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Investigating the Geography of Thought Across 11 Countries: Cross-Cultural Differences in Analytic and Holistic Cognitive Styles Using Simple Perceptual Tasks and Reaction Time Modeling

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This article investigates cross-cultural differences in analytic/holistic cognitive styles among participants from 11 countries: Armenia, Australia, Brazil, Bulgaria, Czechia, Germany, Ghana, Philippines, Slovakia, Taiwan, and Türkiye. Using a preregistered design, 993 university students were assessed with three perceptual tasks based on Navon's hierarchical figures and Gottschaldt's embedded figures. Analytic and holistic cognitive styles were estimated using reaction time modeling, specifically a Bayesian four-parameter shifted Wald distribution and a hierarchical linear ballistic accumulator model. The results revealed notable cross-cultural variations in cognitive styles, though these differences did not align with predictions from analytic/holistic cognitive style theory. Countries traditionally characterized as more holistic or analytic did not consistently show the expected cognitive style patterns. Multilevel modeling examined the influence of country-level variables, such as Hofstede's and Schwartz's cultural dimensions. While some dimensions, like individualism and long-term orientation, were associated with both analytic and holistic thinking, many cultural predictors had no significant impact on cognitive styles. Additionally, exploratory latent profile analysis assessed cognitive metastyles, such as flexibility and rigidity, but the findings do not support the presence of a rigidity metastyle. No profiles exhibited a strong preference for one cognitive dimension while showing a low preference for the other. These findings challenge the straightforward application of analytic/holistic theory across diverse cultural contexts and suggest a need for reevaluation of its generalizability.

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continued

Public Significance Statement

The study investigates cross-cultural differences in the thinking styles of people from 11 countries and challenges the prevailing theory of analytic versus holistic thinking proposed by Nisbett et al. (2001). The study found significant differences that did not align with the theoretical predictions, shedding new light on how thinking styles vary across cultures. These unexpected results have important implications for our understanding of thinking processes and emphasize the need to reconsider existing theories in the field.

Keywords: analytic and holistic cognition, cognitive style, reaction time modeling, latent profiles, cultural differences

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Cross-cultural research is deeply intertwined with general experimental cognitive research on multiple levels. It not only incorporates theories and methodologies from the broader research domain but also serves as a source of inspiration, enriching our understanding of cognitive processes. In recent years, extensive research has been conducted in cognitive cross-cultural psychology within the framework of the theory of analytic and holistic cognition, with many studies focusing on the cognitive and perceptual differences between individuals from cultures delineated as “Western” or “Eastern” (for a review, see Nisbett et al., 2001; Nisbett & Masuda, 2003; Nisbett & Miyamoto, 2005). The theory postulates holistic and analytic cognitive styles, referring to two distinct, relatively stable ways of thinking. Individuals who think holistically tend to process information as an integrated whole, whereas those who think analytically process information as discrete parts of the whole.

Studies indicate that individuals from Eastern countries tend to exhibit a holistic cognitive style, and individuals from Western countries tend to adopt an analytic style. For example, Eastern and Western cultures differ in the cognitive processes of object categorization (Ji et al., 2004; Norenzayan et al., 2002), causal attribution (Masuda & Kitayama, 2004; Miyamoto & Kitayama, 2002), reasoning about contradictions (Peng & Nisbett, 1999), visual attention to focal objects and background (Chua et al., 2005; Nisbett & Masuda, 2003), object–background differentiation (Kühnen et al., 2001), change detection (Masuda et al., 2016; Masuda & Nisbett, 2006), scene memory (Mickley Steinmetz et al., 2018), dependence on visual external reference frameworks (Ji et al., 2000; Kitayama et al., 2003), and global and local distribution of attention (McKone et al., 2010).

To analyze cross-cultural differences across such a diverse spectrum of cognitive processes, various methods have been introduced in the past (for a review, see, e.g., Cools et al., 2014; Kozhevnikov, 2007; Trang Hanová, 2023). These methods can be categorized into four main clusters: (a) self-report questionnaires, which analyze various factors using latent variables as indicators of cognitive style; (b) performance-based measures within the holistic–analytic family, utilizing the processing of Gottschaldt’s embedded figures and employing reaction times (RTs) as indicators of cognitive style; (c) performance-based measures within the global–local family, involving the processing of Navon’s hierarchical figures and again using RTs as indicators of cognitive style; and (d) other methods, which include (A) the use of more complex visual stimuli with eye-movement measurements, employing dwell time and the number of fixations as indicators of cognitive style and (B) various categorization tasks where preferences based on thematic relationships or focal attributes serve as indicators of cognitive style.

In our study, we focus on simple perceptual performance-based measures, including both global–local and holistic–analytic theoretical frameworks, which are among the most widely used in prior cross-cultural research (Trang Hanová, 2023). These methods are rooted in Gestalt psychology, which advanced theories and methods in cognitive research by defining perceptual organization “laws” like proximity, similarity, and closure. Gestalt psychology explores the interplay between wholes and parts, suggesting that wholes have an added value beyond their components, shaped by relationships or higher mental processes. This perspective highlights a natural human inclination toward holistic perception, respectively precedence of global features of stimulus aptly described by Navon (1977) as “seeing forest before trees,” and the tendency to understand sensory

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elements within broader cognitive contexts (Wagemans et al., 2012). It should be noted that the cross-cultural research on Gestalt and analytic–holistic cognitive styles shows significant overlap. While the theory of holistic–analytic cognition predominantly focuses on higher cognitive processes (Nisbett & Masuda, 2003), Gestalt-based research (e.g., McKone et al., 2010; Rozin et al., 2016) emphasizes relatively low-level principles of perceptual organization. The main conceptual linkage is found in Nisbett's references to Witkin's theory of field dependence (Masuda & Nisbett, 2001), which aligns with Gestalt principles.

The global–local paradigm utilizes principles of grouping, particularly proximity and continuity (Wertheimer, 1922), and is rooted in Navon's work (Navon, 1977). Navon (1977) investigated how hierarchical visual scenes process global (the scene as a whole) and local (elements of the scene) characteristics, illustrating the "global precedence effect." This effect suggests that observers initially perceive the global features of a scene before its local elements. Cross-cultural studies have examined global processing across diverse cultures. For instance, a study compared British students with participants from the Himba tribe in northern Namibia (Davidoff et al., 2008). It aimed to determine whether the Himba's emphasis on local details over global context would result in a disadvantage in global processing. Results indicated that the Himba processed stimuli more locally, suggesting a local processing advantage in hierarchical stimulus processing. Furthermore, Oishi et al. (2014) found that Argentinians exhibited a higher number of global choices in global–local processing tasks compared to Americans, with Japanese participants falling in between.

However, the majority of studies indicate that East Asian cultures exhibit a stronger inclination toward holistic perception at the global level, while Western cultures prioritize details at the local level. For example, Kiyokawa et al. (2012) compared in a series of studies the implicit learning of Japanese and English and identified a greater global advantage of Japanese. McKone et al. (2010) compared the speed of processing of Navon figures between Caucasian Australians, second-generation Asian Australians, and East Asians, finding that East Asians showed the strongest global advantage, followed by Asian Australians. In their neurophysiologic study, Rozin et al. (2016) identified a stronger holistic orientation of Asian participants compared to Americans. Similar results were obtained by Yang et al. (2019) when comparing American and Chinese participants.

The analytic–holistic paradigm stems from principles of figure–ground organization, especially the laws of proximity, similarity, good continuation, closure, mirror symmetry, and frame of reference (Wertheimer, 1922), and is originally rooted in the theory of field dependence (for an overview, see Witkin, 1979; Witkin & Berry, 1975). Generally, individuals displaying field dependence tend to rely on information from the surrounding environment, the field, or the context of a situation, and their cognition toward other elements is influenced by this overall field. In contrast, field-independent individuals are better able to disregard the impact of the background image and, for example, locate hidden figures more effectively. The field dependence has been extensively examined by cultural and cross-cultural studies in the past (for review, see Witkin, 1979; Witkin & Berry, 1975) as well as more recently.

Several studies have investigated cross-cultural differences using the Embedded Figures Test, originally developed by Witkin. For example, Kühnen et al. (2001) found that participants from the United States and Germany were more field-independent compared to participants from Russia and Malaysia. Similar results were observed when comparing American participants of Caucasian and Indian origin (Monga & John, 2007). While most studies using the Embedded Figures Test indicate that Western cultures exhibit greater field independence and Asian cultures exhibit greater field dependence, Marquez and Ellwanger (2014) observed the opposite pattern when comparing participants of Asian American and other ethnic origins.

The Framed Line Test is another method based on the principle of field dependence. Duffy et al. (2009) compared North American and Japanese children of various ages and concluded that the division of attention strategies emerges around the age of 6 years. While no differences were observed in performance among younger age groups, older children exhibited divergent performance patterns: American children performed relatively better on the absolute task, whereas Japanese children excelled on the relative task. The results were replicated using the Framed Line Test with adult samples from Western countries (Germany, United Kingdom, United States) and Japan (Kitayama et al., 2003) as well as the United States and Japan (Kitayama et al., 2009; San Martin et al., 2019).

However, recent research has identified several critical issues with studies on analytic and holistic cognition. For example, the majority of studies include samples only from countries traditionally described as Eastern (e.g., Japan, China) or Western (e.g., United States, Western Europe), whereas evidence beyond this dichotomy is still very limited. Studies have primarily compared samples from two or three countries, and large robust comparisons of greater numbers of countries are scarce. To the best of our knowledge, only a handful of studies have compared more than four countries (cf. Abdelnour-Nocera et al., 2017; Allinson & Hayes, 2000; Ji et al., 2004; Rozin et al., 2016; von der Beck et al., 2017). Very recently, Uskul et al. (2023) published presumably the largest study to date, comparing sample groups from 11 countries (12 different cultural groups) using both self-reporting and performance-based methods.

Despite a few studies analyzing cross-cultural differences beyond analytic/holistic cognition applied RT modeling (e.g., Amir et al., 2023; Gao et al., 2022; Gutchess et al., 2021), past research in this area has typically relied on raw unprocessed RT as an indicator of cognitive style. RT, however, not only indicates underlying latent traits but also other cognitive processes, such as psychomotor tempo, stimulus encoding, response carefulness, and working speed (Molenaar et al., 2015). RT also typically exhibits a right-skewed nonnormal distribution, similar to the ex-Gaussian or shifted Wald distributions (Whelan, 2008). It is important, therefore, to design novel procedures for modeling RT, which account for specific cognitive processes to estimate target outcomes more accurately and which incorporate specific, nonnormal RT distributions (for a review, see De Boeck & Jeon, 2019).

Among the most recommended approaches is the joint modeling of responses and RTs through evidence accumulation models (EAMs), such as the drift-diffusion model or linear ballistic accumulator (LBA; N. J. Evans & Wagenmakers, 2020). The application of these models leads to a richer and more detailed description of participants' performance by providing several parameters with potential psychological interpretations. For instance, the drift rate encompasses the quality of information processing, the separation boundary captures the amount of information needed to reach a decision, and the nondecision time conveys the time spent on processes not directly related to decision making itself. Furthermore, EAMs also account for the speed–accuracy trade-off (N. J. Evans & Wagenmakers, 2020; Voss et al., 2013). However, EAMs require a substantial number of erroneous answers to ensure model identification, especially if the tasks are easy to solve and thus lack variability in error answers (Anders et al., 2016; Faulkenberry, 2017). For these tasks, which are typically used in research on analytic and holistic cognitive styles, simplified process models that use only RTs and not accuracy have been proposed. One such model, applied in this study, is the shifted Wald distribution (Faulkenberry, 2017).

Another problematic area under debate relates to dimensionality and the structures of the analytic/holistic thinking construct. Although the construct was originally proposed as two-dimensional (Choi et al., 2007; Lacko et al., 2023; Nisbett et al., 2001; Norenzayan et al., 2002), academics tend to ignore this property. Researchers who employ self-report measures in their experiments often measure several unidimensional factors, and researchers who apply performance-based measures reduce the information obtained from analytic/holistic subtests by creating aggregate unidimensional indices (e.g., differences or RT ratios) to avoid the need to interpret the dimensionality of the construct. In some cases, the approach might be misleading and unreliable (Draheim et al., 2019; Gerlach & Krumborg, 2014), and because various measurement methods are often not associated with each other (Chamberlain et al., 2017; Huygelier et al., 2018; Lacko et al., 2023; Milne & Szczerbinski, 2009; Na et al., 2010, 2020; Peterson & Deary, 2006), it raises questions about the construct's two-dimensional nature (cf. Anakwah et al., 2020; Lacko et al., 2020; Na et al., 2010; Wong et al., 2021). Hence, some academics suggest alternative and more complex models (e.g., Kozhevnikov et al., 2014) and include more general underlying cognitive styles (e.g., flexibility/rigidity) in their research (Lacko et al., 2023). Others suggest examining the latent profiles obtained from multiple methods to obtain a more comprehensive understanding of analytic/holistic processing (Na et al., 2020).

Finally, some research (e.g., Čeněk et al., 2020; K. Evans et al., 2009; Hakim et al., 2017; Lacko et al., 2020; Rayner et al., 2007; Stachoň et al., 2019; von Mühlenen et al., 2018) presents findings that deviate from the theory as they either did not identify the traditional East–West cross-cultural differences or even found differences in the opposite direction than expected. Rigorous verification of the theory's predictive validity is therefore crucial and represents the most critical point in current research.

We believe that insights gained from cultural and cross-cultural research can enhance current theories in general cognitive research for several reasons. First, employing methods predominantly developed in Western contexts and typically administered to Western samples on non-Western, Educated, Industrialized, Rich, and Democratic (WEIRD; Henrich et al., 2010) populations can reveal potential limitations in the generalizability of these methods and the cognitive theories based on their results. This cross-cultural application can also lead to the identification of culturally specific cognitive processes that may otherwise be overlooked, thereby refining and expanding theoretical frameworks. Additionally, as highlighted by Gutchess and Rajaram (2023), the omission of cultural variables (e.g., value dimensions), nationality, and race as variables of interest in cognitive psychology can result in incomplete or biased understandings of perceptual phenomena such as speed of processing of visual stimuli, selective and spatial attention, or even higher cognitive processes such as detection of similarity. Integrating these variables can uncover diverse cognitive patterns and mechanisms, fostering more robust and inclusive theoretical models.

The Present Study

In this quasi-experimental study, we investigate the cross-cultural differences in the analytic/holistic thinking styles of groups from 11 countries (and 12 cultural groups)[1]: Armenia, Australia, Brazil, Bulgaria, Czechia, Germany, Ghana, Philippines, Slovakia, Taiwan, (Eastern and Western) Türkiye. Four prerequisites, two main hypotheses, and two exploratory analyses were preregistered (see https://osf.io/pwxas/) and were built on Hofstede's Individualism Index (Hofstede et al., 2010), where individuals from individualistic countries are anticipated to exhibit more analytical thinking (and therefore individualistic traits), while individuals from collectivist countries are expected to demonstrate relatively more holistic thinking (Ji et al., 2000; Nisbett et al., 2001; Varnum et al., 2010). Despite individualism/collectivism and independent/interdependent self-construals often facing criticism (e.g., Lacko et al., 2021; Oyserman et al., 2002; Schimmack et al., 2005), the index was chosen for its comprehensive coverage of almost all countries, whereas prior analytic/holistic cognitive styles primarily covered "Eastern" (e.g., China, Japan, Korea) and "Western" (e.g., United States, United Kingdom, Germany) countries.

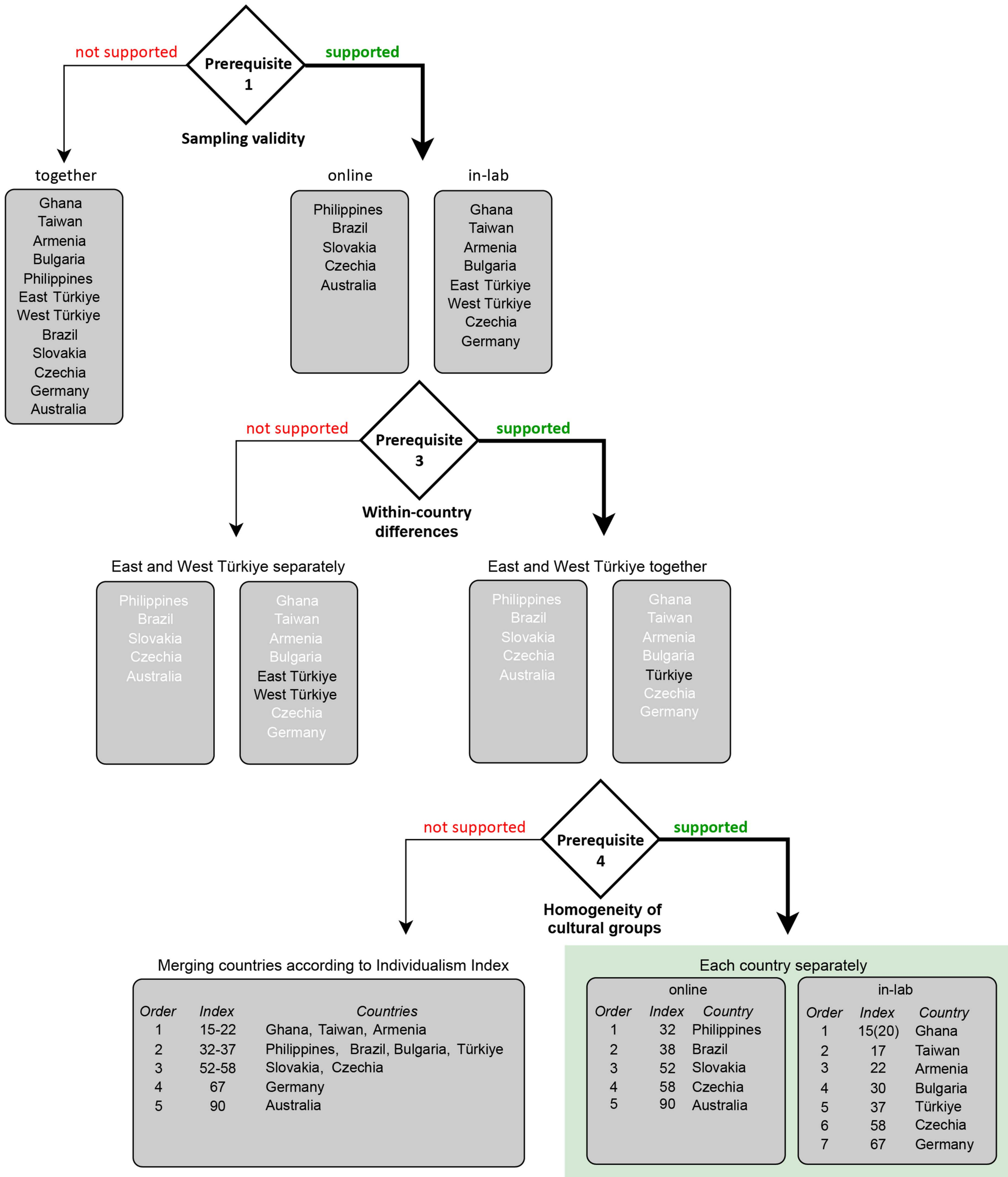
The prerequisites address various partial aspects of the study (see Figure 1). The first prerequisite attempts to estimate the sampling validity by comparing the data collected from Czech subjects online with the data collected in the laboratory (P1). If these two samples are equivalent in terms of crucial parameters (drift) calculated via RT modeling, the data gathered online and in laboratory will be analyzed jointly; if not equivalent, they will be analyzed separately. The second prerequisite attempts to estimate the predictive validity of the methods, that is, whether the methods can identify the differences assumed by the theory. This is achieved by comparing an Eastern country (Taiwan) with two Western countries (Australia [P2a] and Germany [P2b]). The third prerequisite attempts to estimate within-country differences using samples from the eastern and western parts of Türkiye (P3). If a significant difference is detected between West and East Türkiye in crucial parameters calculated via RT modeling, the regions will be analyzed separately; if none is found, they will be analyzed together.

The fourth prerequisite assesses the homogeneity of the cultural groups to reduce the number of pairwise comparisons. Three groups with similar Individualism Index scores were proposed: Group 1 (Armenia, Ghana, Taiwan: index = 15–22), Group 2 (Brazil, Bulgaria, Philippines, Eastern Türkiye: index = 30–38), and Group 3 (Western Türkiye, Slovakia, Czechia online and in the laboratory: index = 52–58). If countries in Group 1 (P4a), Group 2 (P4b), or Group 3 (P4c) are found to be equivalent, they will be analyzed jointly; if not equivalent, they will be analyzed separately.

The first main hypothesis postulates that subjects from different countries in the sample differ in their levels of analytic and holistic thinking (omnibus effects, H1). The second main hypothesis proposes that subjects from more individualistic countries or cultural

[1] Throughout the article, we often use the terms "country" or "culture" to categorize our data. However, these refer to specific samples from the corresponding countries as the sample sizes are limited and not fully generalizable to the entire country, society, or culture.

Figure 1
Prerequisites



Note. See the online article for the color version of this figure.

groups exhibit relatively more analytic characteristics in perceptual and cognitive processes (H2). Based on the Individualism Index, the following order (most holistic/least analytic) is expected: Ghana (index: 15) > Taiwan (index: 17) > Armenia (index: 22) > Bulgaria (index: 30) > Philippines (index: 32) > Türkiye (index: 37) > Brazil (index: 38) > Slovakia (index: 52) > Czechia (index: 58) > Germany (index: 67) > Australia (index: 90). In the case of groups: Group 1 > Group 2 > Group 3 > Germany > Australia.

This ranking aligns with the theory of analytic/holistic cognition (Ji et al., 2000; Nisbett et al., 2001), the social orientation hypothesis

(Varnum et al., 2010), and some of the findings of related works in this area. For example, studies show that Brazilians are more holistic than Westerners (de Oliveira & Nisbett, 2017; Hoersting et al., 2021), Germans are more analytic than Japanese (Kitayama et al., 2009), and Eastern Europeans are more holistic than Western Europeans (Varnum et al., 2008) but categorize more analytically than East Asians (Lacko et al., 2020). Turks generally show more holistic thinking traits than Westerners (Tektas et al., 2017), and people from Western Türkiye demonstrate more analytical eye movements than people from Eastern Türkiye (Šašinková et al., 2023). However, studies of Mediterranean and Turkish samples report rather mixed findings compared to studies of Western or Eastern countries (Uskul et al., 2023).

The first exploratory analysis (EA1) attempts to verify the association between measures aimed at contributing to prior research focused on the dimensionality of constructs and the associations between different cognitive style measures. The second exploratory analysis (EA2) attempts to identify latent profiles in the study's methods and examines whether countries differ in the proportion of latent profiles. This approach aligns with some recent views of analytic/holistic style (cf. Na et al., 2020) and allows for identifying potential patterns of underlying construct in populations or a potential presence of some kind of metacognitive style.

Furthermore, two additional (not preregistered) exploratory analyses were proposed. The third exploratory analysis (EA3) aims to replicate the findings of the main analysis by employing ratios of scores from analytic and holistic subtests of each method instead of using two separate scores. This approach provides readers with more comparable evidence to prior research, as ratios are typically utilized in such studies (e.g., Istomin et al., 2014; McKone et al., 2010).

The fourth exploratory analysis (EA4) aims to further explore the data using multilevel modeling to predict outcomes with variables at the country level. For these purposes, some of the most commonly used cultural dimensions were considered, namely six Hofstede dimensions (individualism, power distance, uncertainty avoidance, long-term orientation, indulgence, motivation toward achievement and success; Minkov & Kaasa, 2022), seven Schwartz dimensions of basic values (harmony, embeddedness, hierarchy, mastery, affective autonomy, intellectual autonomy, egalitarianism; Schwartz, 2008), two Inglehart–Welzel value dimensions (traditional vs. secular-rational values, survival vs. self-expression values; World Values Survey 7, 2023), the cultural tightness–looseness index (Uz, 2015), the WEIRDness score (Klein et al., 2018), and the Gini coefficient with the Human Development Index (HDI).

Method

Sampling and Sample Characteristics

Before data collection, an a priori power analysis was performed using G*Power (Faul et al., 2007) to detect small-to-medium effect sizes (Cohen's $f = .15$). Applying an α of .05 and β of .20 for a one-way analysis of variance (ANOVA) with 13 groups resulted in 793 participants, that is, 61 participants per group (noncentrality parameter $\lambda = 17.84$, critical $F = 1.76$, numerator $df = 12$, denominator $df = 780$). The α and β values were selected arbitrarily to correspond to the most often used criteria in psychology. Since the data collection was part of a larger project, even the effect size was chosen rather arbitrarily to capture differences that could be considered practically significant.

Data were collected from 1,047 participants (university students) using convenience sampling. A preregistered data cleaning procedure, which included removing invalid answers and participants with a history of attention-deficit/hyperactivity disorder, was then performed (see Supplemental Material, Table S2), resulting in 993 subjects for further analysis. The sample's mean age was 23.27 (SD = 5.3); 56% were women; 14% had spent more than half a year abroad. Details of the sample are summarized in Table 1.

Research Procedure

Data were collected both online (Australia, Brazil, Czechia, Philippines, Slovakia) and in a laboratory setting (Armenia, Bulgaria, Czechia, Germany, Ghana, Taiwan, Eastern and Western Türkiye) as part of a larger test battery. Students were divided into groups, either East or West Türkiye, based on their hometowns where they grew up. Testing took approximately one and a half hours (with a break in half administration), and each subject was tested individually. Methods were administered using *Hypothesis* software, which reliably records RT in both laboratory and online settings (Šašinka et al., 2017). To ensure method and item equivalence (Lacko et al., 2022), all texts

Table 1
Sample Characteristics

Sample	*N*	Age range	Age *M* (*SD*)	Gender (woman %)	Gender (man %)	Abroad experience (yes %)	Abroad experience (no %)
Armenia	54	18–32	20.4 (2.3)	45 (83)	9 (17)	11 (20)	43 (80)
Australia	84	18–63	30.9 (12.1)	14 (17)	38 (45)	13 (16)	40 (48)
Bulgaria	60	18–31	21.8 (2.2)	29 (48)	31 (52)	3 (5)	57 (95)
Brazil	66	18–56	28.9 (8.7)	29 (44)	36 (55)	4 (6)	61 (92)
Czechia (online)	50	19–35	23.0 (4.0)	31 (62)	15 (30)	3 (6)	43 (86)
Czechia (in-laboratory)	185	18–51	22.7 (3.5)	130 (70)	52 (28)	39 (21)	146 (79)
Philippines	37	18–22	20.3 (1.4)	22 (60)	14 (38)	0 (0)	37 (100)
Germany	66	18–45	26.2 (5.6)	47 (71)	18 (27)	27 (41)	39 (59)
Ghana	61	20–24	21.3 (1.0)	25 (41)	35 (57)	3 (5)	57 (93)
Slovakia	43	19–28	22.0 (2.2)	33 (77)	9 (21)	17 (40)	25 (58)
East Türkiye	72	19–30	22.4 (1.8)	21 (29)	50 (69)	2 (3)	70 (97)
West Türkiye	64	19–27	21.8 (1.8)	22 (34)	41 (64)	1 (2)	63 (98)
Taiwan	151	20–35	22.3 (2.5)	111 (74)	40 (26)	18 (12)	133 (88)
Total	993	18–63	23.3 (5.3)	559 (56)	388 (39)	141 (14)	814 (82)

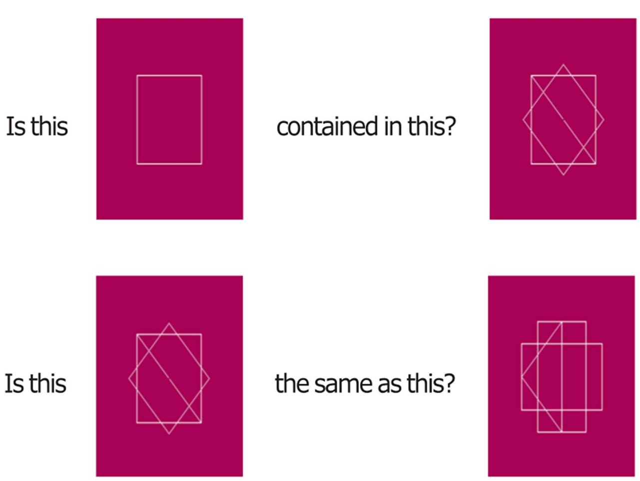
were translated by two independent native speakers, using the back-translation method. All methods involved practice trials to ensure that participants understood the instructions. The study was approved by the Research Ethics Committee of Masaryk University (No. EKV-2018-011).

Measures

Extended Cognitive Style Analysis–Wholistic/Analytic

Extended Cognitive Style Analysis–Wholistic/Analytic (E-CSA-W/A; Peterson et al., 2003, 2005) is based on Gottschaldt's embedded figures, which are complex figures composed of simple shapes. E-CSA-W/A demonstrates sufficient discriminant validity with intelligence, mathematical performance, personality, and academic achievement (Lacko et al., 2023; Peterson et al., 2005; Peterson & Meissel, 2015; Pitta-Pantazi & Christou, 2009). It also demonstrated sufficient split-half and test–retest reliability (Lacko et al., 2023; Peterson et al., 2003). E-CSA-W/A contains 80 items (40 analytic and 40 holistic) and requires participants to identify a simple shape within a more complex figure (i.e., analytic) and decide whether two complex figures are identical (i.e., holistic; Figure 2). Identically to the original guide (Peterson, 2005), participants were asked to "work carefully so that your answers are correct," without any mention of RTs. This does not necessarily pose a problem for shifted Wald distribution as emphasis on speed should influence predominantly the threshold parameter and not the drift parameter (N. J. Evans, 2021; Voss et al., 2004; Wagenmakers et al., 2008). Participants respond by pressing one of two keyboard buttons for *Yes* or *No*. The feedback on answers (correct/wrong) was displayed after each response for 1,000 ms, and the next stimulus was shown after another 500 ms. RTs are assessed as the main indicator of cognitive style, but a preferable method of analysis (Lacko et al., 2023) is modeling the drift parameter from a shifted Wald distribution (Anders et al., 2016; Faulkenberry, 2017). The method was developed to overcome the criticized unidimensionality of Witkin's original Embedded Figures Test (Witkin & Goodenough, 1977); therefore, it was designed as two-dimensional. Subjects displaying a holistic style are quicker to identify similar figures, and subjects with an analytic style are quicker to identify a simple shape from a complex figure.

Figure 2
Example of Extended Cognitive Style Analysis–Wholistic/Analytic Stimuli



Note. See the online article for the color version of this figure.

Compound Figure Test–Search Task

The Compound Figure Test–Search Task (CFT-ST; Lacko et al., 2023) is an instrument based on global and local processing of Navon's hierarchical figures, that is, a large figure (global level) composed of small figures (local level). In general, hierarchical figures show satisfactory test–retest reliability (Dale & Arnell, 2013, 2014), split-half reliability (Gerlach & Poirel, 2018; Gerlach & Starrfelt, 2018), and a lack of association with general intelligence and personality (Lacko et al., 2023; Milne & Szczerbinski, 2009). CFT-ST is based on congruent and incongruent verbal forms (numbers) and requires subjects to identify the correct answer (i.e., search task; Caparos et al., 2015) as quickly as possible. Participants are required to identify local figures in the analytic subtest (16 items) and global figures in the holistic subtest (16 items; Figure 3). Each subtest has an additional three practice tasks with feedback. Fixation crosses are displayed before each trial (for 500 ms), and the figure remains visible until the participant responds (clicking with a computer mouse). The same four choices were available in all tasks (i.e., 2, 4, 5, 8). RTs are assessed as the main indicator of cognitive style, but as with the E-CSA-WA, modeling the drift parameter from a shifted Wald distribution of RTs (Lacko et al., 2023) or LBA (Fitousi & Azizi, 2023) is a preferable method of analysis. Since the method is designed as two-dimensional, participants displaying an analytic style are quicker in identifying local figures, and participants with a holistic style are quicker in identifying the global figure.

Compound Figure Test–Similarity Matching Task

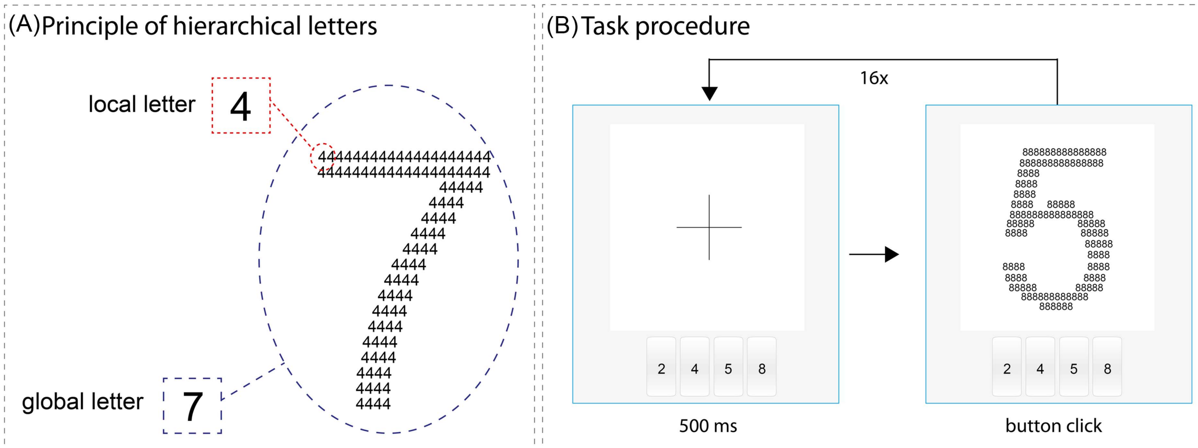
The Compound Figure Test–Similarity Matching Task (CFT-SMT; Lacko et al., 2023) is also based on Navon's hierarchical figures but differs from the CFT-ST in (a) stimuli (incongruent nonverbal stimuli—geometric shapes) and (b) the task's aim (subjects select an answer from two options, i.e., similarity matching task, see Caparos et al., 2015). The psychometric properties of CFT-SMT are similar to the CFT-ST (with the exception of higher test–retest reliability, see Lacko et al., 2023). CFT-SMT contains 20 items, with one sample stimulus and two options (one shares its global feature with the original stimulus and the other shares the local features, see Figure 4). Participants were asked to decide which of the two figures is more similar to the sample figure and were instructed that there is no right or wrong answer. Similar to E-CSA-WA, RTs were not mentioned in the instructions. The interstimulus interval was 1,500 ms. Choice and RT are modeled jointly according to a hierarchical LBA (Annis et al., 2017; Lacko et al., 2023). Similarly to CFT-ST, the method was designed as two-dimensional, so subjects displaying an analytic style prefer figures which share local features, and subjects with a holistic style prefer figures which share global features.

Demographics

In addition to utilizing these methods, we collected information from participants concerning their age, gender, education,

Figure 3

Principle (A) and Task Procedure (B) of Compound Figure Test–Search Task Stimulus



Note. See the online article for the color version of this figure.

socioeconomic status, the size of the city they reside in, marital status, number of siblings, experiences abroad, and diagnostic history of attention-deficit/hyperactivity disorder. All responses were voluntary, and participants had the option to skip questions or choose "other."

Data Analysis

Parameter Estimates

To establish valid indicators of cognitive style, the relevant parameters for modeling RT (i.e., drift parameters) were first estimated. The drift rate represents the quality and speed of evidence accumulation (Ratcliff, 1978; Voss et al., 2013) and reflects both item difficulty and individual differences (Heathcote et al., 2019). In general, a higher drift rate is characteristic of higher accuracy or stronger preferences and lower RT (Boehm et al., 2018; Ratcliff et al., 2016). In other words, the drift rate is expected to be positively associated with accuracy or preference and negatively associated with RT (Lerch & Voss, 2020). This pattern was also observed in our sample, where *r*s with RTs varied between −0.36 and −0.57, while the *r*s with accuracy (applicable only for CFT-SMT) were 0.73 and 0.93. It is assumed that the drift rate is associated with the intended measured construct and is unbiased by other cognitive processes present in raw RTs, such as psychomotor tempo, stimulus encoding, or response carefulness (Molenaar et al., 2015). Thus, for instance, older participants often display slower RTs, not necessarily indicating poorer performance. In certain contexts, their prolonged RTs stem from adopting a conservative response approach, involving the need for more information before making decisions (Theisen et al., 2021). Depending solely on raw RTs might mislead us to perceive their performance as inferior.

A Bayesian four-parameter shifted Wald distribution (Steingroever et al., 2021) was then applied with E-CSA-W/A and CFT-ST, and a hierarchical LBA (Annis et al., 2017) was applied with CFT-SMT, as proposed by Lacko et al. (2023). For easier comparisons with prior studies using raw RTs, all analyses were reevaluated with unprocessed RTs. The findings can be accessed on OSF. Even though individual post hoc comparisons using raw RTs and drift parameters differed in terms of statistical significance in approximately half of the cases for both E-CSA-W/A (30 out of 62) and CFT-ST (25 out of 62), the main findings—specifically, the preregistered order of countries—remained very similar to those conclusions based on drift parameters. This comparison was not possible for CFT-SMT as its results are not based on RTs but on the ratio of scores, making it inappropriate to compare with the two individual drift parameters obtained from LBA. The measurement invariance of answers in CFT-ST and E-CSA-WA across age, gender, and countries was examined via the Rasch tree approach to differential item functioning (DIF; Strobl et al., 2015).

In the case of Bayesian four-parameter shifted Wald distribution (see Figure 5), the Gibbs sampling method was applied, using three Markov chain Monte Carlo (MCMC) chains and 10,000 iterations with weakly informative prior distributions (Lacko et al., 2023). The four estimated parameters are drift, alpha (separation boundary), theta (nondecision time), and across-trial drift variability. The convergence of the MCMC chains was satisfactory ($\hat{R}$s < 1.1 and

Figure 4

Example of Compound Figure Test–Similarity Matching Task Stimuli

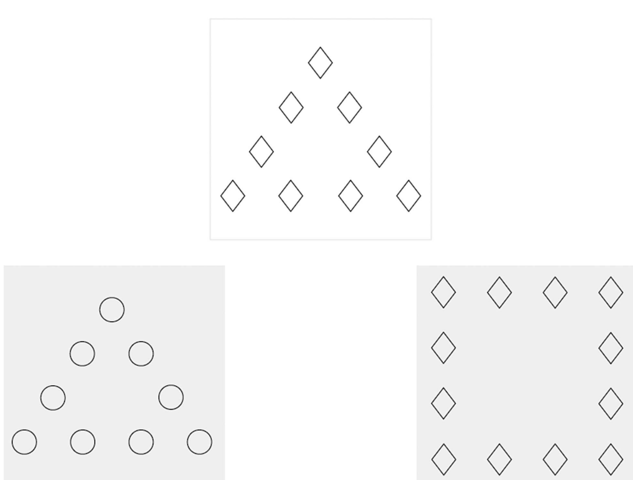
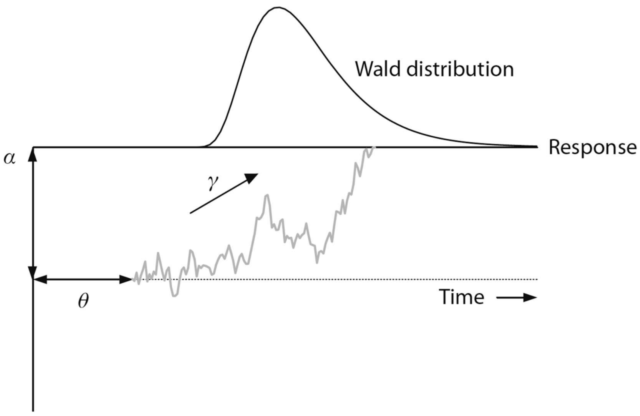


Figure 5
Shifted Wald Distribution



Note. Drift rate (γ) represents the quality of information accumulation, indicated by the slope of information intake. A decision is made once the participant accumulates enough evidence to reach the boundary; the amount of information needed to form a decision is denoted by α. Nondecision time (θ) is associated with processes like stimulus encoding. For the sake of clarity and easier interpretation, the three-parameter model (Anders et al., 2016) is depicted here instead of the four-parameter model used in this study (Steingroever et al., 2021). Figure adapted from "Modeling Across-Trial Variability in the Wald Drift Rate Parameter," by H. Steingroever, D. Wabersich, and E.-J. Wagenmakers, 2001, *Behavior Research Methods*, *53*(3), p. 1062 (https://doi.org/10.3758/s13428-020-01448-7). CC BY-4.0.

$n_{\mathrm{eff}} > 100$). Because of the high correctness rate (approximately 95%, see Supplemental Material, Table S2) and lower amount of items per method, joint modeling of responses and RTs, for instance via drift-diffusion models (Ratcliff et al., 2016), was not feasible. The shifted Wald distribution has been proposed for similar simple perceptual tasks that are easy to solve (Anders et al., 2016; Faulkenberry, 2017) and offer similar interpretations as the drift-diffusion models (Faulkenberry, 2017; but see also Matzke & Wagenmakers, 2009). Consequently, the procedure utilized only RTs from correct answers (Faulkenberry, 2017). Shifted Wald models were fitted separately for each analytic and holistic subtest.

In the case of hierarchical LBA (see Figure 6), the differential evolution MCMC was applied, using 18 chains and 1,700 iterations (1,000 burn-in) with default prior distributions suggested by Annis et al. (2017). LBA models five parameters at the individual level (drift rate for each accumulator, relative threshold, maximum starting point, starting point variability, nondecision time). The visual inspection of MCMC chains via traceplots indicated satisfactory convergence (see OSF). The hierarchical LBA within a Bayesian framework was selected due to its notably lower complexity compared to drift-diffusion models, which is advantageous for methods involving a smaller number of tasks (Brown & Heathcote, 2008). Furthermore, unlike the shifted Wald distribution, it models the drift parameter for both choices ("preferences") instead of only one ("correct answer").

Prerequisites

To verify the prerequisites, *t* tests for independent samples (P2 and P3) and two one-sided tests (Lakens, 2017) were applied, using the smallest effect size of interest set to Cohen's $d = .30$ (P1), which corresponds to the small-to-medium effect size used in power analysis. To verify P4, omnibus noninferiority testing was applied (Campbell & Lakens, 2021), with a corresponding smallest effect size of interest ($\eta_p^2 = .023$).

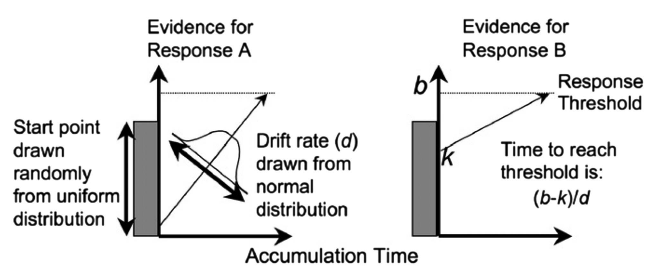
Main Hypotheses

For the analysis of the main hypothesis, Welch's one-way ANOVAs (H1) were applied, with subsequent *post hoc* comparisons using Games–Howell tests (H2) because the homogeneity of variances was violated in several cases (see Supplemental Material, Table S3). To clarify the post hoc tests in terms of each country's deviation from its expected rank on the holistic–analytic spectrum, the Euclidean distance between the expected order of countries and the observed order of countries was calculated for all three methods. This distance was then normalized using the theoretical maximum value. The distances between the observed and expected values for two variable subsets (analytic and holistic) were calculated separately, followed by the total distance as the average of the two distances.

Exploratory Analyses

The study also performed two preregistered and two nonpreregistered exploratory analyses. EA1 was analyzed using Spearman's rank correlation coefficients due to the nonnormal data distribution of most of the variables (see Supplemental Material, Table S4). EA2 was analyzed using latent profile analysis (LPA). Model comparison (from 1 to 9 clusters) was evaluated based on the Bayesian information criterion, bootstrap likelihood ratio test, integrated the complete data likelihood, Akaike information criterion, consistent Akaike information criterion, sample-size-adjusted Bayesian information criterion, and entropy for parameterized Gaussian mixture models fitted by the expectation–maximization algorithm (see Supplemental Material, Table S5 and Figures S1 and S2). The distribution of five latent profiles across countries was investigated using Pearson's

Figure 6
Linear Ballistic Accumulator



Note. Each choice has its own accumulator. The drift rate (*d*) quantifies the slope of information accumulation. The threshold (boundary separation; b) quantifies the amount of information required to trigger a response. A specific response is chosen once one of the accumulators reaches the threshold. The start point of evidence accumulation (*k*) is randomly chosen from a uniform distribution. For the sake of clarity and easier interpretation, a simple linear ballistic accumulator (LBA) model (Brown & Heathcote, 2008) is depicted here instead of the hierarchical LBA used in this study (Annis et al., 2017). Figure adapted from "The Simplest Complete Model of Choice Response Time: Linear Ballistic Accumulation," by S. D. Brown and A. Heathcote, 2008, *Cognitive Psychology*, *57*(3), p. 158 (https://doi.org/10.1016/j.cogpsych.2007.12.002). Copyright 2008 by Elsevier. Reprinted with permission.

chi-squared test followed by 95% simultaneous confidence intervals (CIs) for multinomial proportions (Sison & Glaz, 1995). EA3 was investigated using ANOVA and omnibus noninferiority testing with the same settings for the main hypothesis. The only difference from the main analysis was the use of a ratio of drift parameters instead of separate drift parameters for analytic and holistic subtests.

EA4 was conducted using linear multilevel modeling with a random intercept for countries. Age, gender, and socioeconomic status were included as covariates at the individual level (Level 1), while various cultural dimensions were included at the country level (Level 2). These dimensions were incorporated into the analysis using several independent models. This approach was necessary due to a large number of predictors, with each model featuring a different set of predictors: (a) Hofstede's dimensions, (b) Schwartz's dimensions, (c) Inglehart–Welzel's dimensions, (d) cultural tightness–looseness index, (e) WEIRDness score, and (f) Gini coefficient and HDI predictors. Since Schwartz's embeddedness and Hofstede's Individualism Index showed large multicollinearity (variance inflation factor [VIF] > 10), they were estimated independently. This led to the absence of multicollinearity (all VIFs < 5). This process was repeated for each outcome variable separately.

Software

All analyses were performed in *R* (V4.3.2, R Core Team, 2023). For the main analyses (ANOVAs, equivalence testing), *misty* (Yanagida, 2023) and *TOSTER* (Lakens, 2017) packages were used together with *lsr* (Navarro, 2015) and *rcompanion* (Mangiafico, 2023) packages for effect size computation and *rstatix* package (Kassambara, 2023) for post hoc comparisons. LPA was calculated using *mclust* package (Scrucca et al., 2016) and multinomial CIs via *DescTools* package (Signorell, 2024). Multilevel modeling was estimated using *lme4* package (Bates et al., 2015). The *R* codes provided by Annis et al. (2017) and Steingroever et al. (2021) were adapted for the extraction of drift parameters modeled via hierarchical LBA and Bayesian four-parameter shifted Wald distribution, respectively. These procedures were possible by using *powder* (Annis, 2024) in the case of LBA and *rjags* (Plummer et al., 2023) in the case of shifted Wald. DIF was conducted in *psychotree* package (Strobl et al., 2015).

Transparency and Openness

The data, translations, stimuli materials, instructions (in English), and all *R* syntaxes are available online at https://osf.io/jywdu/ (Lacko et al., 2024). Parameter estimation, data cleaning, hypotheses (including prerequisites and exploratory analyses), and data analysis were preregistered at https://osf.io/pwxas/. The deviations from preregistration are described in the Supplemental Table S1.

Results

Measurement Invariance

The measurement invariance was evaluated using the Rasch tree approach to detect DIF, involving several steps: (a) estimating item parameters using the entire sample, (b) applying a structural change test to assess parameter stability while considering DIF covariates, and (c) if significant instability was detected, splitting the sample based on the covariate causing instability for further analysis. This analysis focused on responses (not RTs) from CFT-ST and E-CSA-WA, assessing simultaneously invariance across age, gender, and countries. Due to the nature of CFT-SMT, which involves choosing one out of two options, this procedure is not applicable since any observed DIF would likely correspond to differences across countries rather than noninvariance. Therefore, the measurement invariance of CFT-SMT is not reported.

The resulting single node (*ps* > .05) in each subtest of both methods indicated no noninvariant items across countries, age, and gender, with one exception (see Supplemental Materials, Figures S8–S11 and Table S16). Specifically, in the holistic subtest of CFT-ST, the Rasch tree identified a single split based on the country covariate (statistic: 202.5, $p = .008$), resulting in two terminal nodes. One node comprised the Philippines, Ghana, and Turkey, while the other included the remaining countries. These nodes differed in Rasch model item parameters, particularly highlighting variations in difficulty parameters for Items 3, 6, 9, and 15. All four of these items represent congruent tasks (e.g., a large five consists of smaller fives), which are generally slightly easier to solve.

Upon closer examination, these differences in difficulty parameters were primarily due to 100% accuracy in the Philippines, Ghana, and Turkey, which resulted in less precise estimation of difficulty parameters. However, the remaining countries exhibited marginally lower but still very high accuracy rates (ranging from 93% to 97%). Although the Rasch tree method identified DIF, we argue that these discrepancies do not indicate systematic differences between the two groups of countries identified by the Rasch tree. Instead, they seem to stem from limitations in parameter estimation caused by the (near) perfect accuracy observed. Consequently, we can consider the methods applied in this study to be invariant across countries, age, and gender.

Prerequisites

Before the main analysis, four prerequisites were preregistered to verify the following: (a) sampling validity (P1); (b) predictive validity of the methods used (P2a and P2b); (c) within-country differences (P3); (d) cultural group homogeneity (P4a, P4b, and P4c). The complete results are given in the Supplemental Table S6. A flowchart summarizing this part is depicted in Figure 1 (see the Present Study section). In all prerequisites testing, drift parameters were used as the main indicator of cognitive style.

First, the results obtained from the same cultural group were examined for dependence on the data collection method (online or in the laboratory; P1). To address this aim, data were collected from Czechia using both methods. Although the mean differences between the methods were small (Cohen's *d* between .026 and .144) for CFT-ST and CFT-SMT, equivalence testing did not provide evidence for the equality between two means (in all cases either upper or lower *ps* < .05). P1 is therefore not supported. Consequently, in testing the main hypothesis, separate analyses were performed for data collected online and data collected in the laboratory.

Second, Australia and Taiwan, which respectively represent countries typically distinguished for analytic and holistic thinking styles (P2a), were compared to assess the predictive validity of the study's methods. The observed differences were not significant (*ps* > .05) nor did they follow the expected directions. Because data collection in these two countries used different methods (online, in the laboratory), Germany was included as a second, highly analytic country to contrast with Taiwan (P2b). Nonetheless, the results were consistent with the first comparison (most of the comparisons showed

$ps > .05$), indicating that our predictions did not align with the current theory of analytic/holistic cognitive styles that questioned the validity of the method. P2a and P2b are therefore not supported.

Third, the differences in the levels of analytic and holistic cognitive style between Eastern and Western Türkiye were investigated to determine whether any within-country differences existed in the overall sample (P3). The analysis did not statistically support P3 (all $ps > .05$), and hence, the two groups for Türkiye were combined into one in all subsequent analyses.

Fourth, a series of equivalence tests were conducted to investigate the possibility of creating fewer culturally homogeneous blocks that are considered equivalent according to the Individualism Index. However, none of these blocks provided sufficient evidence for equivalence (all $ps_{\text{equ}} > .05$), except Czechia (online, in the laboratory) and Slovakia, which demonstrated sufficient equivalence in CFT-ST ($ps_{\text{equ}} = .006$ and .031). Hence, P4a, P4b, and P4c are not supported. Subsequent analyses, therefore, proceed with individual countries instead of cultural blocks.

Main Hypotheses

The study's main hypothesis postulates the variation in analytic/holistic cognitive styles displayed by subjects from a selected range of countries. It is hypothesized that the omnibus effects of differences between countries in the level of analytic cognitive style (indicated by drift parameters) exist (H1) and that these differences follow a specific order (lowest to highest; H2), that is, the Philippines < Brazil < Slovakia < Czechia < Australia for data collection online and Ghana < Taiwan < Armenia < Bulgaria < Türkiye < Germany for data collection in the laboratory. The reverse order is the expected pattern for the level of holistic cognitive style.

The arithmetic means of the drift parameters for each country are reported in Table 2 (for detailed descriptive statistics, including standard deviations and CIs, see Supplemental Tables S7, S8, and S9).

The first main hypothesis (H1) is supported by Welch's ANOVA omnibus effects in all cases, except for the CFT-SMT analytic subtest in online samples, where the effect was nonsignificant. In all other methods and subtests, the omnibus effects were statistically significant, with effect sizes ranging from medium to large (Table 2 for more details). The results clearly show differences in performance between countries relative to measurements (analytic vs. holistic; Table 3).

The expected pattern of cross-cultural differences, however, did not match our hypothesis derived from the current theory of analytic and holistic cognitive styles. H2 is therefore not supported. Because a high number of pairwise comparisons were performed, post hoc tests are reported in the Supplemental Tables S10–S12. The results of post hoc tests indicate that many significant pairwise comparisons do not follow the expected order of countries, and in many instances, they contradict the theory (Figure 7). For example, according to CFT-SMT, Taiwan ranked the most analytic country, and according to CFT-ST and E-CSA-W/A, the second most analytic country. In all tests, Ghana ranked as the least holistic country. According to CFT-SMT and CFT-ST, Germany ranked the most holistic country, and according to E-CSA-W/A, the second most holistic country. According to CFT-ST, Australia was the least analytic country, and according to E-CSA-W/A and CFT-SMT, the most holistic country. According to CFT-SMT, the Philippines was the least holistic country, and according to E-CSA-W/A, the second least holistic country.

Because interpreting such a large number of pairwise comparisons is relatively difficult, the deviation of countries from the expected order, in Euclidean distance, was measured instead (Table 4). This approach identified that the countries that differ most from the theoretical expectations are Australia, Brazil, Philippines, Ghana, Germany, Czechia, and Taiwan, and of these countries, Ghana, Brazil, and Germany deviated distinctively in holistic subtests; Taiwan in analytic subtests; and Czechia, Australia, and Philippines in both subtests. Armenia, Bulgaria, Slovakia, and Türkiye deviated least from the expected order.

Exploratory Analysis I: Association Between Measures

An exploratory analysis of associations between individual subtests was performed (Table 5) and revealed that the analytic and holistic subtests of E-CSA-WA and CFT-ST correlate with each other positively

Table 2
Arithmetic Means of the Estimated Drift Parameters

Country	Analytic			Holistic		
	E-CSA-WA	CFT-ST	CFT-SMT	E-CSA-WA	CFT-ST	CFT-SMT
Online						
Australia	3.053	3.715	1.020	2.794	3.457	2.444
Brazil	2.625	3.815	0.915	2.300	3.561	2.343
Czechia	3.153	4.316	0.885	2.777	3.993	2.327
Philippines	2.907	3.784	0.977	2.520	3.563	2.008
Slovakia	2.983	4.294	0.863	2.700	3.982	2.436
In-laboratory						
Armenia	2.577	3.890	1.162	2.408	3.735	2.273
Bulgaria	2.789	4.048	1.014	2.360	3.907	2.374
Czechia	2.793	4.283	0.978	2.453	4.054	2.315
Germany	3.069	4.391	1.090	2.670	4.150	2.411
Ghana	2.314	3.832	1.312	2.074	3.585	1.970
Türkiye	2.615	3.949	1.423	2.345	3.650	2.307
Taiwan	2.992	4.362	2.033	2.692	4.120	2.086

Note. E-CSA-W/A = Extended Cognitive Style Analysis–Wholistic/Analytic; CFT-ST = Compound Figure Test–Search Task; CFT-SMT = Compound Figure Test–Similarity Matching Task.

Table 3
Omnibus Effects of Welch's Analyses of Variance

ANOVA statistic	Analytic			Holistic		
	E-CSA-WA	CFT-ST	CFT-SMT	E-CSA-WA	CFT-ST	CFT-SMT
Online						
F	5.27	21.96	0.50	7.76	11.77	5.46
df	(4, 106.52)	(4, 112.19)	(4, 113.89)	(4, 106.84)	(4, 119.02)	(4, 113.74)
p	.001	<.001	.736	<.001	<.001	<.001
ω^2	.07	.19	<.01	.07	.13	.07
Interpretation	Medium difference	Large difference	Statistically nonsignificant difference	Medium difference	Large difference	Medium difference
In-laboratory						
F	15.71	18.84	82.39	12.78	19.14	13.68
df	(6, 216.18)	(6, 211.96)	(6, 216.59)	(6, 217.97)	(6, 224.83)	(6, 225.18)
p	<.001	<.001	<.001	<.001	<.001	<.001
ω^2	.11	.15	.18	.08	.14	.07
Interpretation	Medium difference	Large difference	Large difference	Medium difference	Large difference	Medium difference

Note. ANOVA = analysis of variance; E-CSA-W/A = Extended Cognitive Style Analysis–Wholistic/Analytic; CFT-ST = Compound Figure Test–Search Task; CFT-SMT = Compound Figure Test–Similarity Matching Task.

(i.e., subjects who displayed a higher level of analytic thinking also displayed a higher level of holistic thinking). Only the subtests of CFT-SMT correlated in the expected direction, that is, negatively, which is understandable due to the design of the task and the nature of the LBA procedure. More importantly, the effect size of this association was not weak or negligible. The correlations between the subtests of different methods were relatively weak or statistically nonsignificant.

Exploratory Analysis II: Latent Profiles

In the next step, LPA was applied to identify latent profiles. Five latent profiles were identified (for model comparisons, see Supplemental Table S5 and Figures S1 and S2), each characterized by specific patterns in performance-based methods (E-CSA-WA and CFT-ST) and a preference-based method (CFT-SMT). Average posterior class probabilities were sufficient for all profiles (AvePP1 = .90, AvePP2 = .80, AvePP3 = .89, AvePP4 = .99, AvePP5 = .87), as well as the entropy (S = .80), which suggests satisfactory classification accuracy and that the profiles are well-separated (see also Supplemental Material for mixture density plots, Supplemental Figures S3–S7).

In the performance-based methods, participants exhibited either poor performance (low drift parameters from both subtests), balanced performance (medium drift parameters from both subtests), or flexible performance (high drift parameters from both subtests). In the preference-based method, subjects exhibited a tendency to either analytic or holistic thinking, which varied in terms of its magnitude. Based on the means scores (Figure 8), Profile 1 (P1) indicates poor performance with a tendency to holistic thinking ($N = 158$), Profile 2 (P2) indicates a flexible style with a tendency to analytic thinking ($N = 106$), Profile 3 (P3) indicates a balanced style with a tendency to analytic thinking ($N = 262$), Profile 4 (P4) indicates poor performance with a tendency to analytic thinking ($N = 57$), and Profile 5 (P5) indicates a balanced style with a slight tendency to holistic thinking ($N = 251$). Univariate (Cohen's d), as well as multivariate (Mahalanobis distance), interclass distances are reported in the Supplemental Table S13.

A chi-squared test revealed that the proportions of latent profiles differed significantly between the countries in the overall sample, with a large effect size, $\chi^2 = 492.2$, $p < .001$, Cramer's $V = .385$ (see also Figure 9). The 95% simultaneous CIs for multinomial proportions are depicted in Table 6.

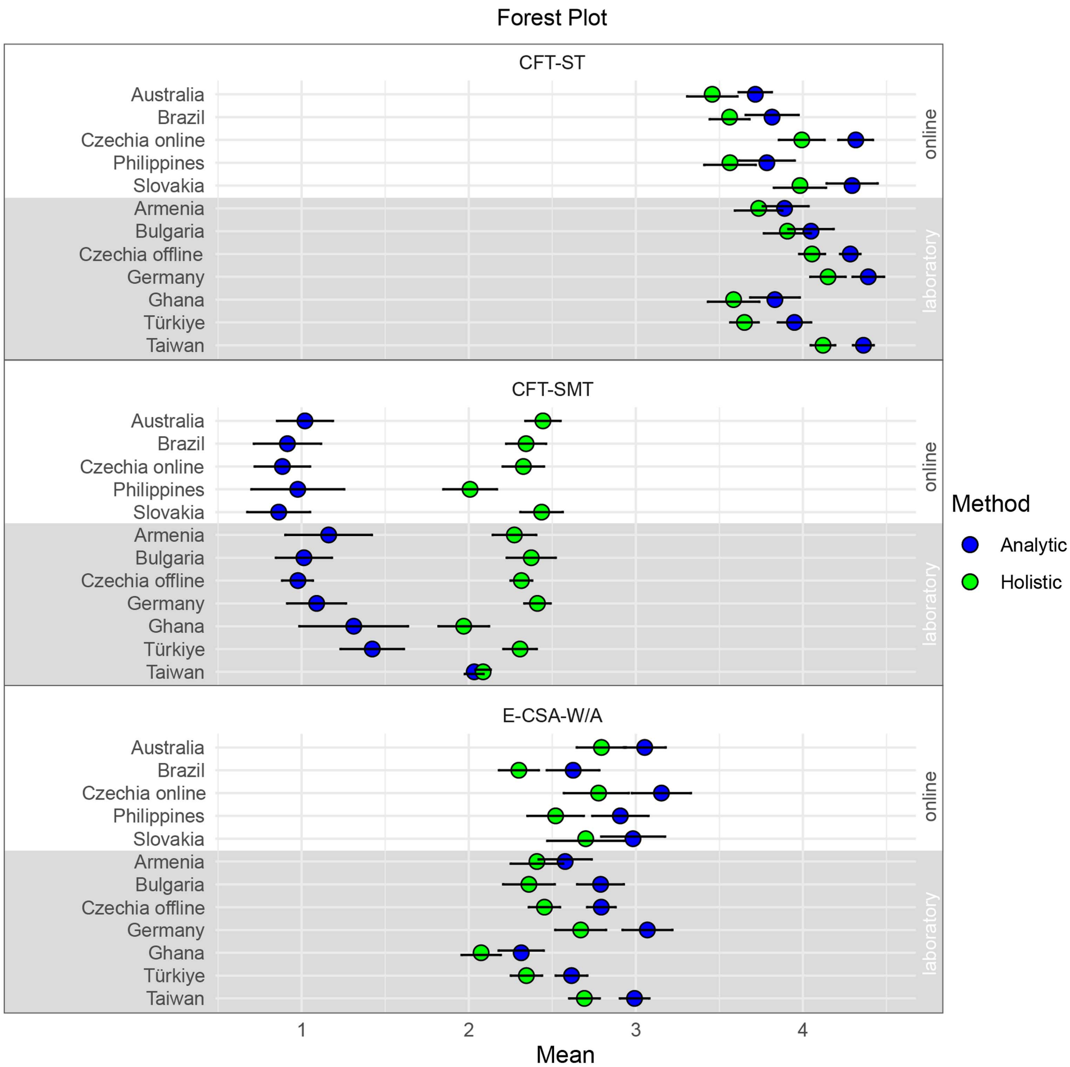
Based on the non/overlapping simultaneous CIs for multinomial proportions, it is evident that Taiwan significantly differs from the rest of the countries. The findings show that the subjects from Taiwan demonstrated either a highly flexible or balanced cognitive style, with a strong tendency toward analytic thinking (58.7% and 41.3%, respectively). The proportion of flexible subjects in Taiwan was notably higher compared to all other countries (ranging from 0.0% to 12.5%), and the proportion of balanced subjects in Taiwan exceeded that in Türkiye (23.6%) and Ghana (10.9%). In addition, Ghana displayed a lower proportion of balanced subjects compared to Czechia (35.2%). Germany was the only other country where a large proportion of participants also showed a flexible style with a tendency to analytic thinking (12.5%). However, the CIs for Germany overlapped with those of the other countries, suggesting a nonsignificant difference. For Ghana and Türkiye, a relatively high proportion of subjects demonstrated poor performance with a tendency to analytic thinking (27.3% and 17.9%, respectively), while for other countries, the proportion of this profile was much smaller (ranging from 0.0% to 9.5%). However, upon inspecting CIs, it becomes apparent that the intervals do not overlap only in the comparison of Ghana with Taiwan and Czechia. The proportions of latent profiles across the remaining countries were relatively similar, as indicated by overlapping confidence intervals. However, Taiwan stood out, demonstrating a lower proportion than all countries in the balanced style profile with a slight holistic preference and lower than most countries in the poor performance profile (specifically Australia, Brazil, Czechia, Germany, Ghana, and Slovakia).

Exploratory Analysis III: Ratios of Drift Parameters

The main findings were reexamined using a ratio of drift parameters instead of a single drift parameter for each subtest. From a total of six omnibus effects, five were not statistically significant, and of those five, three were also practically nonsignificant (for E-CSA-WA in online samples and for CFT-ST in both online and in-laboratory gathered samples). Descriptive statistics, ANOVAs, and equivalence testing are detailed in the

Figure 7

Mean of Drift Parameters and Their Confidence Intervals Across Countries



Note. Circles represent means of drift parameters, error bars represent 95% confidence intervals. CFT-ST = Compound Figure Test–Search Task; CFT-SMT = Compound Figure Test–Similarity Matching Task; E-CSA-W/A = Extended Cognitive Style Analysis–Wholistic/Analytic. See the online article for the color version of this figure.

Supplemental Tables S14 and S15. This analysis clearly indicates no cross-cultural differences in the groups, except for groups tested in the laboratory with CFT-SMT, which exhibited a significant omnibus effect with medium effect size. The groups from Ghana, Türkiye, and Taiwan displayed much higher levels of analytic thinking than the remaining groups. The Taiwan group, especially, exhibited statistically significant pairwise comparisons due to its small variance.

Exploratory Analysis IV: Country-Level Predictors

To further explore the cross-cultural data and examine the role of other cultural criteria beyond the preregistered Hofstede's Individualism Index, we used multilevel modeling. The complete results are reported in Table 7. Even though many associations were found, they usually do not align with expectations. Country-level predictors either do not predict drift parameters or are associated with both analytic and holistic subtests in the same direction, which corresponds to previously reported findings.

Higher individualistic societies, according to Hofstede's Individualism Index, showed higher analytic cognitive style (E-CSA-WA: $\beta = .26$) and higher holistic cognitive style (E-CSA-WA: $\beta = .24$; CFT-SMT: $\beta = .21$). These results are similar to those found with HDI (βs = .26, .23, and .17, respectively) and exactly opposite to those for Schwartz's embeddedness (βs = −.22, −.21, and −.21, respectively). Hofstede's long-term orientation was positively associated with both analytic (CFT-SMT: $\beta = .36$; E-CSA-WA: $\beta = .23$) and holistic cognitive style (E-CSA-WA: $\beta = .20$). Schwartz's intellectual autonomy was positively associated with both analytic (CFT-SMT: $\beta = .46$) and holistic style (CFT-

Table 4
Euclidean Distances of Observed Order From Expected Order

Country	Analytic distance	Holistic distance	Mean distance
Online			
Australia	.595	.817	.706
Brazil	.250	.540	.395
Czechia	.354	.520	.437
Philippines	.479	.777	.628
Slovakia	.323	.204	.263
In-laboratory			
Armenia	.167	.236	.201
Bulgaria	.192	.215	.204
Czechia	.500	.500	.500
Germany	.385	.948	.666
Ghana	.385	1	.693
Türkiye	.289	.136	.213
Taiwan	.727	.395	.562

Note. Distances were standardized by maximum theoretical value. Therefore, 0 corresponds to the total lack of difference, whereas 1 corresponds to the biggest possible difference.

SMT: β = .32). Inglehart–Welzel's traditional versus secular-rational values were positively associated with analytic (CFT-SMT: β = .37; E-CSA-WA: β = .17) and holistic cognitive style (CFT-SMT: β = .35). Inglehart–Welzel's survival versus self-expression values were also positively associated with both analytic (E-CSA-WA: β = .19) and holistic cognitive style (E-CSA-WA: β = .20). The cultural tightness–looseness index was positively associated with holistic (E-CSA-WA: β = .23) cognitive style, and its associations with analytic cognitive style were mixed (CFT-SMT: β = −.19; E-CSA-WA: β = .21).

Six country-level predictors were associated with only one of the subtests. Hofstede's uncertainty avoidance (CFT-SMT: β = .24) and motivation toward achievement and success (CFT-SMT: β = .28) were positively associated with holistic cognitive style, while indulgence was positively associated with analytic style (CFT-SMT: β = .31). Schwartz's hierarchy (CFT-ST: β = −.19) and egalitarianism (CFT-ST: β = −.17) were negatively associated with holistic cognitive style, and affective autonomy was negatively associated with analytic style (CFT-ST: β = −.37). The Gini coefficient was not associated with a single outcome.

Two country-level predictors showed patterns that could correspond to expectations, but only for CFT-SMT. Countries with higher power distance were more analytical (β = .16) and less holistic (β = −.12). Conversely, countries with higher WEIRDness scores exhibited less analytical (β = −.31) and more holistic cognitive style (β = .13).

Regarding the role of covariates, their effects were reanalyzed using multilevel models without country-level predictors. Neither gender nor socioeconomic status was associated with cognitive style. We found that older participants reported lower levels of holistic cognitive style (E-CSA-WA: β = −.08). CFT-SMT and CFT-ST were not associated with any measured individual characteristics.

Table 5
Spearman Correlations Across Methods Subsets

Subtest	1	2	3	4	5	6
1. E-CSA-WA Analytic	—					
2. E-CSA-WA Holistic	.647***	—				
3. CFT-ST Analytic	.202***	.162***	—			
4. CFT-ST Holistic	.177***	.128***	.381***	—		
5. CFT-SMT Analytic	.067*	.120***	.095**	.045	—	
6. CFT-SMT Holistic	.160***	.159***	.027	.010	−.521***	—

Note. E-CSA-W/A = Extended Cognitive Style Analysis–Wholistic/Analytic; CFT-ST = Compound Figure Test–Search Task; CFT-SMT = Compound Figure Test–Similarity Matching Task.
* $p < .05$. ** $p < .01$. *** $p < .001$.

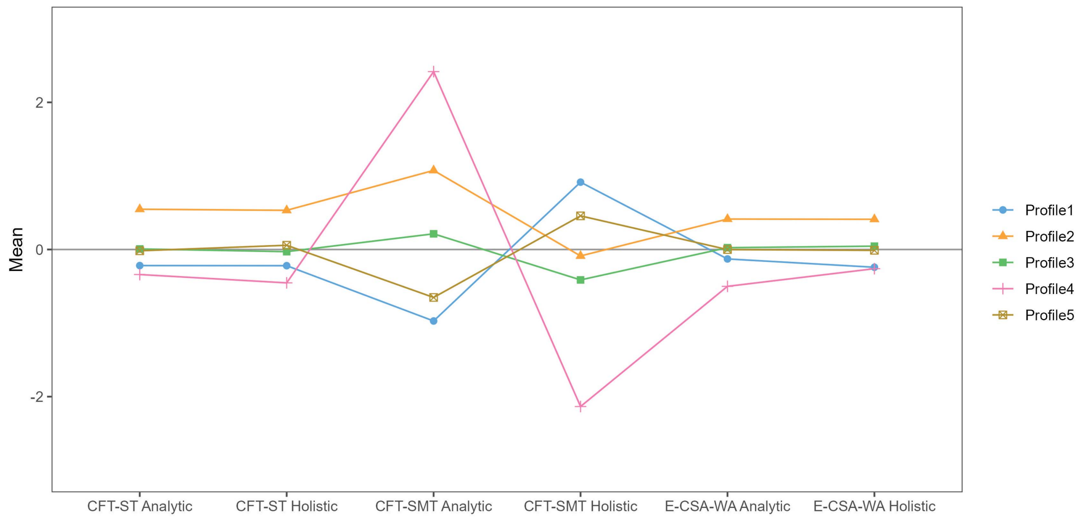
Discussion

The concept of analytic and holistic cognitive styles represents a leading theory in cognitive and cross-cultural psychology for describing the differences and similarities in the perceptual and cognitive processes of individuals from cultures around the world. However, the previous research in this area has certain limitations that must be accounted for in any analysis of cross-cultural samples. Specifically, these limitations are as follows: (a) a lack of robust comparisons of countries with differing cultures; (b) neglect of the factors behind RT and their relationship to cognitive processes; (c) insufficient exploration of the dimensionality of the analytic/holistic construct using multiple methods; and (d) uncertainty in the predictive validity of the theory. To address these limitations, we researched a large sample of subjects from a broad range of cultural backgrounds.

To verify the predictive validity of the theory, countries were compared according to drift parameters. The results for omnibus effects (H1) suggest that subjects from different countries varied in their levels of analytic/holistic cognitive style, a finding which aligns with the theory's main assumption that the effects of culture may manifest in how individuals process information (Nisbett et al., 2001). However, when a more traditional approach was applied to calculate the artificial ratio scores between analytic/holistic subtests (EA3), no cross-cultural differences were found, which leads to questions about the validity of the theory's fundamental premises. Furthermore, post hoc tests (H2) revealed that most countries deviated significantly from the expected levels of analytic/holistic cognitive style, including the Eastern (Taiwan) and Western (Australia) countries. These findings also contradict the part of the theory related to the simple perceptual processes and raise questions about its validity. Nevertheless, the findings are also consistent with some past studies that have identified nonsignificant differences, negligible effect sizes, or even opposing directions of difference (e.g., Čeněk et al., 2020; K. Evans et al., 2009; Hakim et al., 2017; Lacko et al., 2020; Rayner et al., 2007; Stachoň et al., 2019; von Mühlenen et al., 2018).

However, an alternative perspective warrants consideration. A critical inquiry arises concerning how we can assert the theory's inaccuracy when the assurance that the employed methods genuinely measure analytic and holistic cognition is lacking due to their limited predictive validity. In this article, we acknowledge two assumptions that cannot be tested in this study: (a) the existence of the construct of analytic and holistic cognition and (b) the

Figure 8
Arithmetic Means Across Latent Profiles Means

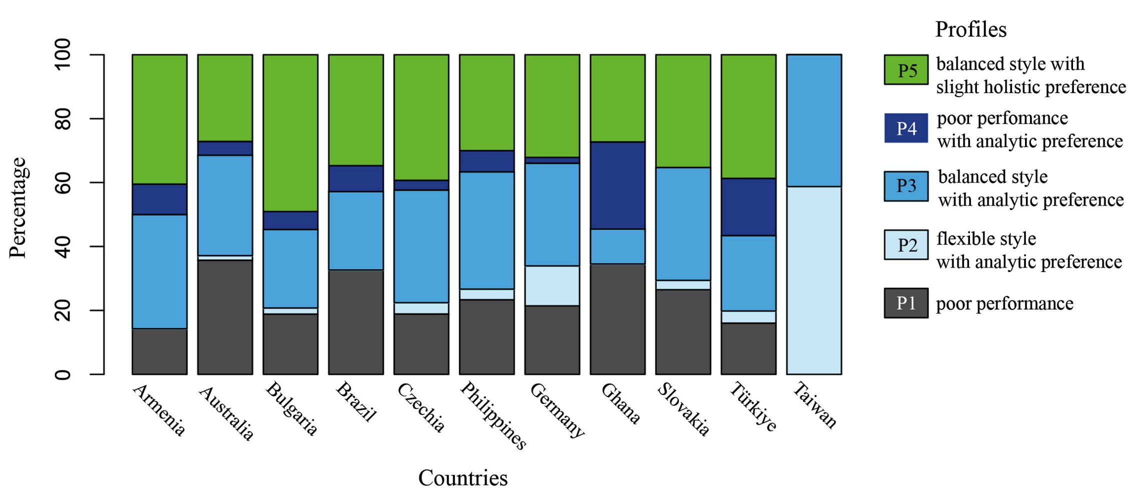


Note. For the sake of clarity, the variables were standardized before analysis (negative value suggests low level, positive value suggests high level). E-CSA-W/A = Extended Cognitive Style Analysis–Wholistic/Analytic; CFT-ST = Compound Figure Test–Search Task; CFT-SMT = Compound Figure Test–Similarity Matching Task. See the online article for the color version of this figure.

effectiveness of the simple perceptual methods in measuring them. Unfortunately, certainty eludes us on both fronts. While it is possible that the methods employed in this research ultimately failed to capture analytic and holistic cognition, making it inappropriate to interpret them against the theory, we contend that this is unlikely. These methods played a pivotal role in establishing the theory and were recognized as prominent indicators of analytic and holistic cognitive styles in previous research (Trang Hanová, 2023). The dilemma persists in the field, where those observing expected differences tend to automatically assume the validity of their measurements, neglecting the verification of psychometric properties (see Lacko et al., 2023), an approach we cannot endorse. We believe that a substantial challenge persists in this field. Even if our measurements would not accurately reflect the intended constructs, it calls for a reevaluation, refinement, and reconstruction of the conceptual foundation of hypotheses. This could be achieved through methods, such as formal modeling and machine-readable hypothesis tests, as advocated by Scheel (2022).

Since the findings of simple perceptual methods in the present study did not support the theory, an investigation of the relationship between measures (EA1) offered additional insight. Consistent with previous research (Chamberlain et al., 2017; Huygelier et al., 2018;

Figure 9
The Proportion of Latent Profiles Across Countries



Note. P = Profile. See the online article for the color version of this figure.

Table 6
95% Simultaneous Confidence Intervals for Multinomial Proportions

Country	P1: Poor performance	P2: Flexible style with analytic preference	P3: Balanced style with analytic preference	P4: Poor performance with analytic preference	P5: Balanced style with slight holistic preference
Armenia	.143 [.000, .307]	.000 [.000, .307]	.357 [.214, .521]	.095 [.000, .259]	.405 [.262, .569]
Australia	.357 [.243, .489]	.014 [.000, .146]	.314 [.200, .446]	.043 [.000, .174]	.271 [.157, .403]
Bulgaria	.189 [.057, .324]	.019 [.000, .154]	.245 [.113, .381]	.057 [.000, .192]	.491 [.358, .626]
Brazil	.327 [.204, .490]	.000 [.000, .163]	.245 [.122, .408]	.082 [.000, .245]	.347 [.224, .510]
Czechia	.189 [.117, .266]	.036 [.000, .113]	.352 [.281, .429]	.031 [.000, .108]	.393 [.321, .470]
Philippines	.233 [.067, .426]	.033 [.000, .226]	.367 [.200, .559]	.067 [.000, .259]	.300 [.133, .493]
Germany	.214 [.089, .357]	.125 [.000, .268]	.321 [.196, .465]	.018 [.000, .161]	.321 [.196, .465]
Ghana	.345 [.218, .491]	.000 [.000, .145]	.109 [.000, .255]	.273 [.145, .418]	.273 [.145, .418]
Slovakia	.265 [.118, .462]	.029 [.000, .226]	.353 [.206, .550]	.000 [.000, .197]	.353 [.206, .550]
Türkiye	.160 [.066, .261]	.038 [.000, .138]	.236 [.142, .336]	.179 [.085, .280]	.387 [.292, .487]
Taiwan	.000 [.000, .086]	.587 [.510, .674]	.413 [.336, .499]	.000 [.000, .086]	.000 [.000, .086]

Note. P = Profile.

Lacko et al., 2023; Milne & Szczerbinski, 2009; Na et al., 2010, 2020; Peterson & Deary, 2006), the associations between measures were found to be weak or statistically nonsignificant. The results therefore suggest that the two-dimensional model might not be valid (Anakwah et al., 2020; Lacko et al., 2020; Na et al., 2010; Wong et al., 2021) and does not apply to countries that do not conform to a simplistic East/West dichotomy (Uskul et al., 2023). The findings of Lacko et al. (2023), who observed a positive correlation between the analytic/holistic subtests of performance-based measures, were also verified. In our study, we observed similar correlation patterns, which undermine the entire concept of measurement as one might expect these correlations to be negative if there truly existed a continuum between analytic and holistic cognition or nonexistent if the dimensions were independent. These associations are not a statistical artifact of the RT modeling used, as they are naturally even stronger when raw RTs are employed (see OSF for a reanalysis with RTs). However, the implications of these findings extend beyond mere statistical considerations. Our results suggest that the anticipated correlations do not manifest as expected. This prompts a critical reevaluation of the theoretical foundations and calls for a more nuanced understanding of the cognitive processes at play. Consequently, the findings of the present study do not support either the original two-dimensional model or a unidimensional model.

An analysis of latent profiles (EA2), based on the work of Na et al. (2020) and exploring rigidity/flexibility as a more general cognitive style suggested by Lacko et al. (2023), identified five latent profiles. Even though the latent profile distributions differed between the subject groups, the differences did not fully align with the theory. Although one group of subjects was highly flexible and able to switch between instructions and perform well in both analytic and holistic subtests (interestingly, from Taiwan), no group of rigid subjects with a strong tendency to perform well in one subtest but poorly in the other was observed. Instead, groups comprised subjects who performed poorly generally or exhibited balanced performance in both subtests. No rigidity was observed, especially with the performance-based methods (E-CSA-W/A, CFT-ST). The flexibility/rigidity cluster is therefore not fully supported by the results presented here, and it is possible that similar methods do not measure analytic/holistic styles but instead measure some form of cognitive ability unrelated to general intelligence (Lacko et al., 2023).

In addition to previous analyses, multilevel modeling was conducted to examine the effect of country-level predictors on cognitive style (EA4). This approach aimed to provide more robust results given the numerous critiques of Hofstede's Individualism Index (e.g., Lacko et al., 2021; Oyserman et al., 2002; Schimmack et al., 2005). Despite many significant associations, most challenge the current view on analytic and holistic styles, as they were either associated with both subtests in the same direction or only with one subtest. This makes interpretation difficult because even if some associations make sense, they are often contradicted by others. None of the indicators (Hofstede dimensions, Schwartz dimensions, Inglehart–Welzel dimensions, cultural tightness–looseness index, WEIRDness score, the Gini coefficient, HDI) demonstrated a stable pattern across most subtests and measures. Only power distance and WEIRDness score showed meaningful associations, but only with CFT-SMT, a method based on preference rather than performance. Although power distance is rarely examined in analytic/holistic cognitive style research, the found associations are opposite to expectations, as higher power distance should be positively associated with holism and negatively with analytism (e.g., Lux et al., 2021). On the other hand, associations with the WEIRDness score align with theory (e.g., Talhelm et al., 2015) and prior research using similar categorization tasks based on preference (Ji et al., 2004; Norenzayan et al., 2002) since more WEIRDness countries should adopt more holistic and less analytic cognition. However, see also Klein et al. (2018), who found the opposite effect in their replication. To conclude, this analysis supports the robustness of the main findings, as none of the commonly used country-level predictors meaningfully explained variances in simple perceptual tasks of analytic and holistic cognition.

In summary, the cross-cultural differences in the simple perceptual processes displayed by people from different countries presumably exist, but they cannot be satisfactorily explained by the current analytic/holistic cognitive style theory. Exploratory approaches (e.g., examination of latent profiles, multilevel modeling with country-level predictors) might be useful for a deeper understanding of the results obtained from a range of methods, but this may also be insufficient.

As a substantial amount of prior experimental evidence spanning over 20 years of research exists, we believe that the time for conceptual considerations of the theory proposed by Nisbett et al. (2001) has come. Meta-analytical evidence about overall effect sizes

Table 7
Country-Level Predictors

Predictor	CFT-ST Analytic	CFT-ST Holistic	CFT-SMT Analytic	CFT-SMT Holistic	E-CSA-WA Analytic	E-CSA-WA Holistic
Hofstede: Individualism	.21	.20	−.08	.21***	.26**	.24**
Hofstede: Power distance	−.09	−.11	.16*	−.12*	−.13	−.10
Hofstede: Uncertainty avoidance	.16	.06	.15	.24**	−.06	−.02
Hofstede: Long-term orientation	.13	.08	.36***	<−.01	.20*	.23**
Hofstede: Indulgence	−.08	−.20	.31***	.01	−.02	.04
Hofstede: Motivation toward achievement and success	.18	.09	−.11	.28***	.11	.15
Schwartz: Harmony	.16	.14	<−.01	.18	.10	.09
Schwartz: Embedded	−.19	−.19	−.08	−.21***	−.22*	−.21*
Schwartz: Hierarchy	−.15	−.19*	.17	−.07	−.11	−.15
Schwartz: Mastery	.13	.14	.17	.08	−.08	−.06
Schwartz: Affective autonomy	−.37***	−.23	−.09	.11	.20	.19
Schwartz: Intellectual autonomy	.46**	.32*	.18	−.03	−.11	−.12
Schwartz: Egalitarianism	−.12	−.17*	−.05	−.02	−.09	−.09
Inglehart–Welzel: Traditional versus secular-rational values	.37***	.35***	.08	.14	.17*	.14
Inglehart–Welzel: Survival versus self-expression values	−.13	−.11	−.14	.05	.19*	.20*
CTL index	.12	.17	−.19***	.13	.21*	.23**
WEIRDness score	.08	.11	−.31**	.13*	.19	.21
Gini coefficient	−.18	−.18	.14	−.01	−.04	−.09
HDI	.13	.10	.12	.17*	.26**	.24**

Note. Standardized β regression coefficients are reported. In the analysis of Schwartz's dimensions, Armenia was omitted due to an unknown score. Similarly, in the analysis of the CTL index, Armenia, Brazil, Ghana, and Taiwan were omitted. For the WEIRDness score analysis, Armenia, Bulgaria, Ghana, the Philippines, and Slovakia were omitted. E-CSA-W/A = Extended Cognitive Style Analysis–Wholistic/Analytic; CFT-ST = Compound Figure Test–Search Task; CFT-SMT = Compound Figure Test–Similarity Matching Task; CTL = cultural tightness–looseness index; WEIRD = Western, Educated, Industrialized, Rich, and Democratic; HDI = Human Development Index.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

seems desirable to determine whether the findings presented in this study represent a rare deviation or are common in the field. Although the first systematic review was already conducted on 100 articles published until November 2020 (Trang Hanová, 2023), it primarily focused on measurement methods and lacked meta-analytical evidence. However, out of these 100 articles, only 48 found statistically significant cross-cultural differences, 41 reported mixed evidence (with nine studies indicating directly opposite differences), and 11 were statistically nonsignificant. Furthermore, despite the emergence of good research practices, including preregistered designs in the field (e.g., Hakim et al., 2017; Lacko et al., 2023; Leger et al., 2024; Wang et al., 2023; Wong et al., 2021), such improvements might not be enough if the theory is critically underspecified (cf. Scheel, 2022). The theory itself requires a deep theoretical reexamination and reconceptualization or should even be abandoned in favor of alternative clarifying concepts, which have greater potential to explain cross-cultural differences in cultural samples beyond the conventional East/West dichotomy.

Limitations and Future Research

The present study has some drawbacks, which should be accounted for in interpreting the presented results. First, the nonequivalence found between sampling procedures for data collected online and data collected in the laboratory data might be a consequence of the study's low statistical power. Even though an a priori power analysis was performed for ANOVA testing, equivalence testing requires a larger sample size, and this was not available (Lakens, 2017). In our study, the power of the equivalence testing was indeed low, ranging from approximately .20 to .50. It is therefore important to include differentiation between data collection online and data collection in the laboratory in any survey, plus set cultural block homogeneity with an adequate equivalence range and sufficient sample size. A similar case is also related to the LPA in which using five latent profiles calculated from six indicators might have decreased power for the estimation of mean differences that are not large (Tein et al., 2013). Furthermore, in the case of the LPA, a multilevel LPA would be a more adequate approach due to the hierarchically nested data (Mäkikangas et al., 2018). However, this was not possible as this procedure is currently implemented only in *Mplus* and not in *R*. Hence, using traditional LPA could potentially invalidate the estimates of latent profiles.

Another limitation is the use of convenience sampling on university students. Even though this may ensure sufficient homogeneity in the samples and allows an examination of the impact of cultures quasi-experimentally without high confounding effects, these samples do not represent the general population. It is probable that a replication of the present study on the general population would yield different results, and hence, the generalizability of its findings is limited. For example, another study observes that, as an effect of globalism, East Asian university students tend to adopt Western value systems such as individualism (Steele & Lynch, 2013). Therefore, future research would deepen the knowledge in this area by investigating comparisons of representative general populations.

Finally, while all three used methods targeted different perceptual and cognitive processes central to the theory and were derived from the Gestalt principles behind the most frequently used methods (Trang Hanová, 2023), they may not capture every aspect of cognitive processes that manifest from cultural influences. Conversely, they can be characterized as rather simple perceptual tasks. Hence, future work could investigate whether expected differences manifest specifically in more complex stimuli (face perception, complex scenes, videos, etc.) and intentional (visual search, categorization in maps, pathfinding, etc.) or unintentional behavior (eye movements, microbehaviors, etc).

Constraints on Generality

In accordance with the constraints on generality statement (Simons et al., 2017), we elucidate the concept of generalizability by considering participants, materials/stimuli, procedures, and historical/temporal specificity. Our study contributes valuable insights into cross-cultural variations in analytic and holistic cognition. Given that our participants were exclusively university students of relatively young age, our findings can be reasonably extrapolated to similar populations, but caution should be exercised in extending them to the general population or specific groups (e.g., children). Replicating our study with analogous populations and employing stimuli based on Navon hierarchical figures and Gottschaldt's embedded figures should yield comparable results in tasks of similar perceptual simplicity. It is important to note that our findings may not be applicable to stimuli other than those used in our study, especially more complex perceptual stimuli or self-report scales. The distinctive aspect of our methodology lies in the utilization of RT modeling with a Bayesian four-parameter shifted Wald distribution and LBA. Replicating our results using raw unprocessed RTs or alternative modeling approaches could result in unsuccessful replications. Finally, considering historical and temporal specificity, the construct under examination is anticipated to be significantly influenced by cultural factors. Consequently, the generalizability of our findings to different cultures or time periods is inherently limited.

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