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The flexibility of the intermediate vs. wholistic/analytic styles – an eye tracking study

Ortal Nitzan-Tamar [a], Bracha Kramarski[a] and Eli Vakil[b]

[a]School of Education, Bar-Ilan University, Ramat-Gan, Israel; [b]Department of Psychology and Leslie and Susan Gonda (Goldschmied) Multidisciplinary Brain Research Center, Bar-Ilan University, Ramat-Gan, Israel

ABSTRACT
In the aftermath of the COVID-19 pandemic, the educational system is increasingly incorporating twenty-first-century skills, such as online learning, that require learners to demonstrate cognitive flexibility. Cognitive flexibility is the ability to quickly reconfigure our minds to meet the task demands. This study investigates the degree of cognitive flexibility of the wholistic-intermediate-analytic dimensions, by classifying patterns of Eye Movements (EM) and behavioural data. Using the E-CSA-W/A test, 113 participants were classified based on their tendency towards a particular style (wholistic/intermediate/analytic). Results indicate that wholistics and intermediates demonstrated greater cognitive flexibility in adapting to the task requirements than the analytics. Analytics were slower at completing the test and made more transitions between Areas of Interest than the other groups. Finally, while the behavioural data demonstrate quantitative differences between the groups, EM provides qualitative information regarding the cognitive process that leads to the response. Theoretical, methodological, and practical contributions are discussed.

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Cognitive flexibility; intermediate vs. Wholistic/analytic cognitive style; eye movements; E-CSA-WA

1. Introduction

To a certain degree, the online learning that was forced upon the educational system worldwide by the COVID-19 pandemic is here to stay (Hu & Spiro, 2021). Online learning, in some cases, involves dealing with multiple nonlinear problem-solving and acquiring flexibility in the knowledge acquisition approach. Therefore, cognitive flexibility might play a critical role in assessing and adapting to an online learning environment. Cognitive flexibility refers to the ability to reconfigure our minds in order to adjust to different tasks and shift appropriately between strategies according to the task demands (Braem & Egner, 2018; Dennis & Vander Wal, 2010). Cognitive flexibility is also the ability to organise previous knowledge and experience into a "scheme," a mental structure that includes a set of knowledge and attitudes of the individual towards a particular subject, that will meet the demands of a novel and complex situation (Spiro et al., 2019). The cognitive style domain is one of the characteristics of individual differences that can account for the level of cognitive flexibility (Kozhevnikov, 2007).

Cognitive styles can be conceived as differences in information processing methods and the use of different learning strategies (Riding & Rayner, 1998). Information processing is reflected by allocating and regulating cognitive resources (Kozhevnikov, 2007) which refers to how individuals divide their limited resources (such as time and visual attention) during a task that might affect their performance (Brown et al., 2019). Different cognitive styles can have a significant impact on how individuals process information as they indicate a tendency to act in a particular manner (e.g. Brown et al., 2019). Some studies have revealed that cognitive style influences users' search behaviour. For example, Bendall et al. (2019) using eye tracking research on a comparative visual search task suited for investigating cognitive style strategies, in which participants are required to identify differences between a pair of images, revealed that analytics performed fewer saccadic eye movements (EM), had a shorter response time, and had similar accuracy scores in relating to wholistic (intuitive) learners. Therefore, Bendall et al. (2019) concluded that analytics

CONTACT Ortal Nitzan-Tamar ortalt83@gmail.com School of Education, Bar-Ilan University, Ramat-Gan 52900, Israel

provided a more effective method for visual search strategy and decision-making than the wholistics. Koć-Januchta et a.l (2017), investigated the visualisers and verbalisers styles, revealed that visualisers spent more time on pictures, while verbalisers spent more time on texts. Furthermore, verbalisers typically entered non-informative, irrelevant areas of pictures earlier than visualisers.

An eye-tracking technique can provide unique insights into the way learners regulate cognitive resources and the nature of the strategies they employ (Bendall et al., 2019; Rayner, 1998). Based on the assumption that scanning of the visual field is not coincidental (Miellet et al., 2013), and that information processing is reflected by the fixation area (Schindler & Lilienthal, 2019), it is possible to monitor resource allocation during a task and subsequently evaluate performance. These processes are usually unconscious to the individual, so he cannot report them, but can be identified by observing eye movements.

For example, in a previous study we have found that although participants were divided into two groups (wholistics and analytics) according to how they processed information in the Extended Cognitive Styles Analysis Wholistic/Analytic test (E-CSA-WA) by Peterson et al. (2003), wholistics processed information and adapted strategies to the nature of the task more efficiently than the analytics. That is, the wholistics were faster in their responses, but this did not affect their performance in terms of accuracy compared to the analytics. In addition, the wholistics also made fewer transitions between the different Areas of Interest (AOIs), indicating a more efficient scan of each AOI and less waste of cognitive resources (Nitzan-Tamar et al., 2016). Considering cognitive flexibility, our previous research indicates that wholistics demonstrated greater cognitive flexibility then the analytics, as they had the ability to adjust their strategy to the task demands. The impact of styles on performance and information processing has also been reinforced by neuroimaging studies (e.g. fMRI), which fortify the vitality of this field (Bendall et al., 2019; Izmalkova & Rzheshevskaya, 2021; Kozhevnikov et al., 2014).

The relationship between cognitive style and selective attention underpins the use of eye tracking as a tool for examining the cognitive flexibility of various learners. Selective attention refers to the ability of individuals to select and pay attention to relevant information while processing information and simultaneously suppressing irrelevant information (Stevens & Bavelier, 2012). Hu et al. (2020), used the CSA-WA test to examine how the wholistic-analytic cognitive style modulates selective attention, revealed that a wholistic versus analytical cognitive style influenced object-based attention via perceptual grouping, that is, wholistics tends to group objects into one larger gestalt.

Research on cognitive style often focuses on the extreme ends of the spectrum (i.e. wholistics vs. analytics), without referring to those in between (Bendall et al., 2019; Hu et al., 2020; Peterson & Meissel, 2015). This approach allows radicalising the phenomenon and filtering unwanted “noise.” Although those ranging between the ends of the spectrum, the intermediates, account for more than a third of the total sample, as measured by E-CSA-W/A (e.g. Chen & Macredie, 2004; Nitzan-Tamar et al., 2016; Peterson & Meissel, 2015), only few studies have examined how these intermediates function while processing information (Graff, 2000; 2003; Nisiforou & Laghos, 2016). Therefore, little is known about their degree of flexibility. Evans and Waring (2006) addressed this omission and used self-reports about learning and teaching preferences to examine the differences between the intermediate style and the wholistic and analytic styles. Their assumption that reactions in this group would be less extreme than in the wholistic and analytic groups was not fully demonstrated. For example, intermediate learners reported being less flexible in their thinking than wholistic and analytic learners. Evans and Waring (2006) recommend exploring the intermediates as a stand-alone style. However, their study relies on self-reports data rather than on an actual learning process, specifically wholistic or analytic oriented tasks. Hence, the way intermediates processes information remains ambiguous.

It is therefore important to investigate the intermediate style in this context, which by definition has no clear preference for one style over another in comparison to the extreme styles. Specifically, its degree of flexibility, i.e. the ability to adapt the selected strategy to the nature of the task, has not yet been sufficiently investigated. In order to deepen our understanding of how learners on the spectrum of wholistic-intermediate-analytic styles process information and the strategies they use for different tasks, this research attempts to characterise EM patterns of the different styles in the E-

CSA-W/A test that require global vs. local processing.

The E-CSA-W/A test is a visual computer-based instrument commonly used for classifying a tendency towards a specific cognitive style (Lacko et al., 2021). As the test is a visual test in which the stimuli consist of simple geometric shapes, it is suitable for implementation using eye tracking techniques. Also, the E-CSA-W/A test has been validated for distinguishing between wholistic and analytic dimension styles (internal consistency $r = .72$; test-retest reliability $r = .55$; Peterson et al., 2003), and has no association with intelligence or performance, therefore suitable to be used as a classified test for the wholistic – analytic dimension in the present study.

1.1. The wholistic-analytic cognitive styles and cognitive flexibility

Cognitive style refers to a learner's preferred approach towards organising and processing information (Riding & Rayner, 1998). Riding and Cheema (1991) proposed a wholistic-analytic dimension that reflects the way individuals organise and capture new information. While wholistics tend to capture a situation as a whole, analytics focus more on the details that comprise the situation. One definition describes cognitive styles as a set of rules (learning strategies) used to process information based on either whole (process the entirety) or partial (focus on details) pattern recognition (Kozhevnikov, 2007). This definition of the wholistic-analytic cognitive styles, and others (e.g. Rezaei & Katz, 2004), ignore the fact that the wholistic-analytic dimension is bipolar (Riding & Cheema, 1991), which means that there are individuals, referred to as "intermediates," who are not distinctly wholistic or analytic, indicates that a learner can develop different strategies depending on the situation (Kozhevnikov, 2007; Messick, 1996). Therefore, intermediates are assumed to be more flexible, and thus to display better performance. However, the extent of their flexibility is unclear.

Most studies assume that intermediates have equal command of both whole and partial strategies, and therefore can process information more efficiently (Davies & Graff, 2006; Evans & Waring, 2006; Kozhevnikov, 2007). Graff (2003) examined the effect of matching the learner's style (wholistic/analytic/intermediate) with a hypertext[1] type (linear/hierarchical/contextual). The results revealed that intermediates performed better than wholistic and analytic learners in contextual hypertexts. In other words, the intermediates benefited from the fact that the information was divided into parts, though they still had access to an overview of the information. Beyond the degree of cognitive flexibility attributed to intermediates, the question arises as to the degree of cognitive flexibility of wholistic and analytics learners. Cognitive flexibility refers to the ability of an individual to adapt their cognitive effort in response to the task requirements (Shin & Kim, 2015), and the ability to adapt learning strategies to the task at hand (Cañas et al., 2003).

Monitoring EM is valuable for examining cognitive processes and learning strategies because it enables sampling of objectively cognitive behaviour in real time, without any intervention or effort from the learner (Bendall & Thompson, 2015; Lai et al., 2013). Hence, monitoring EM can shed light on the underling and overt cognitive processes that characterise different cognitive styles (Nitzan-Tamar et al., 2016).

1.2. Monitoring eye movements

Monitoring EM has become an accepted method in diverse fields of research. It is used to gather information about the visual field, distribution of visual attention, and the information received by the learner while solving a complex problem (Bendall et al., 2019; Rayner, 1998; 2009). Accordingly, EM has become a useful tool for examining learning processes and strategies, and can provide essential information beyond standard behavioural measures (e.g. accuracy or response time). This enables analysis of the underling cognitive processes that led to the solution of the problem (Bendall & Thompson, 2015; Moeller et al., 2009; Vakil et al., 2011).

Nisiforou and Laghos (2016) investigated visual information processing characteristics of wholistics (field dependent), intermediates (field neutral), and analytics (field independent) using eye-tracking techniques while performing the Hidden Figures Test (HFT) (Ekstrom et al., 1976). The results

[1]Definition by Conklin (1987): "Hypertext systems feature machine-supported links-both within and between documents-that open exciting new possibilities for using the computer as a communication and thinking tool".

indicated that analytics and intermediates demonstrated similar EM patterns, less fixations and saccades, that differ from the wholistics. Nisiforou et al. (2014) in an earlier research revealed that navigating a simple page did not yield significantly different observation patterns among the groups. However, the researchers did not report the performance of the intermediate group when navigating medium and complex pages, although significant differences in wholistic and analytic observation patterns were demonstrated (Nisiforou et al., 2014).

In light of the above, further research should be conducted on how intermediates process information. Therefore, the primary goal of this study will be to identify and classify intermediates' EM patterns compared to those of the wholistics and analytics on the E-CSA-W/A test. The characterisation of EM will allow for an examination of the level of cognitive flexibility of each style studied.

The EM measure examined was *Number of transitions* between the two AOIs. This measure provides information on the learners' visual focused perception and the strategies used (Schwonke et al., 2009).

13. Research questions

The study addresses the following research questions:

(1) Do intermediates adapt their strategy to the demands of the task more efficiently, in terms of shorter RT, high or equal accuracy, and less transitions between the AOIs, than wholistics and analytics, making them more flexible?
(2) Which group (wholistic, analytic, or intermediate), if any, processes information more efficiently in order to solve a global/local task?

Since the intermediates by definition use both strategies (whole and partial) effectively, and based on our previous study which indicated that wholistics adapted the strategy to the nature of the task more efficiently than the analytics (Nitzan-Tamar et al., 2016), it is therefore hypothesised that wholistics and intermediates will demonstrate similar EM patterns on the different tasks.

2. Methods

2.1. Participants

The research sample included 173 students (68.2% females) with normal or corrected vision. The majority received course credits for their participation and others volunteered. Participants were assigned to three groups according to their preferred style, based on their E-CSA-W/A score (Peterson, 2005). Forty-four *wholistics* (75% females) scored within a range of 0.75–0.97 ($M = 0.88$, $SD = .059$; age: $M = 29.25$, $SD = 6.08$). Forty-nine *analytics* (67.3% females) scored within a range of 1.28–2.56 ($M = 1.52$, $SD = .26$; age: $M = 28.49$, $SD = 6.45$). Finally, eighty *intermediates* (65% females) scored within a range of 0.98–1.23 ($M = 1.10$, $SD = .08$; age: $M = 28.07$, $SD = 5.75$). This scale division is in accordance with the recommendation of Peterson, the author of the test, in the Administration Guide for the E-CSA-W/A test, based on her research on 276 university students (Peterson, 2005), which is similar to the scale suggested by Riding (1998) based on a secondary school sample of 1,448 students. The study was approved by the School of Education's Ethics Committee at Bar-Ilan University, and each participant signed an informed consent form.

2.2. Materials and apparatus

2.2.1. The E-CSA-W/A test

The E-CSA-W/A[2] test was used with its author's permission. E-CSA-W/A is an 80-item computerised measure used to identify participants' preferred cognitive style along the wholistic-analytic spectrum (Peterson et al., 2003). Forty matching items involving whole cognitive strategy, require participants to determine whether two geometric items are identical. The remaining forty items require participants to determine whether a simple geometric figure is contained within a complex one using a partial cognitive strategy. During the 15-minute test, the number of false responses (accuracy, which correlate negatively with the number of false responses), and response time (RT) (in milliseconds) are simultaneously recoded.

Cognitive style preferences are measured by comparing median RT on the global task with median RT on the local task. Each participant receives a wholistic-intermediate-analytic style

[2]Minor modifications were made in order to obtain accurate eye movement patterns: All captions were removed from the slides.

preference score indicating their position on the spectrum. Scores under .97 indicate a tendency toward a wholistic style; scores between .97 and 1.25 indicate a tendency toward an intermediate style; and scores above 1.25 indicate a tendency toward an analytic style (Peterson, 2005).

2.2.2. Eye tracking equipment

Stimuli display. E-Prime 2.0 software was used to control and record the temporal parameters of the stimulus display, and to link the display duration of stimulus presentation with the computer that recorded EM. Stimuli were presented on a 15.6″ laptop screen, with resolution of 1,366 × 768 pixels, and a monitor driven at a 60 Hz refresh rate.

Eye movements recording. The participants' EM were recorded using the SensoMotoric Instruments (SMI) RED-M remote eye-tracker (version 2.5 SMI, Berlin, Germany), with a 120 Hz sampling rate provides a high gaze position accuracy range of 0.5° (the offset from the true gaze point). A spatial resolution (precision) of 0.1° (the spread of the gaze points) obtained using a 9-point calibration cycle, while each point appeared for 10 milliseconds. All accuracies data were taken from the manual of the supplier. The SMI illuminates the pupil using an infra-red camera measuring the cornea reflection. The camera was positioned at the bottom of the laptop screen, below eye level, and about 60 cm from the participant.

2.2.3. Eye movement measures

All items in the E-CSA-W/A test were divided into two different AOIs. Each AOI contained a figure displayed on the right or left side of the screen. The EM measure recorded in this study was *the number of transitions* from the left to the right figure, and vice versa, and was analyzed using SMI BeGaze™ Eye Tracking Analysis Software. Figure 1 and Figure 2 illustrate EM patterns produced by representative learner from each group, wholistic, analytic, and intermediate, on a global and local stimulus, respectively. The selected learners are representative since they perform an average number of transitions relative to the group to which they belong.

We can distinguish two types of EM data in these Figures that provide us with the information needed to produce the variable number of transitions: (a) fixations, each point describing one fixation, the circle surrounding the point indicating the duration of the fixation, the larger the radius, the longer the fixation, and (b) lines connecting the fixations indicating the transition between two fixations. By counting the number of lines connecting fixations in two different stimuli, it can be determined the number of transitions between the two AOIs.

2.3. Procedure

Participants performed the test individually in a quiet room. After submitting a written informed consent form and background data (e.g. age and gender), they were instructed to place their fingers on two answer keys on the keyboard ("L" was marked "Yes" and "A" was marked "No)". In the global task, participants were instructed to indicate whether two geometric items were identical. In the local task, participants were instructed to indicate if a simple geometric figure was contained within a complex one. There were no time limits, and participants were asked to respond as accurately as possible. Finally, participants were asked to focus their gaze on the screen and avoid sudden head movements throughout the test. Pressing the spacebar started the calibration cycle, and participants were instructed to follow the points only by moving their eyes. Instructions on the E-CSA-W/A test were presented at the beginning of each trial, to allow minimal researcher intervention. Feedback on accuracy was given after each item, and EM were recorded simultaneously.

4. Results

Accuracy and RT are the primary dependent measures of the behavioural data. Transitions is the primary dependent measure of the EM data. Differences between the groups (wholistic, analytics, and intermediates) on the EM measure were analyzed separately for each task (global/local) of the E-CSA-W/A test in order to investigate the differences in the strategies used for each task.

4.1. Behavioural measures

Accuracy. Mixed analysis of variance with repeated measures was conducted in order to analyse the effect of Group (wholistic, analytics, and intermediates) and Task Type (global/local), a between-subjects and within-subjects factor, respectively, on the dependent measure Accuracy.

Results revealed significant differences between the groups, . All groups were more accurate when

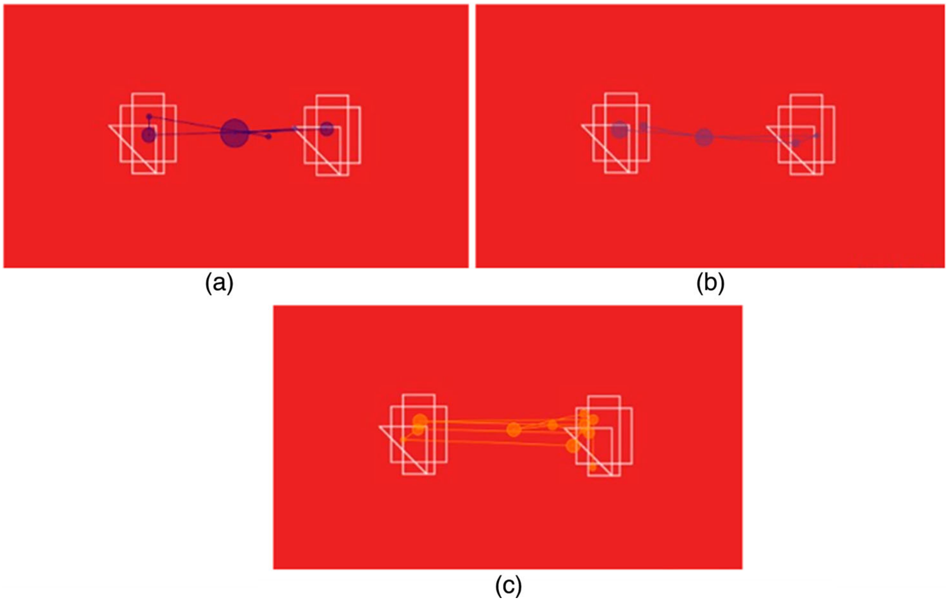

Figure 1. Differences in EM patterns produced by intermediate (1a), wholistic (1b), and analytic (1c) learners on a global stimulus.

completing the global task than the local task, $F(1, 169) = 4.53$, $p < .05$, $\eta^2 = .03$. The interaction did not reach significant, $F(2, 169) = 1.75$, $p = .18$, $\eta^2 = .02$, indicating that there was a similar level of accuracy on both the global and local tasks for all groups (see Figure 3).

Response time. Mixed analysis of variance with repeated measures was conducted in order to analyse the effect of Group (wholistic, analytics, and intermediates) and Task Type (global/local), a between-subjects and within-subjects factor, respectively, on the dependent measure RT (in milliseconds).

Results revealed significant differences between the groups, $F(2, 169) = 38.56$, $p < .001$, $\eta^2 = .31$. It took longer for all groups to complete the global task than the local task,

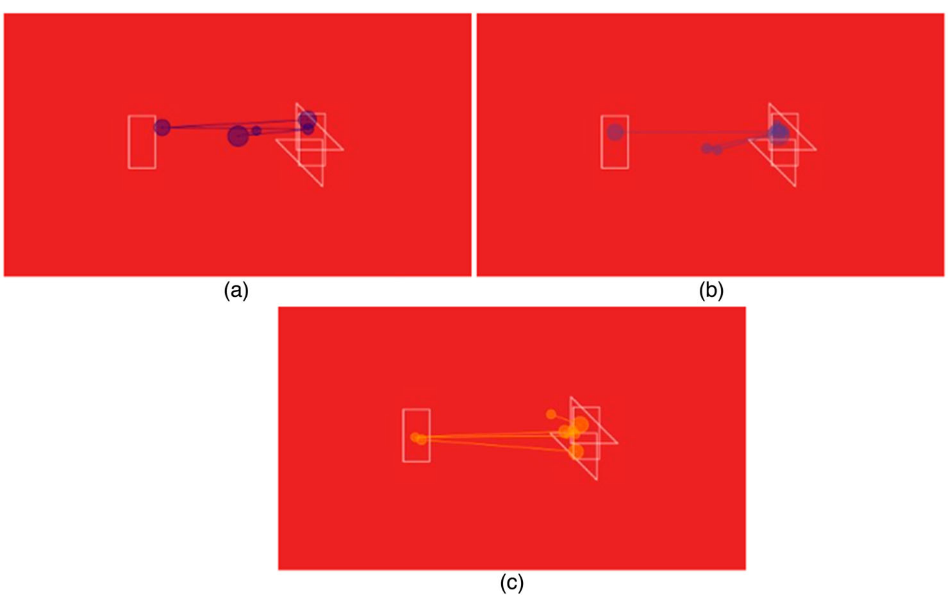

Figure 2. Differences in EM patterns produced by intermediate (2a), wholistic (2b), and analytic (2c) learners on a local stimulus.

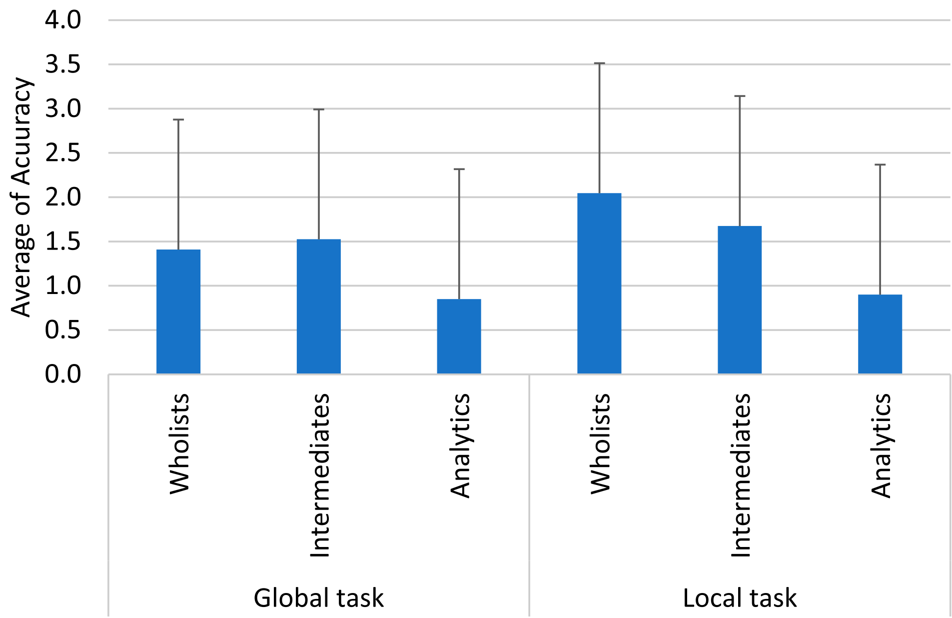

Figure 3. Accuracy, the average number of false responses and standard deviation, on the global and local tasks by the wholistic, intermediate, and analytic groups.

$F(1, 169) = 225.24$, $p < .001$, $\eta^2 = .57$. A significant Group × Task interaction was found, $F(2, 169) = 248.62$, $p < .001$, $\eta^2 = .75$. Tukey post-hoc test revealed that the analytic group's RT on the global and local tasks was significantly longer compared to the other groups. On the other hand, there were no significant differences between the intermediate and the wholistic group's RTs on the various tasks (see Figure 4).

4.2. Eye movement measures

The items in the E-CSA-W/A test were divided into two different AOIs to analyse the EM measures. Each item of the global task contained two AOIs, i.e. right and left figures. Each item of the local task contained two AOIs, right (complex) and left (simple) figures (see Figure 2(a–c)).

One-way ANOVA was conducted in order to analyse the differences between groups (wholistic, analytics, and intermediates) in the number of transitions for both the global and local tasks.

Number of transitions in the global task. One-way ANOVA (2 × 3) revealed significant differences between the groups, $F(2, 172) = 10.50$, $p < .001$, $\eta^2 = .11$. Subsequent Tukey post-hoc analyses revealed significant differences between the analytic group and the other two groups. On average, the analytic group made more transitions ($M = 134.88$, $SD = 36.87$) than the wholistic group ($M = 105.70$, $SD = 28.68$) and the intermediate group ($M = 112.04$, $SD = 33.29$). On the other hand, differences in transitions between intermediate and wholistic groups did not reach significance (see Figure 5a).

Number of transitions in the local task. One-way ANOVA (2 × 3) revealed that differences in transitions between groups did not reach significance, $F(2, 172) = .83$, $p = .44$ (see Figure 5b).

5. Discussion

The present study compared cognitive processing between the intermediate group and the extreme groups, wholistics and analytics, as reflected by behavioural and EM measurements on the E-CSA-W/A test. The main goal of this study was to shed some light on how the intermediate group processes information and investigate their level of cognitive flexibility compared to the extreme groups. Hence, beyond the behavioural differences used to classify the participants' cognitive style, simultaneous measures of EM were also examined in order to understand the underlying processes that took place.

5.1. Behavioural differences in the E-CSA-W/A test

The analytics' RT was longer than that of the wholistics and intermediates in both the global and local tasks. In terms of the level of accuracy, it was

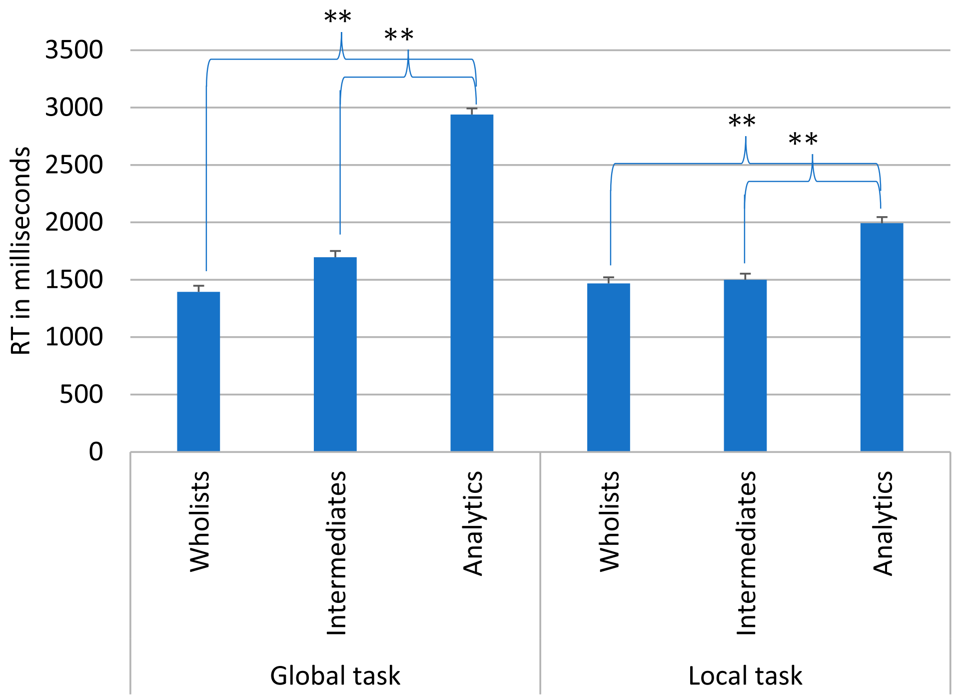

Figure 4. Median RT (in milliseconds) and standard deviation on the global and local tasks by the wholistic, intermediate, and analytic groups.

found similar for all groups on both the global and local tasks, indicating that the difficulty level of the two tasks was similar across all groups. In our previous study, differences in behavioural measures were interpreted as indicating reflective or impulsive style of the analytic and wholistic styles, respectively (Kozhevnikov, 2007; Nitzan-Tamar et al., 2016). These findings reinforce the assumption that the analytics are defined as having a reflective style, therefore their RT is longer.

Hence it can be assumed that the behavioural measures enabled classification of the sample groups into two main groups: (a) the analytics can be defined as having a reflective style, therefore demonstrating longer RT; the wholistics and intermediates can be defined as having an impulsive style, therefore demonstrating shorter RT than the analytics. More specifically, on both tasks, the analytics were less efficient than the wholistics and the intermediates since they reach the same level of performance in a longer time, while the intermediates were similar in their performance to the wholistics. However, these behavioural measures cannot indicate the learner's cognitive processes during the tasks, or the strategy used in the different tasks. EM measures might illuminate the nature of the different groups' cognitive processes when solving the E-CSA-W/A test.

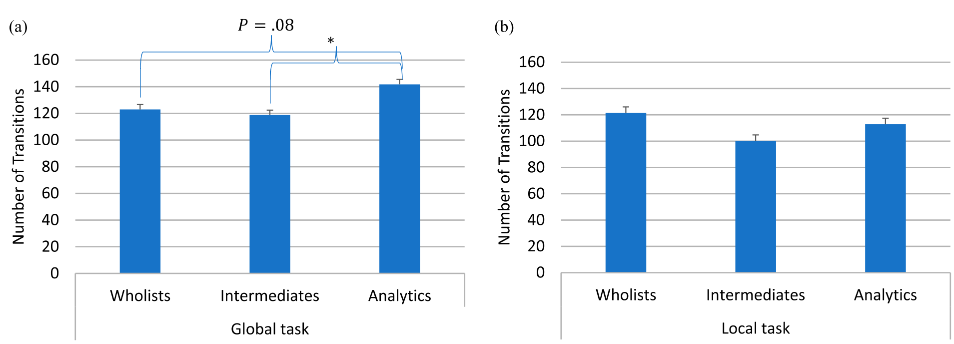

Figure 5. Number of transitions between the different AOIs and standard deviation on (a) the global task and (b) the local task, by the wholistic, intermediate, and analytic groups.

5.2. EM differences in the E-CSA-W/A test

On the global task the analysis revealed more transitions between the different AOIs among the analytics compared to the wholistics and intermediates. This might indicate use of partial vs. whole strategy by the different groups. As the partial strategy compares two elements at a time until the entire image has been scanned, many transitions are necessary to compare all the elements that comprise the stimuli. In contrast, the whole strategy requires in-depth processing of each stimulus separately followed by comparison of the two complex stimuli in each of the AOIs, and thus requires fewer transitions.

Specifically, it can be assumed that wholistics and intermediates used the whole strategy for the global task. On the other hand, the analytics performed more transitions between the different AOIs, reflecting use of partial strategy. These findings are consistent with Davies's (2009) findings, which showed that in the global task, the analytics used partial strategy and processed the details that comprise the whole, compared to the wholistics who used the whole strategy that is more suited for this task. However, Davies did not refer to the intermediate group in his research.

In the local task, unlike the global task, there are differences in the complexity of the two stimuli. The simple stimulus on the left consists of one geometrical figure (see Figures 2(a–c)) and requires less information processing. On the other hand, the right stimulus is complex and consists of several geometrical forms, which requires more information processing. This enables use of both the whole and partial strategies.

In terms of transitions, the analytic group demonstrated similar patterns to that of the intermediate and the wholistic groups. This suggest that intermediates and wholistics adopted the partial strategy for the local task, as predicted. These findings coincide with previous studies. For example, Nisiforou and Laghos (2016) used the HFT which resembles the local task of the E-CSA-W/A test. They found that analytics and intermediates demonstrated less transitions and fixations compared to wholistics. However, and contrary to our findings, they found that the analytics outperformed the intermediates. These differences can be explained by the differences in the complexity of the stimuli in the different tests, as the HFT uses more complex stimuli than the E-CSA-W/A test.

If so, analytics persevered in their partial strategy for solving both tasks and did not adjust the strategy to the task requirements as the wholistics and intermediates did. Therefore, it can be assumed that wholistics and intermediates exhibited greater cognitive flexibility in adapting the strategy to task demands than analytics.

5.3. Conclusions and contribution

This study investigated the cognitive flexibility that characterise different cognitive styles on the wholistic-intermediate- analytic dimension while solving the E-CSA-W/A test, and offers methodological, theoretical, and practical contributions to the field of cognitive style.

Methodologically, the study presents a unique combination of two research tools simultaneously to examine the cognitive style. The first one, the E-CSA-W/A test, classifies the individual according to behavioural measures. The second, characterises in real time the way the information is processed using EM that expands and deepens the information obtained from behavioural measures alone. Analysis of the RT of the different groups might indicate that the intermediate group behaves similarly to the wholistics and differently from the analytics, possibly since the wholistics and the intermediates complete the task more quickly compared to the analytics. However, the EM data facilitates deeper investigation of the different styles and strategies used for solving the test. It is assumed that the wholistic and intermediate groups used the whole strategy to solve the global task and the partial strategy to solve the local task, while the analytics clearly adhered to the partial strategy when solving both tasks. These findings have led us to conclude that wholistics and intermediates exhibited greater cognitive flexibility compared to analytics.

The present study reinforced the insight that cognitive styles can be classified using EM monitoring based on the diagnosis of the activated strategy. Accordingly, the whole strategy is characterised by less transition between different AOIs as compared to the partial strategy. Therefore, in order to deepen our understanding of cognitive flexibility, we recommend the implementation of EM monitoring in conjunction with other tests designed to classify the cognitive styles. An example of such a test is the Embedded Figure Test (EFT) developed by Witkin et al. (1971), which measures field-dependence and field-independence styles in parallel to wholistic and analytical styles. This test has been extensively used to study wholistic versus analytic cognitive styles. The EFT consists of a simple geometric form that the participant is required to locate quickly within an embedding context, with the degree of difficulty increasing as the test progresses. The visual nature of the EFT test allows EM monitoring to occur simultaneously.

Theoretically, the current study has the potential to contribute to the field of cognitive styles. It enhances our knowledge on information processing and flexibility among intermediates, who have not been sufficiently researched in the literature, despite its size (about one-third of the participants) in the population, compared to the extreme groups. The behavioural and EM data revealed that intermediates and wholistics use similar information processing strategies, but intermediates use the partial strategy more efficiently. In terms of flexibility, it appears that in the global task, the intermediates performed equally to the wholistics, while in the local task they seemed to have an advantage over the wholistics, and used the partial strategy more efficiently, as reflected in fewer transitions between the different AOIs, probably because they have mastered both strategies. These findings are consistent with previous studies (e.g. Graff, 2003; Kozhevnikov, 2007; Riding & Caine, 1993).

Specifically, the current study proposes to examine differently the wholistic-analytic dimension of the cognitive style, as proposed by Riding and Cheema (1991), in which, instead of placing the learner on the continuum between analytic and wholistic styles, classifies the learner according to their level of cognitive flexibility. Peterson (2005) indicated that it is not recommended to use the E-CSA-W/A ratios to assign people to style categories since there will be a reduction in the reliability of the data. In the current study, Patterson's test classification was performed simultaneously with EM monitoring, which is considered a suitable tool for examining learning strategies, and we believe that the classification did not adversely affect the reliability of the EM data. This study's findings may also explain Patterson's reluctance to analyse data solely based on the E-CSA-W/A test classification, as a result of monitoring EM, we found that learners could be classified into two rather than three styles based on their EM. Accordingly, learners who have been classified as intermediates or wholistics according to the E-CSA-W/A test will be classified as learners with cognitive flexibility, that is, able to adapt their strategy to the requirements of the task. In contrast, a learner who is classified as analytic according to this test will be defined as a learner with a less flexible style on the CSA-W/A test. This classification may have practical implications at various levels, especially when it comes to learners with less cognitive flexibility and who have a clear preference for using one strategy, the partial strategy.

From a practical perspective, this research has important implications in numerous areas concerned with individual differences, among these is education. Online learning that became an integral component of the curriculum following the COVID-19 pandemic, invites dealing with flexible information presented in a nonlinear manner, so when designing a learning site or online study materials it will be worthwhile to use less segmented hypertext design for instructional purposes to facilitate online learning more effectively for analytic learners (Graff, 2006).

Does a learner with a less flexible cognitive style, on the CSA-W/A test, find it difficult to learn in a setting that does not support his preferred method of learning? Is it possible to train the brain to exhibit more cognitive flexibility?. Further research is needed to address these questions, and to examine whether training in different learning strategies can encourage analytic learners, on the CSA-W/A test, to adapt their strategy to the task type and to improve their cognitive flexibility.

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No potential conflict of interest was reported by the author(s).

Data availability statement

The data that support the findings of this study are available from the corresponding author, Dr. Ortal Nitzan via email: ortalt83@gmail.com, upon reasonable request.

ORCID

Ortal Nitzan-Tamar http://orcid.org/0000-0001-7770-3247

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