVA was performed on the mean accuracies for Session 3, with training difficulty (difficult- vs. easy-first), comparison difficulty (D1-D3 vs. D4-D6), and block (17-24) as variables. Overall, the higher the cognitive ability, the higher the accuracy, $F(2, 43) = 4.50$, $MSE = 0.21$, $p < .02$. However, this cognitive ability effect was more prominent for D1-D3 judgments than for D4-D6 judgments, $F(2, 43) = 4.17$, $MSE = 0.05$, $p < .02$.

To specifically examine if there were significant accuracy differences between the two initial training conditions for each level of cognitive ability in Session 3, separate ANOVAs were performed on the different-judgment accuracies for Session 3 for high, medium, and low cognitive-ability groups respectively, with training difficulty (difficult- vs. easy-first), comparison difficulty (D1-D3 vs. D4-D6), and block (17-24) as variables. The analyses resulted in no significant training condition effect, or training difficulty comparison difficulty or block interactions, all $Fs < 1$, for high and low cognitive ability groups. However, the medium cognitive ability groups showed the greater accuracy differences between the difficult- and easy-first training conditions for D1-D3 judgments than for D4-D6, $F(1, 21) = 4.48$, $MSE = 0.03$, $p < .05$. Since those in the two training conditions had identical stimulus-specific exposure to these D1-D3 stimuli, this result is not due to differential experience with the stimuli. The results suggest that initial difficult training was the most effective for the medium cognitive ability participants and the strategic skills gained in that training context had persistent effects on the difficult comparison performance in Session 3.

General Discussion

Overall, the present results suggest that the strength of the impact of initial training difficulty on transfer visual discrimination performance varies with the level of cognitive ability. The impact of initial training difficulty was minimal for individuals with high and low cognitive ability, whereas this impact was prominent for individuals with medium cognitive ability. Individuals with high cognitive ability are able to acquire and apply an exhaustive and precise strategy for comparing very similar stimuli that evolved with practice into a constrained comparison of features that were most relevant for comparisons. Even when they were initially trained in the easy context and transferred to the difficult context, they quickly adapted to changes in task difficulty and were able to acquire exhaustive and precise strategy and constrain their comparisons on the critical features. Flexibility of strategy use, or strategy shifting, reflected their ability to adapt to changes in task difficulty.

The impact of initial training context was also minimal for individuals with low cognitive ability, yet in a different way from those with high cognitive ability. Unlike high ability individuals, low ability individuals were not able to optimize strategic skills developed across training and transfer. Low ability individuals were unable to acquire and apply exhaustive and precise strategic skills even when they were initially trained in the difficult context, where their different-comparison accuracy never reached 80%.

In contrast to individuals with high and low cognitive ability, those with medium cognitive ability showed strong evidence in support of the initial training effect on transfer performance. Initial training difficulty on one session alone produced differential performance when the amount of stimulus-specific exposure to novel transfer stimuli was equated. The difficult-first group exhibited superior transfer to the novel stimuli, and the enhanced processing strategy and performance level persisted through extended transfer trials even in Session 3. Although the easy-first group showed improvement during transfer trials in Session 2, they never matched the accuracy of the difficult-first group. These results suggest that the strategic skills initially acquired through processing dissimilar stimuli negatively impacted transfer performance even when easy and difficult groups were matched on the number of transfer stimuli processed.

What this study further suggests is that visual comparison ability can be characterized as the ability to learn processing strategies that are sufficiently detailed to accommodate the most difficult comparisons and differentiate between relevant and irrelevant information. In general, good performers are able to detect deviations that poor performers are not able to detect (e.g., Bell, Gardner, & Woltz, 1997). Also, good performers are able to know which task information is relevant and which is irrelevant and are therefore able to focus their processing on task-relevant information, but poor performers do not have the ability (e.g., Haider & Frensch, 1996). One aspect of acquiring a visual comparison skill, then, should be the ability to constrain task processing on task-relevant information, an ability referred to as information reduction.

The phenomenon has been discussed theoretically for the domains of visual perception (e.g., Gibson, 1963), sports and perceptual motor skills (e.g., Abernathy, 1993), problem solving (e.g., Bransford, Sherwood, Vye, & Rieser, 1986), and expertise (e.g., Ericsson & Lehmann, 1996). The information reduction view suggests that the strategies acquired during training should differ as a function of task difficulty, but it does not make predictions about the transfer of strategies to novel stimuli and their malleability. This is important to explore. For example, if strategies were not malleable, then human information processing would be optimal for only those stimuli viewed during initial training. If they are malleable, then it is important to determine the circumstances that encourage the speedy modification of strategic comparisons at transfer to enable optimal processing of novel stimuli. The past studies suggest that initial training difficulty impacts learning and transfer of strategic comparison skills that selectively use relevant information (Cross et al., 2004; Doane et al., 1996, 1999).

However, the present study provides insight into expansion on the previous findings. The present finding suggests that it is the individuals with a midrange of cognitive ability that are sensitive to initial training context. Initial training for individuals at both high and low extremes is not as effective as for those in the midrange. This finding has a practical implication for visual skill training. To enhance training effectiveness for visual discrimination tasks, it is important to assess individual differences in cognitive ability prior to assigning individuals to a training context. This will provide important information necessary to identify individuals for effective training and transfer in changing environmental situations.

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