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ORIGINAL ARTICLE

Cognitive functioning: is it all or none?

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Abstract
Under various circumstances, the cognitive system operates in a global manner that is not very precise and barely discriminatory. This form of operating has been described via a general principal that Diamond (Developmental Psychology 45:130–138, 2009) has denominated the All or None Hypothesis. This author has described a set of corollaries derived from this hypothesis that make it possible to verify it in each one of these domains. Although there is evidence of the global and non-discriminate way in which the cognitive system operates in populations of children, to date, there are no studies that have examined whether this mode of operation is also present in populations of adults. Researchers have yet to determine whether these corollaries apply to middle-aged adults. For this reason, this is the current study's principal objective. A sample of 73 participants with ages ranging from 18 to 57 of both genders was evaluated. A modified version of the arrows test in Davidson et al. (Neuropsychologia 44:2037–2078, 2006) was used to analyze the three corollaries. The results obtained in this study can be interpreted as evidence in favor of the corollaries analyzed herein. Furthermore, they indicate that adult populations have a global response mode that is barely differentiated and that is activated by default in the face of problems and situations that demand behaviors and/or thoughts that are not very analytical and differentiated. However, in contexts that demand greater discrimination, this global mode is substituted by a controlled mode that requires greater cognitive effort and more differentiated processing.

Introduction

Recent findings indicate that under various circumstances, the cognitive system operates in a global manner that is not very precise and barely discriminatory (see Diamond 2009). In other words, the most frequent and natural form of response—that which is activated instantly by default—is diffuse and hardly differentiated. This response pattern characterizes the Central Nervous System (CNS) during the early years of life. As the author explains, the mirror movements that are so frequently observed in children under 7 years of age reflect the significant difficulty that they have in performing a variety of tasks that require discriminate movement and coordination of their extremities. For example, in tasks that demand making one movement with one hand and simultaneously another with the other to reach for and recover an object, children cannot help, but make the same movement with both hands, thus failing the task. This observation suggests that the CNS operates at a lower level modality that exercises global and non-specific control.

Synaptogenesis, a widely researched phenomenon in the field of neuroscience, provides another example of the global and non-specific way that the CNS operates. This phenomenon refers to the spectacularly fast increase in neural connections experienced during the first 3 years of life (Blakemore and Frith 2007). Many of these connections, however, are global, non-specific, and of little use; thus, over time, the system eliminates them through the process of synaptic pruning. In this way, the process of neuronal connectivity evolves slowly and progressively from a state of lesser precision and specificity to one that is more discriminated and specific.

According to Davidson, Amso, Anderson and Diamond (2006) and Diamond (2009), the global mode—the non-specific and not very discriminatory way the CNS operates—is not only a distinctive feature of motor and sensory processing, but also of cognitive processing.

Independent of the level of analysis considered, this form of operating has been described via a general principal that

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Diamond (2009) has coined the All or None Hypothesis. In brief, the hypothesis posits that the mind, either naturally or by default, tends to act in a global and non-specific manner, and only activates more selective, discriminatory, and controlled processing when the situation calls for it. By a global and diffuse mode of operation, we mean a prepotent response that is quickly activated as a first response to any type of task, and that is present in adults as well as children. This hypothesis resembles dual process theory, which posits that we have two processing modalities to global diverse tasks: the first is quick, unconscious, and automatic (heuristic), while the second is slow, conscious, and controlled (analytic) (Frankish 2010; Saab 2011). Within this framework, Kanheman (2011) refers to two different forms of processing as Systems 1 and 2: the first operates quickly and automatically, without voluntary control, and the second is associated with voluntary and conscious forms of acting, choosing, and thinking.

As previously mentioned, this simple, fast, and initial response mode is inadequate when it comes to dealing with the situations and problems that people confront on a daily basis. Under some circumstances, it is necessary to activate a more discriminatory and specific response, which implies greater cognitive control and effort. Consequently, in these situations, one must inhibit the cognitive system's initial and dominant mode of acting, and this effort manifests itself in increased errors and greater response times (Davidson et al. 2006; Diamond 2009; Kanheman 2011). This idea can be related to current models on executive processes, which argue that inhibition is one of the principal mechanisms of executive control (Miyake and Friedman 2012; Miyake et al. 2000) along with cognitive flexibility and working memory.

One of the advantages of the All or None Hypothesis is that it helps explain a heterogeneous set of phenomena from diverse domains. With respect to the study of perception, behavior, and cognition, Diamond (2009) has described a set of corollaries derived from this hypothesis that make it possible to verify it in each one of these domains.

The first corollary establishes that when changing the rules of a task, it is always easier on the subject to change all or none (global mode) than to change some but not others. The second corollary posits that it is always easier to process all of the salient features or attributes of an object or stimulus (global mode) than only some of the properties. The third corollary states that it is easier to always inhibit a dominant response (global mode) than to do so only some of the time. The fourth corollary holds that it is easier to do the same thing with both extremities (mirror movement) (global mode) than to do different movements with each. Finally, the fifth corollary maintains that thinking of movement in a certain direction activates a prepotent tendency to move one's body in that direction (global mode) and, therefore, requires inhibition of that tendency to move in the opposite direction.

These corollaries are important, because they make it possible to test the hypothesis from which they are derived. Hence, this study seeks to provide evidence on the first three corollaries through the application of a task-change paradigm. As noted in the scientific literature (Davidson et al. 2006; Diamond 2006; Diamond and Kirkham 2005), and as Diamond (2009) explains, although there is evidence of the completed and non-discriminate way in which the cognitive system operates in populations of children, to date, there are no studies that have examined whether this mode of operation is also present in populations of adults. In other words, researchers have yet to determine whether these corollaries apply to adults with mature nervous and cognitive systems, and who are below the age of late adulthood (age of 65). For this reason, this is the current study's principal objective.

Methodology

Research design and participants

A cross-sectional, correlational, retrospective, ex post facto research design (Montero and León 2007) was used. Researchers worked with a convenience sample of 73 participants with ages ranging from 18 to 57 ($M = 30.92$; $SD = 12.61$), of which 61% were women and 39% were men, all of them residents of the City of Mar del Plata. Participation was voluntary and all of the subjects were presented with an Informed Consent form that explained the objectives of the study and described the task that would be administered. The form also assured subjects that the data would remain confidential and that the results would only be used for research purposes in accordance with National Law 25.326 on the protection of personal data and the "Guidelines on ethical conduct in the Social Sciences and Humanities" developed by the Ethics Committee of CONICET (2857-06), Argentina's National Science and Technical Research Council; CONICET's guidelines are based on the APA's code of conduct for psychologists (2002). Participants were selected using the following inclusion criterion: not have had a psychiatric, psychological, or neurological illness that could affect cognitive performance.

Adults were recruited from within the Universidad Nacional de Mar del Plata, Argentina. The task was administered individually on an HP computer with a 15.6″ monitor in a quiet place, and lasted 10 min.

Instruments

A modified version of the arrows test in Davidson et al. (2006) was used to analyze the three corollaries. The arrows test is a classic task-switching test with a high level of demand on two of the major executive control processes:

cognitive flexibility and inhibition. The indices are described below.

Test description

The arrows test (see Davidson et al. 2006) was modified and included in a computerized test battery called Tareas de Autorregulación Cognitiva (TAC) (Introzzi and Canet Juric 2012; Richard´s et al. 2017). The modified arrow test appears in the TAC under the name Tarea de los dedos (see results about the validity and reliability of this task in Introzzi, Canet Juric, Montes, Lopez and Mascarello 2015, and Richard´s et al. 2017).

The test consists of three experimental blocks presented in the following sequence: congruent, incongruent, and mixed block. Each experimental block is preceded by a practice block of eight trials distributed randomly that show and explain what the participant is expected to do. These practice blocks are the same as their corresponding experimental blocks, except that they contain fewer trials. Furthermore, participant performance on practice blocks is not used to calculate the performance indices. The experimental block (the blocks on which performance indices are measured) will not commence until the participant responds correctly on 80% of the practice block trials; if the participant does not achieve this threshold, the practice block is re-administered until this criterion is achieved.

The congruent block is the first experimental block presented; it is preceded by its corresponding practice block. In this block, a drawing of a hand with its index finger pointing straight down appears on either the right or left side of the monitor, and the participant is to hit the key corresponding to the side of the monitor in which the stimulus appears: the "Z" key for left and the "M" key for right. In other words, the participant is to hit the key that is ipsilateral to the location of the stimulus. The experimental block presents ten stimuli on the left side of the monitor and ten on the right side of the monitor; these trials are presented in a mixed, random order.

When the congruent block is global, the incongruent block follows; both the practice block and the experimental block are comprised of incongruent trials. In these trials, the drawing of the hand is presented in the extreme left or right side of the monitor, with the finger pointing diagonally (at a 45° angle) to the opposite side, and the participant is to hit the key that is contralateral to the stimulus (for example, if the stimulus appears on the left with the finger pointing to the right, the participant is to hit the "M" key). Therefore, if the hand appears in the extreme right side of the monitor with the finger pointing to the left, the participant is to hit the "Z" key, and in the inverse situation, with the hand appearing in the extreme left side of the monitor with the finger pointing go the right, the participant is to hit the "M" key. In short, the diagonally positioned hand always points to the opposite side, indicating that the participant is to hit the key that is contralateral to the location of the stimulus being presented. The practice block is comprised of 8 trials and the experimental block of 20 trials (in 10 of them, the stimulus appears on the right side of the monitor, and in the other 10, it appears on the left side). In both cases, the trials are distributed randomly.

The incongruent block is followed by the mixed block, which consists in congruent stimuli (finger pointing straight down) and incongruent stimuli (finger pointing to the opposite side). The practice block consists of four congruent and four incongruent trials (with half of the stimuli of each type appearing on the left side of the monitor and the other half on the right side). The experimental block is comprised of 40 trials, 20 of them congruent and 20 incongruent. The stimuli are distributed as follows: 20 on the right side (10 congruent and 10 incongruent) and 20 on the left side (10 congruent and 10 incongruent), such that there are an equal number in terms of location (left vs. right) and response rule (congruent vs. incongruent).

The mixed block is based on a classic task-switching paradigm, as the participant is required to quickly and efficiently alternate between two incompatible rules (indicate the same or the opposite side). For this reason, it is necessary to continually configure and reconfigure the processes and operations that are to be executed (Allport and Wylie 2000; Butler and Weywadt 2013; Crone et al. 2006; Davidson et al. 2006; Demanet et al. 2010; Monsell 2003; Monsell et al. 2001; Rogers and Monsell 1995; Terry and Sliwinski 2012; Yeung and Monsell 2003).

In all the blocks, the same sequence is repeated: first, a prompt appears (a cross) in the center of the monitor that remains there for the entire block. Then, the stimuli are presented in a sequential manner, at the same distance either to the left or to the right of the cross with an interval of 500 ms between stimuli. Each stimulus remains on the screen for 750 ms, and the participant is to emit a response in that period of time.

Based on the participants' execution in the experimental blocks, a set of the basic performance measures were obtained: (a) average percentage of correct responses; (b) average response time (RT) discriminated by trial type (congruent and incongruent); and (c) percentage of anticipatory responses (responses emitted in 200 ms or less). Anticipatory responses were excluded from the correct responses and RT analysis, because they were made too quickly to be considered as a response to the stimulus (see Davidson et al. 2006). Incorrect responses were also excluded from calculations that utilize RTs. These basic measures made it possible to calculate other indices that will be described in detail below, under a description of each of the first three corollaries.

Description and expected results for each corollary

Corollary 1 *When the rules of a task are changed, it is always easier to switch everything or nothing than to switch one thing (*e.g., *the rule or the response) but not another.*

From this statement, there are three possibilities: (a) the absence of change; (b) partial change; and (c) global change. Therefore, according to this corollary and in operative terms, possibilities (a) and (c) correspond to the global mode, which means that they should be easier than possibility (b), since the latter demands a more discriminated response that is more specific and difficult than in the other two cases. In summary, according to the All or None Hypothesis, while possibilities (a) and (c) represent the default indiscriminate global mode of acting, possibility (b) represents a more specific and discriminate functioning that consequently requires greater cognitive control and effort.

The finger task's mixed block makes it possible to obtain a set of performance indices for each of these possibilities, which makes it ideal for testing this corollary. For the absence of change—possibility (a)—the indices are the average RT and the number of correct responses in tests in which there is no change in the rule or in the response location (the only two factors that can vary in this task). In other words, when the trial repeats the same rule (congruent or incongruent) and the same response location ("Z" or "M" key) as the trial that immediately preceded it. To summarize, both indices reflect performance in trials preceded by a trial that is exactly the same, both in terms of the rule and the response location. Conversely, possibility (c) represents the inverse situation—global change. The indices in this case are the average RT and the number of correct responses in trials, where both the rule and the response location change with respect to the trial immediately preceding it. Finally, to analyze possibility (b), the following four indices are used, which collectively cover all the possibilities of partial change: (b1) Same Rule Different Location: average RT (SRDL-RT) and number of correct responses (SRDL-C) in trials with the same rule but different response locations with respect to the trial immediately preceding it; and (b2) Different Rule Same Location: average RT (DRSL-RT) and number of correct responses (DRSL-C) in trials, where the rule changes, but the response location remains the same with respect to the trial immediately preceding it.

To summarize, according to the All or None Hypothesis, the indices should show greater RTs and a lower percentage of correct responses in Partial Change situations (possibility b) relative to the other two situations (possibilities a and c).

Corollary 2 *It is easier to take into account multiple salient features of a stimulus than only one of its properties. Indeed, it is often difficult to ignore irrelevant properties of an attended stimulus.*

This corollary posits that it is easier to respond to the salient or prepotent traits of a stimulus than to its less salient traits, since the latter requires ignoring the salient traits, which implies more discriminate and specific processing.

The finger task is based in part on the Simon effect. This effect holds that human beings have a motor tendency to respond in the same location as the stimulus (Craft and Simon 1970; Hommel et al. 2004; Lu and Proctor 1995; Simon 1990; Simon and Berbaum 1990, as cited in; Davidson et al. 2006). In this task, the effect manifests itself in a marked decrease in RT and greater precision when the response is ipsilateral to the stimulus (stimulus–response congruence) compared to situations in which the response is contralateral to the stimulus (stimulus–response incongruence) (see Kornblum and Lee 1995; Simon 1990). This difference is explained by the two-stream hypothesis. This hypothesis maintains that the processing and response to relevant and irrelevant properties take place in parallel and through two streams: one fast and the other slower and controlled (see Kornblum et al. 1990). In the finger task, the relevant trait is the direction or orientation of the stimulus; this is clearly established in the instructions. In the three blocks, participants are instructed to pay attention to the direction in which the finger is pointing, as this trait indicates the response location; if the finger points diagonally, participants are to hit the key that is contralateral to the stimulus, and if the finger points straight down, they should hit the ipsilateral key. Thus, the relevant trait is the direction of the stimulus. Conversely, the irrelevant trait is whether the hand appears on the right or left side of the monitor, since the location of the stimulus does not provide information that is relevant or of interest with respect to the task the participant is to perform.

The fast stream processes and responds quickly and automatically to location due to the natural connection that exists between location and ipsilateral responses (see Simon effect). Since in congruent trials, the relevant and irrelevant traits overlap and demand the same response, it is sufficient to activate the fast processing stream, which corresponds to the global and fast processing mode. In incongruent trials, however, the relevant and irrelevant traits are in clear conflict. In these cases, while the location (irrelevant trait) corresponds strongly with the response location (for instance, left key), the direction (relevant trait) indicates that the opposite key should be hit in response (for instance, the right key). In these instances, the activation of the fast stream or global mode is insufficient, and it, therefore, becomes necessary to activate the slower stream or controlled mode to inhibit the global mode and emit a more discriminate response that corresponds to the stimulus.

Therefore, in accordance with Corollary 2, participants are expected to show shorter RTs and greater precision in trials, where the most and least salient traits require the same response location, and where the global and automatic mode is sufficient to arrive at the correct response (congruent trials) than in those that demand a discriminated and controlled response (incongruent trials).

The differences between these two situations were analyzed by comparing participant performance in: (a) the two pure blocks (congruent block vs. incongruent block) and (b) in the mixed block's congruent and incongruent trials (congruent trials vs. incongruent trials).

Corollary 3 *It is easier to always inhibit a dominant response all the time than only some of the time.*

This corollary states that although inhibition implies cognitive control and effort, it is easier to always inhibit the response than to do so only some of the time. In other words, it establishes that it is always easier to act uniformly than to act one way some of the time and another way the rest of the time. Inhibition is one of the principal mechanisms of executive control (Lehto et al. 2003; Miyake et al. 2000); it participates in those situations when it is necessary to suppress or cancel a response or prepotent tendency that interferes with achieving an objective or goal (Friedman and Miyake 2004; Nigg 2000).

In the fingers task, inhibition is involved in the purely incongruent block as well as in the mixed block, since both include incongruent trials that require the participant to inhibit the dominant or prepotent response (ipsilateral response). The fundamental difference between these blocks is the proportion of incongruent trials each presents. While 100% of the trials are incongruent in the incongruent block, only 50% are incongruent in the mixed block. This makes it possible to discriminate between the two conditions: condition (a) corresponds to the incongruent block, which requires participants to inhibit the prepotent response in all trials, while condition (b) corresponds to the mixed block, where participants are required to inhibit their responses some of the time (more specifically, in 50% of the trials). This makes it possible to compare performance under conditions, where inhibition is always required vs. when it is required only some of the time. According to the All or None Hypothesis, although inhibition is a process that requires control and effort, condition (a) constitutes a less complex and discriminate activity than condition (b), which requires inhibition in only some of the trials. This is because under condition (b), the tendency to respond must always be controlled, since the activity also includes congruent trials that require another type of response (non-inhibited trials). This should manifest itself, then, in: (a) shorter RT and greater response precision in the incongruent vs. the mixed block, and (b) shorter RT and greater response precision in mixed-block trials that are immediately preceded by a trail of the same type (congruent or incongruent) vs. those that are immediately preceded by a trail of a different type (congruent or incongruent).

Results

Prior to testing each corollary, the assumptions for the analysis of variance with repeated measures design were verified. It found the existence of: (a) independent random sampling; (b) normal sample distributions (K-S ≤ 0.05) except for some precision indices; (c) variance/covariance matrix circular (Mauchly's sphericity test, $p = 0.23$); and (d) null hypothesis on the equality of means across the conditions. Since the analysis of variance is robust with respect to both, normality and homogeneity of variance violations (Glass et al. 1972; Schmider et al. 2010), parametric tests were used to facilitate the interpretation of the results.

One advantage of computerized instruments—such as the task that was employed—is that they provide objective documentation of individual RTs, a key indicator to measure the trade-off effect. This refers to adults preferring to take more time to respond; in other words, to sacrifice speed for the sake of precision, a slower response time increases the possibility of a greater number of correct responses. This effect was corroborated as significant correlations were found ($r \geq 0.48$, $p < 0.001$) between the RTs and the number of correct responses across all three blocks: congruent, incongruent, and mixed. Furthermore, mixed-block trials had greater RTs and lower precision than incongruent-block trials, and this difference was even more marked when compared to congruent-block trials. This demonstrates the greater complexity of the mixed block, which requires a rule change.

Next, we turn to the results of the analysis to verify the three aforementioned corollaries.

Corollary 1 *When the rules of a task are changed, it is always easier to change all or none than to change some but not others.*

The results show that when the task does not require the subject to change anything—because the rule as well as the response location remains the same (absence of change)—the response is quicker and more precise than when there is a change in both the response location and rule (global change), and even more so when only the rule changes, but the response location remains the same (partial change). The tables and graphs that follow (Tables 1, 2; Figs. 1, 2) show that RT and precision indicate that change appears to be more difficult and demands greater executive control in partial change situations (condition b) than in situations of global change and where change is

Table 1 Precision under the four conditions: (1) absence of change, (2) partial change (of location), (3) partial change (of rule), and (4) global change

Condition	Mean	SD	*N*
(1) Precision same rule same location	97.70	9.72	73
(2) Precision same rule different location	96.60	9.54	73
(3) Precision different rule same location	89.30	8.40	73
(4) Precision different rule different location	94.10	12.60	73

Table 2 RTs under the different conditions: (1) absence of change, (2) partial change (of location), (3) partial change (of rule), and (4) global change

Condition		Mean	SD	*N*
(1)	RT same rule same location	517	91.53	73
(2)	RT same rule different location	600	115.86	73
(3)	RT different rule same location	654	96.78	73
(4)	RT different rule different location	605	103.07	73

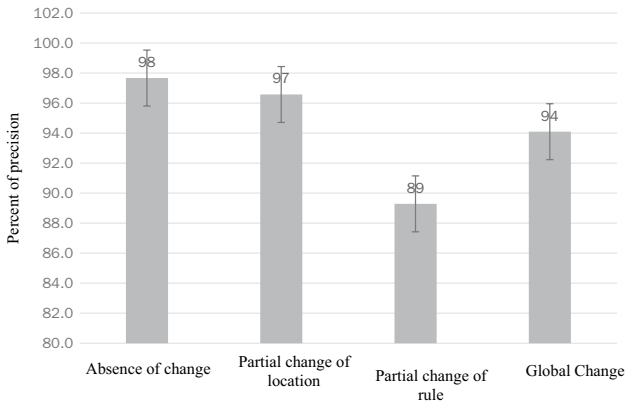

Fig. 1 Overview of change conditions: absence of change, partial change of location, partial change of rule, and global change; bars represent standard error. 95% confidence intervals

absent (conditions a and c) (RT: F (3) = 114.23, $p < 0.001$; Precision: F (3) = 20.31, $p < 0.001$). Similarly, post-hoc comparisons indicate that the DRSL condition generated greater RTs and less precision than the SRDL condition (both associated with partial change). All statistical contrasts by conditions were statistically significant ($p < .001$), except for conditions 1 and 2 (absence of change and global change). In terms of the explained within-subject variance (Eta^2), RTs contributed 61.3% and precision contributed nearly 22%. The power to detect a true difference using this test statistic, setting the Type I error at 0.05, is 100%.

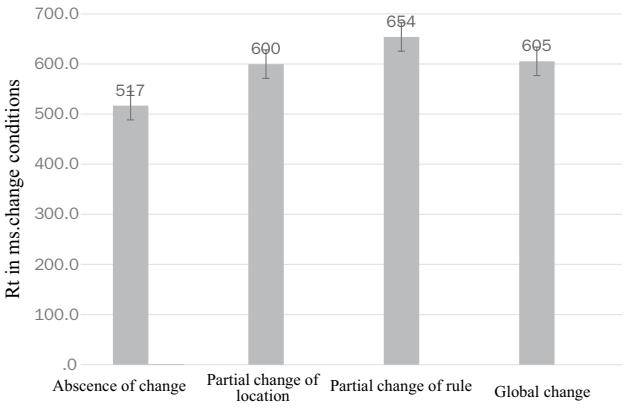

Fig. 2 Overview of RTs under the varying change conditions: absence of change, partial change of location, partial change of rule, and global change; bars represent standard error. 95% confidence intervals

Table 3 Descriptive statistics for the pure blocks (congruent and incongruent)

	Blocks	Mean	*N*	SD
Precision	Congruent	98.65	73	3.01
	Incongruent	92.97	73	10.16
RT	Congruent	375.91	73	84.22
	Incongruent	467.95	73	97.99

Table 4 Descriptive statistics for the mixed block (congruent and incongruent trials)

	Condition	Mean	*N*	SD
Precision	Incongruent trials	94.39	73	11.67
	Congruent trials	94.62	73	7.29
RT	Incongruent trials	598.57	73	107.22
	Congruent trials	582.19	73	94.88

Corollary 2 *It is easier to process all of the salient features or attributes of an object or stimulus than only some of the properties.*

The results compare participant performance in: (a) the two pure blocks (congruent block vs. incongruent block) (Table 3) and (b) the mixed block's congruent and incongruent trials (congruent trials vs. incongruent trials) (Table 4).

With respect to the verification of this corollary, the first analysis provided evidence of the expected effect: shorter average RTs ($M = 375.91$; SD = 84.22) and greater precision percentage ($M = 98.65$; SD = 3.08) in the congruent block than in the incongruent block [RT ($M = 467.95$; SD = 97.99); precision ($M = 92.97$; SD = 10.16)]. The differences were

statistically significant for both RT [$t(73) = 9.61$, $p < 0.001$] and precision [$t(73) = 5.33$, $p < 0.001$] (see Table 3).

The second analysis makes it possible to compare performance between congruent and incongruent trials in the MB (see Table 4); in other words, in the framework of a context of change, where the subject must activate inhibition some of the time and not others. The results show greater average RTs ($M = 598.57$; SD = 107.22) in the MB's incongruent trials compared to the MB's congruent trials ($M = 582.19$; SD = 94.88) (see Table 4). The difference between RTs was statistically significant for related samples [$t(73) = 3.28$; $p < 0.05$]. The difference was not statistically significant; however, for precision, [$t(73) = -1.75$; $p > 0.05$]. The absence of a significant difference for this latter index (correct responses) is common in adult populations (Wylie and Allport 2000). This is explained by the scant number of documented errors in trials with change as well as in those without change. In adult populations, RT is a more sensitive and appropriate measure to evaluate performance (Davidson et al. 2006).

Corollary 3 *It is easier to always inhibit a dominant response than to do so only some of the time.*

According to this corollary, it is expected that there will be: (a) shorter RTs and greater precision in the incongruent block compared to the mixed block and (b) shorter RTs and greater precision in trials immediately preceded by a trial of the same type (congruent or incongruent) compared to those immediately preceded by trials of a different type (congruent or incongruent) in the mixed block.

In summary, the corollary states that changing between tasks implies more discriminate and specific processing, since, as the All or None Hypothesis maintains, in some instances, the participant is to act one way and in others another way, and this demands greater executive control than always acting in the same way, given that this latter way of acting supposes more global and dominant processing.

The first analysis made it possible to compare performance between the IB, where inhibition is always required (global processing), and the MB, where inhibition is required only some of the time (specific processing). Greater RTs were found for the MB ($M = 590.18$; SD = 98.79) than for the IB ($M = 467.95$; SD = 97.99). The differences between the average RTs were significant in the direction of an increase in favor of the MB [$t(73) = 13.49$; $p < 0.001$]; however, they were not statistically significant for precision, just like for Corollary 2. The second analysis made it possible to compare performance in trials immediately preceded by a trial of the same type (congruent or incongruent) vs. trials immediately preceded by a trial of a different type (congruent or incongruent) in the mixed block. Table 5 shows the descriptive results obtained via a *t* test for related samples. It can be observed that precision is lower and the RTs are greater in trials with change compared to trials without change; thus, the expected effect was found.

Table 5 Descriptive statistics for trials with change and trials without change in the mixed block

	Condition	Mean	*N*	SD
Precision	Trials with change	30.67	73	2.93
	Trials without change	96.12	73	5.92
RT	Trials with change	630	73	108.24
	Trials without change	472	73	80.30

There were statistically significant differences in RTs—they were greater in trials with change—($t(73) = 22.05$; $p < 0.001$)—and in precision, it was lower in trials with change—($t(73) = -120.10$; $p < 0.001$).

Discussion

The All or None Hypothesis proposed by Diamond (2009) maintains, in summary, that the cognitive system operates, naturally and by default, in a manner that is global and fast, but not very precise and scarcely discriminated. According to the author, this global operating mode is present in adults as well as children, and can be tested via a set of corollaries that make it possible to verify this principle and general hypothesis. Is there a global operating mode in adults? Do Diamond's proposed corollaries hold up in adult populations? Do adults also act in an automatic and default manner that is global and not very discriminated? This study has attempted to answer these questions by using a change task that generated a set of measures that are suitable for testing the various corollaries.

Situations that demand a change in behavior or thinking create the ideal conditions for detecting this global mode of functioning. According to the All or None Hypothesis, conditions of global change or the absence of change elicit a global mode of operating, while conditions of partial change, by demanding a more specific and discriminated response, require a differentiated, precise, and controlled mode of functioning (Corollary 1).

This statement is supported by the differences found in the speed and precision of responses in experimental conditions that demand different degrees of discrimination in the response. Hence, a significant decrease in documented performance in the partial change condition suggests that in this context a more controlled and discriminated mode is operating, while a global and less specific mode is operating under the other conditions. These results may help us understand why sometimes we find it easier to execute a change that is absolute and radical rather than a subtle

change or to qualify a point of view with respect to a certain matter, or accept that someone we consider to be a good person is capable of doing something bad.

In addition, the All or None Hypothesis also applies to the field of perceptual processing. In this area, the hypothesis establishes that the global mode operates in those situations or visual processing contexts, where it is not necessary to analyze and respond to the various aspects or traits of a stimulus in a discriminated manner (Corollary 2). In these cases, the global mode of functioning is activated by default, resulting in a speedy and precise response. This study's analysis was consistent with this prediction, as a significant decrease in response time was observed under the condition that required the subject to ignore the most salient feature of the stimulus to focalize on a less salient perceptual feature or trait. This result suggests the existence of a fast, global mode of operating that can be effective when faced with stimuli that require a global and not very discriminated perceptual analysis, but that is ill suited to contexts that demand finer processing. In these latter situations, according to the All or None Hypothesis, the global mode is substituted by a more controlled mode of operating that, despite being slower and demanding more effort, is more efficient and suitable.

Finally, in the area of behavior, controlling one's conduct in a continuous manner over time may demand certain effort, but, in adults at least (Davidson et al. 2006), it does not appear to require a highly differentiated and controlled mode of functioning. According to the All or None Hypothesis, in this type of context, the activation of the global mode may be sufficient. However, discontinuous control, meaning that which is activated under some circumstances but not in others, does demand more differentiated and specific processing. In operative terms, having to always control or inhibit a dominant behavior is easier than having to do so only some of the time (Corollary 3). The analysis of this study's adult sample confirms this prediction. Controlling the prepotent tendency to always respond on the ipsilateral side in all the trials is easier than controlling the same tendency only some of the time.

To sum up, once individuals establish a thought or a response in their minds, it is easier to always continue down the same road than to go up and down this and another road various times (Davidson et al. 2006; Diamond 2009). A finding of interest, which is compatible with the aforementioned, can be noted from the results obtained in the area of thought. In this respect, it was observed that once a rule is activated, it is easier to continue applying the same rule than to change it. The decrease in response time and precision documented in trials, where change was necessary, suggest that in these cases, it is necessary to activate a more controlled and differentiated processing mode than the global mode, just as the All or None Hypothesis maintains.

In conclusion, the results obtained in this study can be interpreted as evidence in favor of the corollaries analyzed herein. Furthermore, they indicate that adult populations have a global response mode that is barely differentiated and that is activated by default in the face of problems and situations that demand behaviors and/or thoughts that are not very analytical and differentiated. However, in contexts that demand greater discrimination, this global mode is substituted by a controlled mode that requires greater cognitive effort and more differentiated processing; this is manifested in a notable decrease in response precision and/or speed. This description is compatible with the general idea expressed by Diamond (2009) in the All or None Hypothesis, which offers a simple explanation of how the cognitive system works in different contexts.

Since the corollaries refer to high-level cognitive functions such as flexibility and inhibition, which affect lower level processes and enable individuals to regulate and control their thoughts, actions, and emotions during goal-directed behavior (Chevalier et al. 2012; Friedman and Miyake 2017), we consider that their study constitutes a major topic in cognitive science. These executive "top–down" functions are necessary to carry out many everyday-life activities such as reading, driving, or even crossing the street (Chevalier et al. 2013), as well as for academic achievement, social competence, and problem behaviors (Bull et al. 2011; Fuhs and Day 2010).

Furthermore, it remains for future research to analyze and compare each response mode (global and controlled) in child and adult populations for the purpose of exploring the changes that operate in both response forms over the course of human development. Similarly, and in accordance with current models on executive processes (see review in Friedman and Miyake 2017; Miyake and Friedman 2012), it would be interesting to explore the specific contributions of cognitive flexibility, working memory, and inhibition to the controlled mode of functioning proposed in the theory.

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Compliance with ethical standards

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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