Impulsivity, Intelligence, and Discriminating Reinforcement Contingencies in a Fixed-Ratio 3 Schedule

José Héctor Lozano Bleda and Miguel Ángel Pérez Nieto

Universidad Camilo José Cela (Spain)

Research conducted in academic contexts suggests a moderating effect of impulsive behavior on the relationship between aptitude and achievement. According to these studies, intelligence scores being equal, higher levels of impulsivity have an adverse effect on achievement (Helmers, Young, & Pihl, 1995; Vigil-Colet & Morales-Vives, 2005; Zeidner, 1995). The present study aims to contrast the aforementioned moderator effect in the context of a discriminant learning task, carried out under a fixed-ratio 3 reinforcement schedule. To that end, an impulsive behavioral pattern was identified in a sample of 1,600 participants' task execution based on response rate and latency. Said pattern was consistent and stable across several trials and can be ascribed to subjects' interactive style (Hernández, 2000). The observed interaction effect supports the hypothesis that impulsivity has a moderating effect on the aptitude-achievement relationship, highlighting how it impacts achievement differentially depending on the subject's level of aptitude.
Keywords: impulsivity, intelligence, learning, discrimination.

Estudios relativos a contextos académicos sugieren un efecto moderador del comportamiento impulsivo sobre la relación entre aptitud y rendimiento. De acuerdo con estos trabajos, a igualdad de valores de inteligencia, una mayor impulsividad iría en perjuicio del aprendizaje (Helmers, Young, & Pihl, 1995; Vigil-Colet & Morales-Vives, 2005; Zeidner, 1995). El presente trabajo tiene por objeto contrastar dicho efecto moderador en el contexto de una tarea de aprendizaje discriminativo bajo un programa de reforzamiento razón fija 3. A tal fin, se ha identificado un patrón de comportamiento impulsivo en la ejecución de una muestra de 1,600 participantes con base en indicadores comportamentales de tasa y latencia de respuesta. El patrón de comportamiento identificado permite ser atribuido al estilo interactivo de los individuos, mostrando consistencia y estabilidad a lo largo de diferentes ensayos (Hernández, 2000). El efecto de interacción observado viene a respaldar la hipótesis de un efecto moderador de la impulsividad en la relación aptitud-rendimiento, poniendo a su vez de manifiesto cómo la impulsividad afecta al rendimiento de manera diferencial, en virtud del nivel aptitudinal que presentan los individuos.
Palabras clave: impulsividad, inteligencia, aprendizaje, discriminación.

Impulsivity has been defined as the "predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individual or to others" (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001, p. 1784), emphasizing the rapid, unplanned nature of impulsive behavior. Numerous studies have demonstrated the relationship between impulsivity and learning disabilities (Bolster, Marshall, Bow, & Chalmers, 1986; Brown & Wynne, 1984; Gilger, Eliason, & Richman, 1989; Kavale & Forness, 1996; Nagle & Thwaite, 1979; Routh, 1979; Sigg & Gargiulo, 1980; Tarver & Hallahan, 1974). The relationship between impulsivity and intelligence, on the other hand, is less apparent. While some researchers have reported low, negative correlations between impulsivity and IQ (Lynam, Moffitt, & Stouthamer-Loeber, 1993), and between impulsivity and reasoning ability (Schweizer, 2002), this relationship is certainly not entirely univocal. For example, Miller, Flory, Lynam, and Leukefeld (2003) did not observe a significant relationship between impulsivity and verbal or performance IQ. Similarly, Phillips and Rabbit (1995) maintain that impulsivity is positively correlated with intelligence when it is assessed by simple questions that ought to be responded to quickly; in such a situation, responding with haste and without checking one's answers could actually be advantageous. Those assertions bring to mind Dickman's distinction between functional and dysfunctional impulsivity (Dickman, 1990). According to him, *functional impulsivity* implies rapid decision-making under circumstances where working that way may be advantageous, while *dysfunctional impulsivity* refers to hasty decision-making lacking in reflection, which hurts performance.

Studies on academic achievement have suggested a moderating effect of impulsivity on the intelligence-learning relationship, such that if intelligence scores are equal, increased impulsivity is detrimental to learning (Helmers et al., 1995; Vigil-Colet & Morales-Vives, 2005; Zeidner, 1995). These results have been interpreted by some authors within the framework of R. B. Cattell's investment theory (Cattell, 1987), according to which personality influences the way individuals invest their resources, thereby moderating the relationship between intelligence and achievement (see Vigil-Colet & Morales-Vives, 2005). Investment theory is also a good basis for explaining why personality dimensions are more closely related to crystallized intelligence than to fluid intelligence (Ashton, Lee, Vernon, & Lang, 2000; Goff & Ackerman, 1992; Jensen, 1998), since they are expected to affect achievement more than they affect aptitude. Nevertheless, authors constantly state the need for a greater volume of research geared toward elucidating the relationship between intelligence, impulsivity, and achievement. That we know of, the above results have not been replicated under experimental conditions, applying learning assessment tasks.

From our point of view, studying the interaction between intelligence and impulsivity on achievement lends itself to analysis from an interbehavioral perspective. That way, one could explain the joint influence of competence and personality on a single behavior, based on the contextual characteristics under which that behavior occurs (Santacreu, Hernández, Adarraga, & Márquez, 2002; Santacreu, Rubio, & Hernández, 2004). On the one hand, *competence* refers to the individual's efficacy at carrying out an action. In this case in particular, context determines which among a set of possible behaviors is most appropriate given the reinforcement contingencies at work. One is able or unable to carry out said behavior by virtue of his or her competence. *Personality* or *interactive style*, on the other hand, refers to the personal, idiosyncratic manner with which one executes actions (Hernández, 2000). Personality, in that sense, manifests itself under circumstances where situational reinforcement contingencies remain relatively open with respect to one's *manner* of behaving, that is, circumstances under which it is possible to behave in different manners, each with an equal probability of efficacy. The individual opting for one manner of behavior or another, then, is explained by his or her personality.

From that perspective, an appropriate context in which to judge the relationship between impulsivity and achievement would require subjects to execute a task wherein programmed reinforcement contingencies determine the most effective behavior. In that case, impulsivity would manifest itself in the particular *manner* in which individuals behave, in terms of the level of rapidness and planning shown in their response. In light of the above, the task should not impose time limits or temporal criteria on goodness of execution, so as to keep contingencies from being closed and preserve behavioral variability.

If exhibiting a higher or lower level of impulsivity does not bring about differences in achievement (no relationship), reinforcement contingencies would be totally open to impulsive behavior, and any observed between-subjects variability in execution rapidness and planning could be completely attributed to interactive style, that is, personality. If, however, increased impulsivity either facilitates or worsens achievement (relationship), in other words, if reinforcement contingencies are not entirely open to impulsivity, then interpreting that behavior would take on new subtlety. For example, if achievement is lowered by rapid, unplanned response (which seems to be the case in academic contexts), then when individuals behave impulsively *despite* reinforcement contingencies, that behavior can only be explained by personality (*impulsive* interactive style). Conversely, when an individual's behavior is reflective, *supported* by reinforcement contingencies, it would be impossible to discern which of the two, reinforcement contingencies or personality, is the basis for behavior. In this case, subjects could very well be adapting their behavior to the situational reinforcement contingencies at hand, independently of interactive style. Note that if impulsivity were to favor achievement, the reverse would

occur. Finally, if the aim is to analyze the possible interaction between intelligence and impulsivity on achievement, performance on the task should demonstrably correlate with measures of intelligence.

According to the definition provided at the start of the introduction (Moeller et al., 2001), response latency and response rate should constitute adequate behavioral measures of planning and quickness of execution, respectively. A brief interval between the time the stimulus is presented, configuring the task's context, and when the subject emits his or her first response, could be considered an indicator of reaction rapidness and absence of behavioral planning. On the other hand, a high response rate could also be interpreted to indicate rapid task execution. If this is true, it follows that individuals with short response latencies would also be expected to have high response rates, and vice versa. Please note that these proposed impulsivity measures are not related *a priori* with effective performance (e.g. error frequency or rate). That relationship will need to be verified empirically.

Based on the considerations above, the present study's objective is to analyze the possible interaction between intelligence and impulsivity on achievement in the context of a reinforcement contingencies discrimination task, the *Flag Test* (Santacreu, 2004), in due compliance with the following requirements: a) it presents a behavioral criterion for goodness of execution (in terms of reinforcement, one behavior is more effective than all others); b) it does not impose time limits or temporal criteria on goodness of execution; c) it allows us to examine measures of response latency and rate; and d) achievement on the task demonstrably correlates with a measure of general intelligence (Lozano, Hernández, Rubio, & Santacreu, 2011). Thus, if achievement is worsened by rapid execution without reflection, as in academic contexts, then the context will be deemed appropriate to assess the interaction we aim to analyze.

Based on previous studies, and taking Cattell's investment theory as a point of reference, it seems prudent to assume that if achievement on the task requires that some degree of intelligence be invested, impulsive execution will not affect individuals who differ in level of ability equally. Therefore, we expect impulsivity to differentially affect achievement, worsening it to a greater extent in subjects with lower aptitudes.

Method

Participants

The sample analyzed consists of 1,600 participants, 505 women (31.6%) and 1,095 men (68.4%). The women ranged in age from 21 to 43 years-old ($M = 27.99$; $SD = 3.40$) and the men from 21 to 52 ($M = 29.14$; $SD = 3.74$). Participants were hoping to take part in an air traffic control training course, and all held a college degree.

Materials

Tests were administered in an environment called SIDEP (*Sistema informatizado de evaluación psicológica*; Santacreu, 2007) (*Computerized System for Psychological Evaluation*) that was employed during data collection and management. Each individual had a computer terminal (PC compatible) equipped with a 17'' Phillips 107-s monitor. Participants were prevented from observing each other's execution by the way the room was set-up, and the filter installed in each monitor's screen. The tasks utilized are described below.

Flag Test to Assess Discriminant Learning and Persistence (Santacreu, 2004): This test displays a set of nine buttons on the screen (80 × 80 pixels each), organized into a square shape (three rows by three columns). Each button displays a drawing of a flag within; ergo, the buttons as stimuli have two different dimensions: *position* and *flag*. The objective lies in pushing the buttons until a «*Correct*» message appears on the screen, at which point the next trial begins. Specifically, subjects are instructed to obtain the correct message by pressing as few buttons as possible.

The test, then, consists of a discriminant learning task with reinforcement contingencies in which the individual must learn over the course of 10 trials, to press a certain flag (S^D) (target flag) three times (B) in order to yield the correct message (R^+). The button pushes do not necessarily have to be consecutive, which is why the sequence of pushes leading to a hit, and therefore execution time, may vary from trial to trial and subject to subject.

The target flag is randomly chosen by the program from among nine flags available when execution begins; it differs across subjects. The flags' positions within the set change randomly from one trial to the next. The target flag, however, remains the target throughout all trials. For that reason, the sequence of button pushes leading to a hit is the same for the duration of the task's execution. Ten trials were used in this study, with no time limitation. At the methodological level, this is considered a *discrete trial* procedure, in which subjects are administered a *fixed ratio* 3 (*FR-3*) reinforcement schedule.

The present study utilized the following indicators from the *Flag Test*:

Proportion of button pushes on the target flag (PPT_n): The quotient of the number of pushes on the target flag to the number of total pushes during trial n (the theoretical range admits values from 0 to 1). This is considered a measure of achievement at discriminating reinforcement contingencies.

Response Latency (LAT_n): The time that passes (measured in milliseconds) during trial n from the start of the trial until a button is first pressed. This constitutes an indicator of response rapidness and lack of behavioral planning.

Response Rate (RR_n): The number of button pushes per second during trial n. This is considered to measure rapidness of execution. It is worth mentioning that when taking the quotient of this index, we take the number of

seconds that pass from when the first button push takes place until the end of the trial. That way, the time interval does not include response latency, so as to avoid over-estimating the relationship between LAT_n and RR_n.

Task Execution Duration (DUR): The sum of the time passed (measured in seconds) from the start of each trial to its end, for all ten trials. This can be considered an indicator of time invested in executing the task. Note, however, that this index does not measure achievement, because the task does not impose any time criteria on goodness of execution.

TRASI (*Test adaptativo informatizado para la evaluación del razonamiento secuencial y la inducción como factores de la habilidad intelectual general*; Rubio & Santacreu, 2003) (*Adaptive, Computerized Test to Assess Sequential Reasoning and Induction as Factors of General Intellectual Ability*): This test is made up of 30 items, each of which presents a series of four elements that must be completed with a fifth, selecting from four response alternatives. Each element presents a complex, geometric figure comprised of sub-elements to which a logical or mathematical rule must be applied to determine the series' progression. Each item has a maximum completion time of 3 minutes. The test's internal consistency Cronbach's alpha is .84. The data on test-retest reliability fall between .598 and .649, and its criterion validity is .785 according to Cattell's *G Factor Test*, and .75 according to Raven's *Advanced Progressive Matrices Test*

The indicator employed from the *TRASI*:

General Intelligence (GI): Number of items correctly responded to (the theoretical range admits values between 0 and 30). This constitutes a measure of general intelligence.

Procedure

Administering these tests was part of a selection process for a training course for air traffic controllers. Participants completed a battery of computerized tests individually that included different instruments to assess personality and cognitive abilities. The tests required for this study were among the ones given. The assessment lasted approximately 3 hours (including a 15-minute break in the middle) and during that time, no communication was allowed between participants. The average duration of task execution was 5 minutes for the *Flag Test* and 49 minutes for the TRASI.

Results

Descriptive Analysis

Regarding descriptive statistics (Table 1), there was a high variability in scores according to all indicators analyzed.
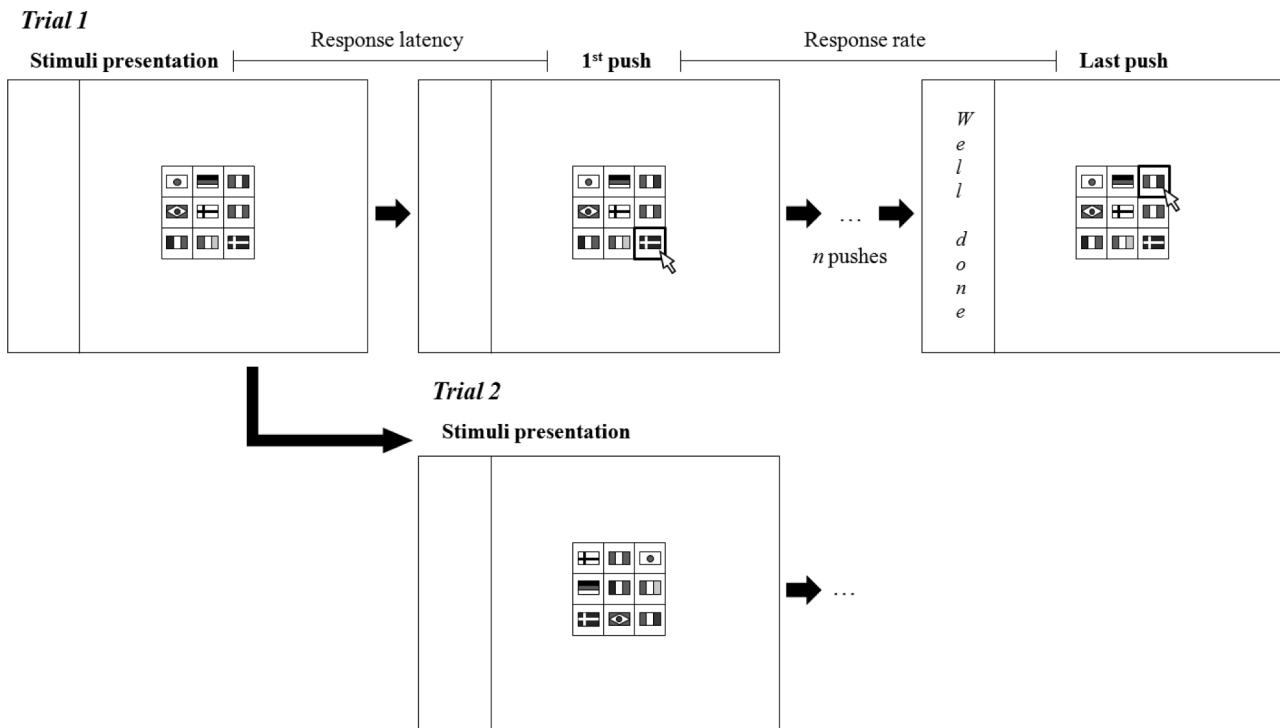

Figure 1. Task Execution Sequence in the Flag Test.

Table 1

Descriptive Statistics for the Variables Average Proportion of Button Pushes on the Target Flag (PPT), Task Execution Duration (DUR), Average Response Latency (LAT), Average Response Rate (RR) and General Intelligence (GI)

	M	SD	Min	Max	Asymmetry	SE	Kurtosis	SE
PPT	.217	.164	.06	.94	2.526	.061	6.237	.122
DUR	152.879	72.205	24.29	718.43	1.831	.061	6.291	.122
LAT	1722.280	1271.377	388.50	10179.60	2.778	.061	10.790	.122
RR	1.885	.526	.40	3.93	.109	.061	.341	.122
GI	15.94	3.679	5	27	−.007	.061	−.294	.122

Table 2

Matrix of Correlations for the Variables General Intelligence (GI), Average Proportion of Button Pushes on the Target Flag (PPT), Task Execution Duration (DUR), Average Response Latency (LAT), and Average Response Rate (RR)

	1	2	3	4	5
1. GI		.139***	−.114***	−.043	.094***
2. PPT			−.394***	.043	−.021
3. DUR				.633***	−.670***
4. LAT					−.597***
5. RR					

* $p < .05$; ** $p < .01$; *** $p < .0005$

Correlation Analysis

The matrix of correlations between the various indicators (Table 2) conveys a high, negative correlation between the indices *LAT* and *RR* (r_{xy} = -.597; $p < .0005$), such that long response latencies are associated with low response rates and vice versa. The intelligence index, meanwhile, exhibited significant correlations with *PPT*, *DUR*, and *RR*, but not *LAT*.

Analysis of the Stability and Consistency of Response Latency and Rate

Though a one-way repeated-measures ANOVA indicated response latencies were not stable across trials [λ = .939; $F(9, 1, 591) = 11.438$; $p < .0005$; $\eta^2 = .061$], a pairwise comparison analysis revealed that values stabilized after the sixth trial ($p > .05$). The split-half procedure ($r_{xx'}$ = .870) and Cronbach's *Alpha* statistic ($\alpha = .846$) yielded high values of internal consistency for the latency measures.

As for response rates' progression, the one-way repeated-measures ANOVA indicated they were not stable [λ = .887; $F(9, 1, 591) = 22.537$; $p < .0005$; $\eta^2 = .113$]. Nevertheless, the pairwise comparison revealed that scores stabilized after the third trial ($p > .05$). The split-half procedure ($r_{xx'}$ = .974) and Cronbach's *Alpha* statistic ($\alpha = .957$) showed the measures of *RR* to have high values of internal consistency.

Analysis of the Pattern of Response Latency and Rate

Toward the aim of classifying participants into different groups as a function of their response latencies and rates,

a two-step cluster analysis was performed using the variables *LAT* and *RR* corresponding to the ten trials. The results of this analysis, based on Schwarz's Bayesian information criterion (*BIC* = 16422.738; Δ*BIC* = -6043.081; *Ratio of change in BIC* = 1.000; *Ratio of distance measures* = 2.944), suggest participants be grouped into two clusters: C_1: $n = 572$ (35.75%) and C_2: $n = 1,028$ (64.25%). The first cluster's response rates were below the mean and their response latencies above the mean on each one of the trials, response rate turning out to be more important to the cluster's formation. The opposite occurred for the second cluster, which exhibited response latencies below the mean and response rates above the mean for each trial, response latencies being more relevant to the cluster's formation. All variables included in the analysis contributed to the formation of the two clusters.

The results of the *t*-test suggest the two clusters differed significantly in the variables *LAT* and *RR* on each trial ($p < .0005$). Observing Figure 2, it becomes apparent that the first cluster exhibited significantly higher response latencies and significantly lower response rates than the second cluster on all trials. In light of these results, we can henceforth refer to the two as the low (IMP_{Low}) and high impulsivity (IMP_{High}) clusters, respectively.

A one-way repeated-measures ANOVA indicates latency was not stable in either cluster: IMP_{Low} [$F(9, 1, 590) = 11.192$; $p < .0005$; $\eta^2 = .060$; IMP_{High} $F(9, 1, 590) = 3.850$; $p < .0005$; $\eta^2 = .021$]. However, a pairwise comparison reveals that latency stabilized after the sixth trial ($p > .05$) in the IMP_{Low} cluster, and after the third in the IMP_{High} cluster ($p > .05$).
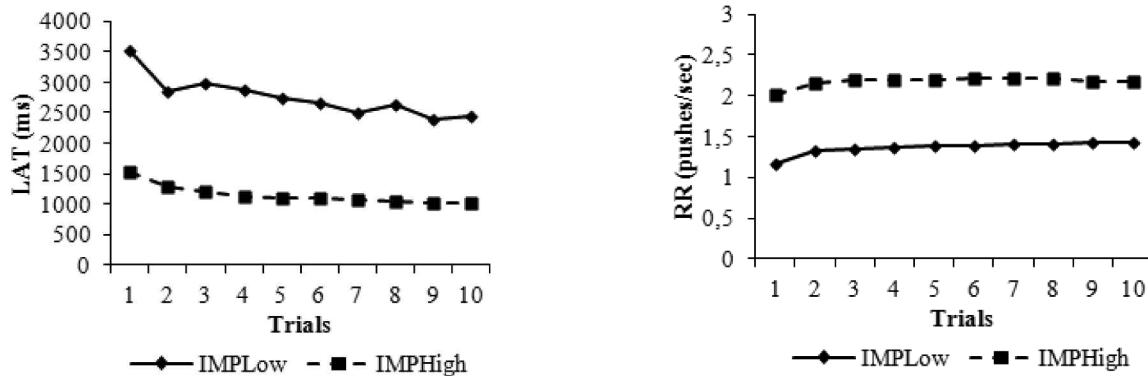
Figure 2. Progression of Response Latency (LAT) and Response Rate (RR) by Trial in the Low (IMP$_{Low}$) and High (IMP$_{High}$) Impulsivity Clusters.

Similarly, significant differences in response rate were observed over the course of the trials in both clusters: IMP_{Low} [$F(9, 1, 590) = 14.038$; $p < .0005$; $\eta^2 = .074$; IMP_{High} $F(9, 1, 590) = 11.577$; $p < .0005$; $\eta^2 = .061$]. Nevertheless, the findings of a pairwise comparison analysis convey that measures stabilized after the fourth trial ($p > .05$) in the IMP_{Low} cluster, and after the second in the IMP_{High} cluster ($p > .05$).

It is also noteworthy that the two clusters differed significantly in the time they dedicated to performing the task [$t(718.455) = 20.164$; $p < .0005$; Cohen's $d = 1.052$], the IMP_{High} cluster having a lower task execution duration [IMP_{Low}: $M = 202.952$, $SD = 87.087$; IMP_{High}: $M = 125.017$, $SD = 41.558$].

Analysis of the Interaction between Intelligence and Impulsivity on Achievement

With the objective of analyzing the possible effect on achievement of the interaction between intelligence and impulsivity, we first proceeded to divide the sample into two intelligence groups. To do so, the median of the *GI* variable was used as a cut-off point (*Mdn* = 16), creating two groups: GI_{Low} ($n = 900$; 56.3%; $M = 13.31$; $SD = 2.261$) and GI_{High} ($n = 700$; 43.8%; $M = 19.32$; $SD = 2.014$). The *t*-test conveys that the two groups differed significantly in terms of achievement *PPT* [$t(1295.591) = -2.915$; $p < .01$; Cohen's $d = -.147$], the GI_{High} group exhibiting higher achievement [GI_{Low}: $M = .206$, $SD = .145$; GI_{High}: $M = .231$, $SD = .185$].

Next, a factorial ANOVA was performed using *intelligence group* and *impulsivity group* as factors, and average *PPT* as the dependent variable. The results show that *intelligence group* had a significant effect [$F(1, 1, 596) = 5.329$; $p < .05$; $\eta^2 = .003$], *impulsivity group* had a marginally significant effect [$F(1, 1, 596) = 3.320$; $p = .069$; $\eta^2 = .002$], and *intelligence group* × *impulsivity group* had a significant interaction effect [$F(1, 1, 596) = 4.768$; $p < .05$; $\eta^2 = .003$]. A simple effects analysis reveals
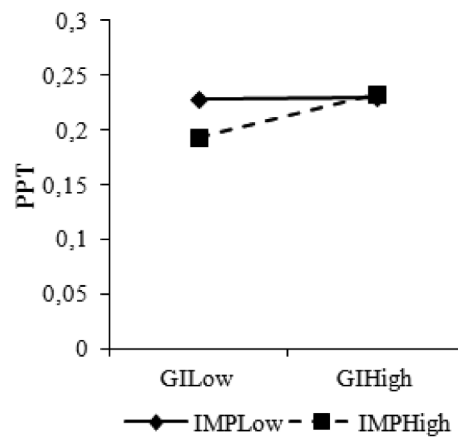

Figure 3. Average Proportions of Button Pushes on the Target Flag (PPT) in the Low (GI$_{Low}$) and High (GI$_{High}$) Intelligence Clusters, and the Low (IMP$_{Low}$) and High (IMP$_{High}$) Impulsivity Clusters.

significant differences between the levels of the *intelligence group* factor only within the IMP_{High} level of the *impulsivity group* factor ($p < .0005$), those differences favoring the GI_{High} group. In addition, significant differences between the levels of the *impulsivity group* factor were only found within the GI_{Low} level of the *intelligence group* factor ($p < .01$), those differences favoring the IMP_{Low} group (Figure 3).

Discussion

The results of the present study have allowed us to identify: a) certain individuals' impulsive interactive style during task execution, and b) the moderating effect that impulsivity has on the aptitude-achievement relationship. First of all, in light of the distribution of *LAT* and *RR* scores, we may assert that the *Flag Test* is an appropriate context in which to examine behavioral variation in terms of both execution velocity and response latency. Meanwhile, the

measures of response latency and rate used were found to exhibit high values of reliability and internal consistency. As could be expected when considering those two indices as indicators of impulsivity, a high, negative correlation was observed between them, such that high values of latency are associated with low response rates and vice versa. On the other hand, a cluster analysis suggested a two-cluster solution was most fitting, each cluster being characterized by a singular, relatively stable behavioral pattern. The analyses performed allowed us to conclude that participants grouped into the first cluster exhibited high latencies and low response rates (IMP_{Low}), and those grouped into the second, low latencies and high response rates (IMP_{High}). The differences observed in the pattern that relates response latency and rate for each cluster seems to adhere to what could be labeled an *impulsive* interactive style, which could be defined as the *tendency to respond with haste and rapidness to the presentation of stimuli*. In accordance with the established requirements (Santacreu et al., 2002), the behavioral pattern observed reflected wide behavioral variability as well as an acceptable level of stability from one trial to the next. That being said, the IMP_{Low} cluster's response latencies and rates were more stable.

Regarding the relationship between intelligence and impulsivity, our results suggest the interaction between the two had a significant effect on achievement, such that greater impulsivity was to the detriment of achievement only in individuals with lower intelligence scores. These results are along the lines of those reported by Vigil-Colet and Morales-Vives (2005) about academic contexts, in which impulsivity was found to moderate the intelligence-learning relationship. These findings lend themselves to an interpretation based on R. B. Cattell's investment theory, according to which it makes sense that the achievement of individuals with fewer resources is affected to a greater extent by the effect of impulsive behavior. An explanation for our results may well lie in the fact that individuals with high intelligence scores need less time to carry out discrimination, such that among people with a high level of intelligence, the achievement of those with an *impulsive* style is not lower than those with an *unimpulsive* style.

The two clusters' differences in achievement demonstrate a certain closure of contingencies that prevents us from judging the interactive style of subjects who exhibit an *unimpulsive* pattern. Those participants may have adjusted their behavior to contextual requirements, given that impulsive behavior seems to be penalized here by the reinforcement contingencies. However, there is no doubt about the *impulsive* style of participants who behave impulsively. Insofar as said behavior takes place *despite* the reinforcement contingencies, it can only be explained by the individual's interactive history. In that vein, it makes sense that the IMP_{High} cluster exhibited more behavioral stability; their behavior is explained by a consistent, stable

style of interaction with the environment (Hernández, 2000). Conversely, the heightened instability of the IMP_{Low} cluster during the first few trials could be attributed to a process of adjusting one's behavior to the reinforcement contingencies at hand.

In any case, it is important to clarify that the differences observed here can only be attributed to the context of the particular task we employed. In that sense, animal research suggests impulsivity worsens achievement only on complex tasks requiring one to process a considerable amount of information. On simple tasks, on the other hand, which pose limited demands to processing and require simple, rapid answers, high impulsivity facilitates achievement (Bizot & Thiébot, 1996). There are reasons both conceptual and empirical to suggest those results may extend to human beings. In that vein, Humphreys and Revelle (1984) suggest impulsivity influences arousal, which would allow for increased execution speed on simple cognitive tasks, without necessarily increasing the number of errors. Dickman's (1990) findings point in the same direction by showing how much functional impulsivity was demonstrated to positively correlate with achievement on tasks requiring few cognitive demands. It would be interesting, therefore, to direct further research toward studying the contextual characteristics that determine the direction of impulsivity's influence on achievement, and the role of intelligence in that relationship. To our understanding, the interbehavioral model makes for an appropriate theoretical framework in which to study these characteristics.

Lastly, it is important to point out that the effect size of the interaction analyzed was especially low ($\eta^2 = .003$). Nevertheless, that result may have been influenced by the low percentage of variance in achievement explained by variance in intelligence (.3%). However, the interaction effect did turn out to be statistically significant, thereby supporting our hypotheses, which we made based on theory and results obtained in academic contexts (Helmers et al., 1995; Vigil-Colet & Morales-Vives, 2005; Zeidner, 1995). In light of the above, and given the absence of data from experimental contexts, we believe the results obtained constitute a strong incentive to focus a greater volume of research on this, and other types of learning tasks that even more so require investment of intelligence.

References.

Ashton, M. C., Lee, K., Vernon, P. A., & Lang, K. L. (2000). Fluid intelligence, crystallized intelligence, and the openness/intellect factor. *Journal of Research in Personality*, *34*, 198–207. http://dx.doi.org/10.1006/jrpe.1999.2276

Bizot, J. C., & Thiébot, M. H. (1996). Impulsivity as a confounding factor in certain animal tests of cognitive function. *Cognitive Brain Research*, *3*, 243–250. http://dx.doi.org/10.1016/0926-6410(96)00010-9

Bolster, B., Marshall, W., Bow, J., & Chalmers, N. (1986). Visual selective attention and impulsivity in learning-disabled children. *Developmental Neuropsychology*, *2*, 25–40. http://dx.doi.org/10.1080/87565648609540325

Brown, R. T., & Wynne, M. A. (1984). Attentional characteristics and teachers ratings in hyperactive, reading disabled, and normal boys. *Journal of Clinical Child Psychology*, *13*, 38–43. http://dx.doi.org/10.1080/15374418409533167

Cattell, R. B. (1987). *Intelligence: Its structure, growth and action.* New York, NY: North-Holland.

Dickman, S. J. (1990). Functional and dysfunctional impulsivity: Personality and cognitive correlates. *Journal of Personality and Social Psychology*, *58*, 95–102. http://dx.doi.org/10.1037//0022-3514.58.1.95

Gilger, J., Eliason, M., & Richman, C. (1989). A comparison of cognitive and behavioral patterns in learning-disabled children: Subtype and sex differences. *Developmental Neuropsychology*, *5*, 227–243. http://dx.doi.org/10.1080/87565648909540434

Goff, M., & Ackerman, P. L. (1992). Personality-intelligence relations: Assessment of typical intellectual engagement. *Journal of Educational Psychology*, *84*, 537–522. http://dx.doi.org/10.1037//0022-0663.84.4.537

Helmers, K. F., Young, S. N., & Pihl, R. O. (1995). Assessment of measures of impulsivity in healthy male volunteers. *Personality and Individual Differences*, *19*, 927–935. http://dx.doi.org/10.1016/S0191-8869(95)00107-7

Hernández, J. M. (2000). *La personalidad: Elementos para su estudio* [Personality: Elements of its study]. Madrid, Spain: Biblioteca Nueva.

Humphreys, M. S., & Revelle, W. (1984). Personality, motivation, and performance: A theory of the relationship between individual differences and information processing. *Psychological Review*, *91*, 153–184. http://dx.doi.org/10.1037//0033-295X.91.2.153

Jensen, A. R. (1998). *The g factor: The science of mental ability.* Westport, CT: Praeger.

Kavale, K. A., & Forness, S. R. (1996). Social skills deficits in learning disabilities: A meta-analysis. *Journal of Learning Disabilities*, *29*, 226–237. http://dx.doi.org/10.1177/002221949602900301

Lozano, J. H., Hernández, J. M., Rubio, V., & Santacreu, J. (2011). Fluid intelligence and discriminative operant learning of reinforcement contingencies in a fixed ratio 3 schedule. *Learning and Individual Differences*, *21*, 585–589. http://dx.doi.org/10.1016/j.lindif.2011.07.009

Lynam, D., Moffitt, T., & Stouthamer-Loeber, M. (1993). Explaining the relation between IQ and delinquency: Class, race, test motivation, school failure or self-control? *Journal of Abnormal Psychology*, *102,* 187–196. http://dx.doi.org/10.1037/0021-843X.102.2.187

Miller, J., Flory, K., Lynam, D., & Leukefeld, C. (2003). A test of the four-factor model of impulsivity-related traits. *Personality and Individual Differences*, *34*, 1403–1418. http://dx.doi.org/10.1016/S0191-8869(02)00122-8

Moeller, F. G., Barratt, E. S., Dougherty, D. M., & Schmitz, J. M. (2001). Psychiatric aspects of impulsivity. *American Journal of Psychiatry*, *158*, 1783–1793. http://dx.doi.org/10.1176/appi.ajp.158.11.1783

Nagle, R. J., & Thwaite, B. C. (1979). Modeling effects on impulsivity with learning disabled children. *Journal of Learning Disabilities*, *12*, 331–336. http://dx.doi.org/10.1177/002221947901200509

Phillips, L. H., & Rabbit, P. M. A. (1995). Impulsivity and speed-accuracy strategies in intelligence test performance. *Intelligence*, *21*, 13–29. http://dx.doi.org/10.1016/0160-2896(95)90036-5

Routh, D. K. (1979). Activity, attention, and aggression in learning disabled children. *Journal of Clinical Child Psychology*, *8*, 183–187. http://dx.doi.org/10.1080/15374417909532916

Rubio, V., & Santacreu, J. (2003). *TRAS-I: Test adaptativo informatizado para la evaluación del razonamiento secuencial y la inducción* [Adaptive, computerized test to assess sequential reasoning and induction]. Madrid, Spain: TEA.

Santacreu, J. (2004). *Flag test to assess discriminant learning and persistence.* (Technical report). Madrid, Spain: Universidad Autónoma de Madrid.

Santacreu, J. (2007). *SIDEP, a Computer Based Assessment System (CBA).* (Technical report). Madrid, Spain: Universidad Autónoma de Madrid.

Santacreu, J., Hernández, J. M., Adarraga, P., & Márquez, M. O. (2002). *La personalidad en el marco de una teoría del comportamiento humano* [Personality within the framework of a theory of human behavior]. Madrid, Spain: Ediciones Pirámide.

Santacreu, J., Rubio, V., & Hernández, J. (2004). Evaluación objetiva de la personalidad: Una alternativa a los cuestionarios [Objective personality assessment: An alternative to questionnaires]. *Análisis y Modificación de Conducta*, *30*, 803–825.

Schweizer, K. (2002). Does impulsivity influence performance in reasoning? *Personality and Individual Differences*, *33*, 1031–1043. http://dx.doi.org/10.1016/S0191-8869(01)00209-4

Sigg, J. M., & Gargiulo, R. M. (1980). Creativity and cognitive style in learning disabled and nondisabled school age children. *Psychological Reports*, *46*, 299–305. http://dx.doi.org/10.2466/pr0.1980.46.1.299

Tarver, S. G., & Hallahan, D. P. (1974). Attention deficits in children with learning disabilities: A review. *Journal of Learning Disabilities*, *7* 560–569. http://dx.doi.org/10.1177/002221947400700906

Vigil-Colet, A., & Morales-Vives, F. (2005). How impulsivity is related to intelligence and academic achievement. *The Spanish Journal of Psychology*, *8*, 199–204.

Zeidner, M. (1995). Personality trait correlates of intelligence. In D. H. Saklofske and M. Zeidner (Eds.), *International handbook of personality and intelligence.* New York, NY: Plenum Press.