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Neurocognitive Evidence for Different Problem-Solving Processes between Engineering and Liberal Arts Students

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Abstract

Differences exist between engineering and liberal arts students because of their educational backgrounds. Therefore, they solve problems differently. This study examined the brain activation of these two groups of students when they responded to 12 questions of verbal, numerical, or spatial intelligence. A total of 25 engineering and 25 liberal arts students in Taiwan participated in the experiment. The results were as follows. (i) During verbal intelligence tasks, differences between the two groups were observed in the information flows of verbal message comprehension and contextual familiarity detection in the problem-identifying phase, whereas no significant differences were found in the resolution-reaching phase. (ii) During numerical intelligence tasks, differences between the two groups were observed in the information flows of mental calculation and message comprehension in the problem-identifying phase and those of verbal perception and analogical reasoning in the resolution-reaching phase. (iii) During spatial intelligence tasks, differences between the two groups were observed in the information flows of spatial relation integration and spatial context memory retrieval in the problem-identifying phase and those of spatial attention and contextual relation integration in the resolution-reaching phase.

Keywords: electroencephalography, engineering students, liberal-arts students, problem-solving processes

Evidencias Neurocognitivas para Diferentes Procesos de Resolución de Problemas entre Estudiantes de Ingeniería y de Artes Liberales

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Resumen

Existen diferencias entre los estudiantes de ingeniería y de artes liberales debido a sus trasfondos educativos. Por lo tanto, resuelven sus problemas de forma diferente. Este estudio examina la activación cerebral de estos dos grupos de estudiantes cuando respondieron a 12 preguntas de inteligencia verbal, numérica o espacial. Un total de 25 estudiantes de ingeniería y 25 estudiantes de artes liberales en Taiwán participaron en el experimento. Los resultados fueron los siguientes. (i) Durante las tareas de inteligencia verbal, se observaron diferencias entre los dos grupos en los flujos de información de la comprensión de mensajes verbales y en la detección de familiaridad contextual en la fase de identificación de problemas, mientras que no se encontraron diferencias significativas en la fase de resolución. (ii) Durante las tareas de inteligencia numérica, se observaron diferencias en los flujos de información de cálculo mental y comprensión del mensaje en la fase de identificación de problemas y en aquellos de percepción verbal y razonamiento analógico en la fase de resolución. (iii) Durante las tareas de inteligencia espacial, se observaron diferencias entre los dos grupos en los flujos de información de la integración de la relación espacial y de la recuperación de memoria en el contexto espacial en la fase de identificación de problemas y en aquellos de atención espacial y de integración de la relación contextual en la fase de resolución.

Palabras clave: electroencefalografía, estudiantes de ingeniería, estudiantes de artes liberales, procesos de resolución de problemas

Differences exist between students who majored in engineering and those who majored in liberal arts. Liberal arts students favour the general aspects of their work, whereas engineering students tend to focus on the specific aspects of their jobs (Neumann, 1983); this difference results from their educational backgrounds. Engineering education aims to introduce students to a wide range of technical subjects, form cross-disciplinary networks of engineering specialities, prepare students to effectively manage increasingly cross-disciplinary activities, and help students gain the ability to address the rapid changes to human lives caused by technological development. By contrast, liberal arts education enables students to acquire communication skills required for efficiently interacting with citizens from diverse societies and cultures, helps students to gain an appreciation and knowledge regarding the history of fine arts, and introduces students to the basic mathematics and science required to manage financial affairs and everyday life (Jenkins, 2014). Therefore, liberal arts students address problems differently from engineering students (Bordoloi & Winebrake, 2015).

Intelligence quotient (IQ) tests are generally designed to assess an individual's problem-solving ability, capture performance differences across cognitive tasks, and the results can be used to predict real-world outcomes (Gläscher et al., 2010). Cognitive neuroscientists have attempted to understand the organising principles that govern human intelligence, with new research providing novel insights into brain-based biomarkers, particularly the neural architecture of goal-directed, intelligent behaviour (Barbey et al., 2012; Miller & Phelps, 2010). In the past 20 years, extensive functional neuroimaging evidence has indicated that the prefrontal cortex plays a central role in cognitive control and the flexibility of human intelligence (Bishop, Fossella, Croucher, & Duncan, 2008; Duncan et al., 2000; Miller & Cohen, 2001).

Neuroscientists still debate whether human intelligence reflects the combined performance of brain systems involved in IQ tasks or draws on specific systems mediating their interactions (Gläscher et al., 2010). The central question is whether prefrontal networks and distributed cortical regions are computationally necessary for the core features of human intelligence (Barbey et al., 2012; Deary, Penke, & Johnson, 2010). According

to an alternative framework, human intelligence depends on various cognitive processes that are mediated by functionally specialised brain regions, including the (i) temporal and occipital regions for processing sensory information, (ii) parietal regions for sensory integration and abstraction, (iii) frontal regions for reasoning and problem-solving, and (iv) anterior cingulate for response selection and automatic response inhibition (Barbey et al., 2012; Barbey & Sloman, 2007; Gläscher et al., 2010). Accordingly, studies have indicated that education and cognitive activity was significantly correlated with both general cognitive ability and specific skills (Ritchie, Bates, & Deary, 2015) and that the interaction of education and cognitive activity significantly affected episodic memory but not executive functioning (Lachman, Agrigoroaei, Murphy, & Tun, 2010).

IQ tests contain three major question types. Each type examines different abilities, namely verbal, numerical, and spatial problem-solving (Carter & Russell, 2008; Spearman, 1904), and demands different information processing, thus predicting different aspects of human performance (Oakhill, Yuill, & Garnham, 2011). The language processing network, which comprises the medial frontal cortex, left temporal cortex, left dorsal and ventral frontal regions, and posterior cingulate, has long been considered crucial for the development of verbal intelligence (Basagni et al., 2017; Liu, Chang, Yang, & Liang, 2018). In addition, the frontoparietal network, which comprises the dorsolateral prefrontal cortex and intraparietal sulcus, is identified as the primary system for the development of numerical intelligence (Cohen Kadoshend, Soskic, Iuculano, Kanai, & Walsh, 2010; Kanjliaa, Lanea, Feigenzona, & Bedny, 2016). Finally, the spatial processing network, primarily comprising the right superior temporal and posterior parietal cortices, is considered crucial for the development of spatial intelligence (Ivanitskii et al., 2015; Liang et al., 2017; Yao, Lin, King, Liu, & Liang, 2017).

Although cognitive neuroscience has progressed remarkably towards understanding human intelligence, relative contributions supporting high-level cognition and predicting performance remain poorly characterised (Paul et al., 2016), particularly between different professional disciplines. Based on the aforementioned findings, the present neurocognitive study was conducted to characterise the brain activities exhibited by university students when they

responded to various verbal, numerical, and spatial intelligence tasks. Particularly, electroencephalography (EEG) was used to assess the brain activities of students majoring in engineering and liberal arts. We recorded the EEG data of each participant in two phases of each experimental IQ task: the problem-identifying and resolution-reaching phases. This study investigated differences in the brain activations of engineering and liberal arts students when engaging in the problem-identifying and resolution-reaching phases of experimental tasks corresponding to verbal, numerical, and spatial intelligence. The outcomes can contribute to the design of interdisciplinary talent development programmes as well as identification of useful avenues of inquiry for future research.

Methods

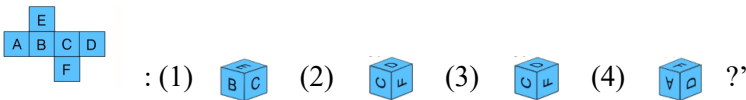
Participants

A total of 25 engineering and 25 liberal arts students in Taiwan participated in the EEG experiment. The engineering students were majoring in either electrical or computer engineering, whereas the liberal arts students were majoring in either Chinese or foreign language. All the participants were Taiwanese second-year or third-year undergraduates who had normal or corrected-to-normal vision and no history of drug or alcohol abuse or cardiovascular or vestibular disorders. Because of signal malfunction or dropouts during the course of the study, the EEG data of only 19 engineering students (8 women and 11 men; aged 20–22 years) and 17 liberal arts students (10 women and 7 men; aged 20–23 years) were acquired for further analyses.

Materials

On the basis of the Taiwanese version of the Stanford–Binet Intelligence Scale, a comprehensive IQ test used globally to diagnose intellectual deficiencies in young people, we developed 12 items (four items each for verbal, numerical, and spatial intelligences). Verbal intelligence items comprised synonyms or antonyms, analogical relationships, word-building tests, and practical knowledge and understanding of social rules and concepts.

An example of a verbal intelligence item is ‘Which of the following is not like the others: (1) handsome, (2) flirtatious, (3) graceful, or (4) pretty?’ Numerical intelligence items consisted of mathematical operations involving simple arithmetic (e.g. percentages, powers, and fractions), figures and thinking, and estimations and more global judgments. An example of a numerical intelligence item is: ‘Which of the following is an illogical number followed by 111, 339, and 5525: (1) 8869, (2) 6645, (3) 9976, and (4) 7749?’ Spatial intelligence included items that prompted mental generation and rotation of visual images, solving spatial navigation problems, and visualising objects from different angles (e.g. thinking about objects in three dimensions to draw conclusions from limited information). An example of a spatial intelligence item is ‘Which cannot be made by folding this labelled cardboard



Experimental Equipment and Procedure

The participants received a detailed explanation of the experiment and were asked to sign consent forms after they arrived at the laboratory. Their brain responses were recorded using a 32-channel inflatable wireless K32S EEG headset with a sampling rate of 250 Hz and 16-bit quantisation. A single reference electrode was placed on the mastoid behind the ear, and electrode impedance was minimised ($\leq 5 \text{ K}\Omega$). This headset employed comb-like sensors that mitigated interference from hair and made unobstructed contact with the scalp for precise brain activity detection. The headset with spring-loaded dry electrodes and a soft cap maximised contact between all sensors and all parts of the scalp to ensure accuracy and quick placement. Scalp markers were placed in accordance with the international 10–20 system and aligned with underlying cerebral structures.

The experiment began after the participants had donned the headset and steady EEG signals were being received. The participants were asked to watch a prerecorded presentation on a computer screen and minimise their movements. We first recorded their brain responses for 30 s during resting

periods to serve as a baseline, ensuring that an observed response was not present before the introduction of experimental tasks. The participants then worked mentally to determine which number belonged in the space with the question mark of each IQ test item. During the experiment, they were not permitted to use a pencil or paper or ask questions. We did not record the participants' answers, because the central focus of this research was problem-solving processes rather than correctness.

Short breaks were scheduled between items as intertrial intervals to prevent overlapping brain responses from being recorded. In other words, separate EEG data for problem-solving processes were acquired for each question. The experiment was completed in approximately 25 minutes, including experiment description and EEG headset testing. The process was identical for all the participants to ensure consistency in the experiment. On average, the engineering students spent approximately 10 s on each verbal question (mean [M] = 10.06 s, standard deviation [SD] = 3.08 s), 26 s on each numerical question (M = 26.22 s, SD = 5.62 s), and 22 s on each spatial question (M = 21.78 s, SD = 4.12 s), whereas the liberal arts students spent approximately 10 s on each verbal question (M = 9.84 s, SD = 2.92 s), 28 s on each numerical question (M = 28.16 s, SD = 7.14 s), and 25 s on one spatial question (M = 24.90 s, SD = 6.32 s).

Data Analysis

All collected data were carefully examined, and noise signals, including line noise, systematic noise, oculomotor activities, and muscle movements, were removed using a finite–infinite response filter with cut-off frequencies of 1 and 50 Hz. Abnormal trends and extreme values of signals were detected using kurtosis with a five z -score threshold and removed manually. The removed channels were replaced with averages of the data of the corresponding (engineering or liberal arts) group. After removing noise and abnormal and extreme channels, filtered EEG signals were split into two phases; from the beginning of second 2 to the end of the second 3 (problem-identifying phase) and the final second (named as the resolution-reaching phase) (Hanson & Bunzl, 2010). To generalise filtered EEG data, we averaged them respectively within the verbal, numerical, and spatial categories for each participant. The

workflow is presented in Figure 1. All the aforementioned processes were performed using the EEGLAB toolbox (Delorme & Makeig, 2004) either through native or plug-in routines.

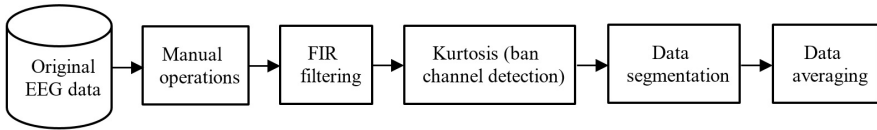


Figure 1. Work-flow of EEG data preparation

In this study, independent component analysis was performed with the infomax algorithm (Jung, Makeig, Mckeown, Bell, Lee, & Sejnowski, 2001) to process filtered EEG data into separate quasi-independent signal sources. The pseudolocations of all quasi-independent signal sources, known as dipole locations, were estimated using DIPFIT (version 2.3) with the single equivalent current dipole model (Delorme, Palmer, Onton, Oostenveld, & Makeig, 2012), a plug-in routine in EEGLAB. According to probe locations F3, F4, P3, and P4 of the 10–20 system, estimated dipoles were divided among seven brain areas: the left frontal region (K1), right frontal region (K2), left temporal region (K3), frontoparietal region (K4), right temporal region (K5), left parieto-occipital region (K6), and right parieto-occipital region (K7) (Figure 2). Corresponding independent components (ICs) to partitioned dipoles were averaged by these areas. Averaged ICs were used to represent the signal for each brain area. The workflow of dipole partition is shown in Figure 3.

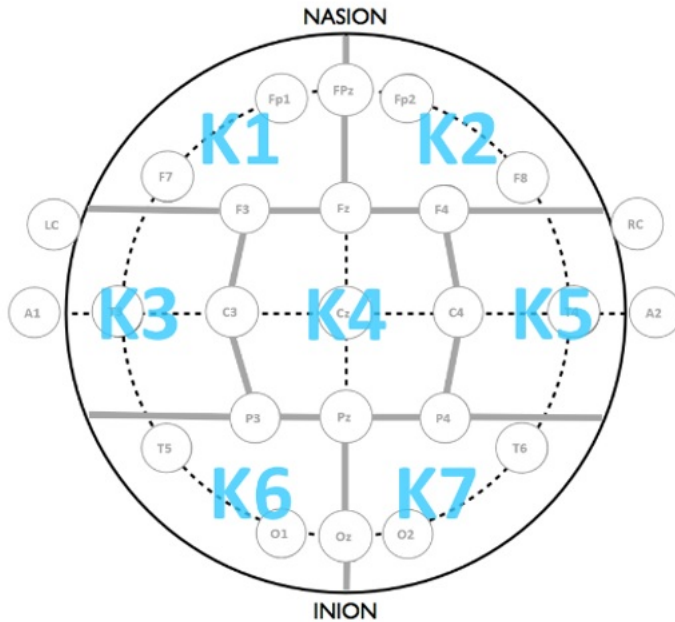


Figure 2. Montage of dipole partition

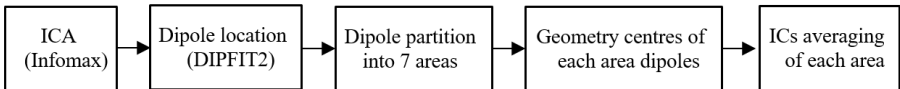


Figure 3. Work-flow of dipole partition processes

A multivariate vector autoregressive (MVAR) model has been widely used to analyse neural activity data and brain connectivity (Bressler & Seth, 2011; Friston, Bastos, Oswal, van Wijk, Richter, & Litvak, 2014; Lin et al., 2016) and is the commonest operational model of Granger causality (Granger, 1969). In this study, we adopted the multivariate Granger causality (MVGC) toolbox (Barnett & Seth, 2014) to implement the MVAR model to investigate brain activity networks in a time domain. Compared with other tools (Delorme & Makeig, 2004), MVGC improves computational efficiency and accuracy

through asymptotical equivalent methods, namely ordinary least squares (OLS) and Durbin recursion, for maximal likelihood estimation. Additionally, MVGC improves statistical inference processes. Granger causality clarifies that if the past of a variable x_1 helps to predict the future of a variable x_2 , then the general expression of the MVAR model and a p th order MVAR are expressed as Equation 1. Let \mathbf{X} consist of random variables $\{\mathbf{x}_1, \mathbf{x}_2, \dots, \mathbf{x}_T\}$; T is the total time points, \mathbf{x}_t is an n -dimensional column vector with elements $x_{1t}, x_{2t}, \dots, x_{nt}$, and t is an index of the time point. In this equation, p is the model order that can be determined through order selection.

$$\mathbf{x}_t = \sum_{k=1}^p \mathbf{A}_k \cdot \mathbf{x}_{t-k} + \boldsymbol{\varepsilon}_t \text{ (Equation 1)}$$

The Bayesian information criterion was used for order selection in this study; $\boldsymbol{\Sigma}$ is the residual ($\boldsymbol{\varepsilon}_t$) covariance matrix with white assumption. For the stationary assumption, $\boldsymbol{\Sigma}$ does not depend on time t . For valid Granger causality analysis, MVAR coefficients in Equation 1 must be summable and stable. In this study, the OLS algorithm was used for parameter estimation. The whiteness, consistency, and stationarity of fitted models were confirmed (Barnett & Seth, 2014; Ding, Bressler, Yang, & Liang, 2000). The Granger causality matrix \mathbf{F} was determined by the log-likelihood ratio of reduced and full regression. Each element, f_{ji} , in \mathbf{F} directionally represented the strength of variable x_i to variable x_j , where $i \neq j$. A two-sample t test was used to examine estimated differences in the brain networks of the engineering and liberal arts students. The workflow of the brain connectivity analysis is shown in Figure 4.

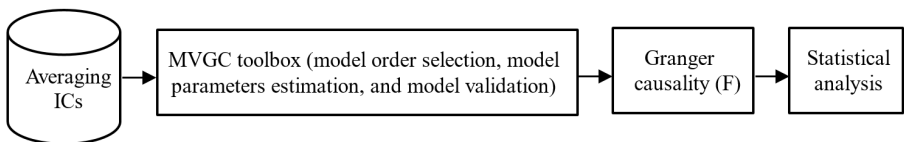
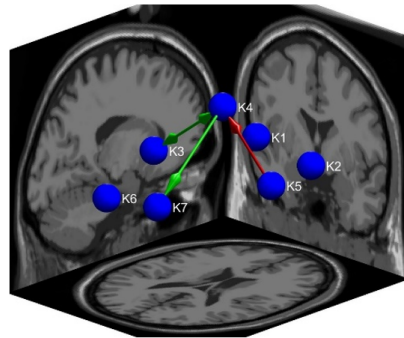
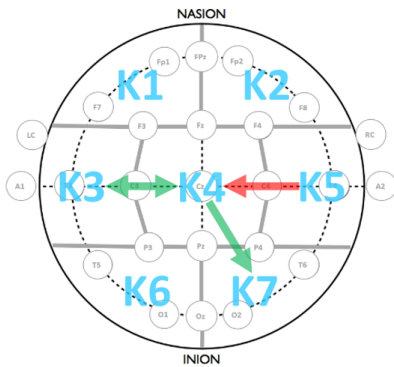


Figure 4. Work-flow of brain connectivity analysis

Results and Discussion

The following three sections discuss verbal, numerical, and spatial intelligence. In each section, we first present and describe our results from Granger causality analysis; that is, the estimated brain connectivity in both the problem-identifying and resolution-reaching phases; and subsequently discuss their academic and practical implications.

Verbal intelligence. In this study, a two-sample t test with $\alpha = 0.05$ was applied to examine the mean difference in estimated Granger causality f values between the engineering and liberal arts students. Higher f values indicated stronger effects. The findings of the brain connectivity analysis revealed that K4 played a key role in the problem-identifying phase during verbal intelligence tasks. The mean f values of the links K4 to K3, K3 to K4, and K4 to K7 were significantly higher for the engineering students than for the liberal arts students. The analysis also indicated that the hub was located in K4 (the frontoparietal region), with bidirectional information transfer to K3 (the left temporal region) and unidirectional information transfer to K7 (the right parieto-occipital region). In addition, the mean f value of the link with unidirectional information transfer from K5 (the right temporal region) to K4 was significantly higher for the liberal arts students than for the engineering students. The results of the two-sample t test are listed in Table 1. However, no significant differences in brain connectivity were observed between the engineering and liberal arts students in the resolution-reaching phase.



5a. Graphical view

5b. Anatomical view

Figure 5. Estimated brain connectivity in the problem-identifying phase for verbal intelligence tasks.

Note: Arrows represent causality directions (green arrow: engineering > liberal arts; red arrow: liberal arts > engineering).

Table 1

Two-sample t test during PI in the VI task.

	K1	K2	K3	K4	K5	K6	K7
K1	NaN	0.7393	-0.5646	0.2326	-0.9916	0.2398	0.8537
K2	0.3481	NaN	-0.1144	-1.039	-1.1664	-1.1799	-0.6748
K3	-0.3301	0.9148	NaN	2.8719**	-0.5921	1.3983	0.4331
K4	1.5698	1.1403	2.5467*	NaN	-2.2611*	-1.1825	1.3321
K5	-1.0079	0.9141	-0.0767	-0.6772	NaN	-1.4027	-0.989
K6	-0.5792	1.3377	-1.0649	-1.8395	-1.3714	NaN	-1.0216
K7	0.8445	1.4084	-0.4992	2.2682*	-0.7534	0.9183	NaN

Notes: *p < 0.05 **p < 0.01 ***p < .0001.

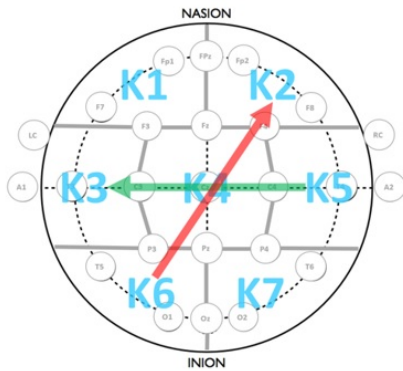
PI refers to the problem-identifying phase; VI refers to the verbal intelligence task.

Regarding brain activation during verbal intelligence tasks, Banich and Compton (2018) indicated that the right hemisphere recognises the forms of verbal messages before the left hemisphere constructs abstract representations

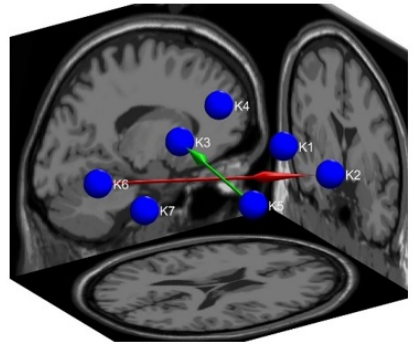
of these messages for comprehension. Generally, all the participants in this study followed this pattern in which the right temporal region plays a critical role in recognising words, the frontoparietal region helps to detect mnemonic conflicts, and the left temporal region decodes words. We found that the frontoparietal region (K4), the core of the anterior cingulate cortex (ACC), served as a hub for rapidly transferring information in the problem-identifying phase. The ACC typically controls mechanisms that monitor differential familiarity (Bunge, Burrows, & Wagner, 2004). Verbal intelligence often involves understanding relationships in statements and drawing conclusions from them or completing an argument; these tasks explain the ACC's role as the hub.

Our EEG analysis continually revealed that compared with the liberal arts students, the engineering students demonstrated more activity in the circulated process between verbal recognition and message comprehension in the problem-identifying phase. By contrast, compared with the engineering students, the liberal arts students spent more cognitive resources in recognising (which might include appreciating) verbal forms and detecting familiarity in that phase. These results suggest that frequently practicing text feature identification and verbal message comprehension can enhance the verbal problem-solving ability of engineering students, whereas continually evoking relevant word families can improve this same type of ability among liberal arts students.

Numerical intelligence. In the problem-identifying phase of numerical intelligence tasks (Figure 6), EEG data revealed that the mean f value of the link with unidirectional information transfer from K5 (the right temporal region) to K3 (the left temporal region) was significantly higher among the engineering students than among the liberal arts students. In addition, the mean f value of the link with unidirectional information transfer from K6 (the left parieto-occipital region) to K2 (the right frontal region) was significantly higher among the liberal arts students than among the engineering participants. The results of the two-sample t test are listed in Table 2.



6a. Graphical view



6b. Anatomical view

Figure 6. Estimated brain connectivity in the problem-identifying phase for numerical intelligence tasks.

Note: Arrows represent causality directions (green arrow: engineering > liberal arts; red arrow: liberal arts > engineering).

Table 2

Two-sample t test during PI in the NI task.

	K1	K2	K3	K4	K5	K6	K7
K1	NaN	0.8613	-1.1419	-0.0525	-0.78	-1.0423	-0.0787
K2	-0.7671	NaN	0.1246	0.102	-1.3734	-2.9398*	-1.8396
K3	0.3222	1.1892	NaN	-0.3952	2.2055*	1.1689	0.2103
K4	1.2449	0.743	-1.2299	NaN	-0.1271	-1.8574	0.7677
K5	-1.0309	-1.2693	0.4234	1.4348	NaN	1.0058	-1.2959
K6	0.9496	-1.1074	0.2424	0.9608	-0.5243	NaN	1.3423
K7	0.0365	-1.4683	-0.2	-0.6376	1.1758	1.2864	NaN

Notes: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

PI refers to the problem-identifying phase; NI refers to the numerical intelligence task.

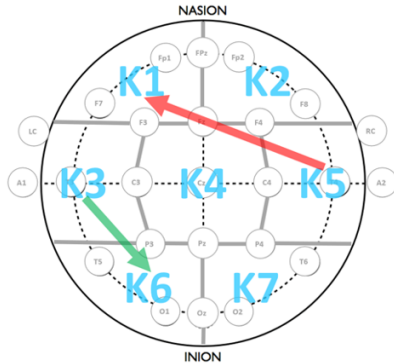
Regarding brain activation during numerical intelligence tasks, recent studies have suggested that the extent of numerical processing depends on the

frontal and parietal regions of both hemispheres (Ansari, 2007; Cohen Kadoshend et al., 2010; Kanjliaa et al., 2016). Generally, the frontoparietal network (including the prefrontal cortex) of all the participants in this study was activated during numerical intelligence tasks. We found that the ACC in the frontoparietal region (K4) still acts as a core for promptly transferring information in the problem-identifying phase. Numerical intelligence often involves figures and thinking, quantity discrimination, and identification of odd alphanumeric characters, highlighting the functions of cost calculation and error monitoring, which are controlled by the ACC (Apps, Rushworth, & Chang, 2016; Bunge et al., 2004).

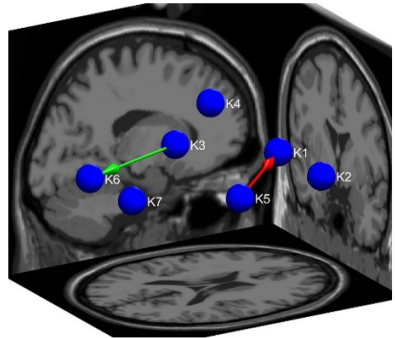
EGG analysis revealed that compared with the liberal arts students, the engineering students used more cognitive resources for transferring information from number recognition and nonverbal communication (the right temporal region) (Banich & Compton, 2018; Wisniewski, Wendling, Manning, & Steinhoff, 2012) to verbal comprehension and calculation ability (the left temporal region) (Banich & Compton, 2018; Takeuchi et al., 2011) in the problem-identifying phase. By contrast, the liberal arts students used more cognitive resources for transferring information from verbal perception (the left parieto-occipital region) (Boccia, Piccardi, Palermo, Nori, & Palmiero, 2015) to emotion regulation and thought (the right frontal region) (Dennis & Solomon, 2010; Gallup & Platek, 2002) in the same phase. These results indicate that the engineering students in this study devoted their efforts to calculation directly, whereas the liberal arts students exhibited more activity with question reading and understanding. Practicing mathematical skills and improving them through daily life tasks and personal reflections have proven effective in developing students' confidence and awareness of their numerical competence (Attridge & Inglis, 2013; Shelton, 2016).

In the resolution-reaching phase (Figure 7), the mean f value of the link with unidirectional information transfer from K3 (the left temporal region) to K6 (the left parieto-occipital region) was significantly higher among the engineering students than among the liberal arts students. Moreover, the mean f value of the link with unidirectional information transfer from K5 (the right temporal region) to K1 (the left frontal region) was significantly higher among

the engineering students than among the liberal arts students. The results of the two-sample *t* test are listed in Table 3.



7a. Graphical view



7b. Anatomical view

Figure 7. Estimated brain connectivity in the resolution-reaching phase for numerical intelligence tasks.

Note: Arrows represent causality directions (green arrow: engineering > liberal arts; red arrow: liberal arts > engineering).

Table 3

Two-sample t test during RR in the NI task.

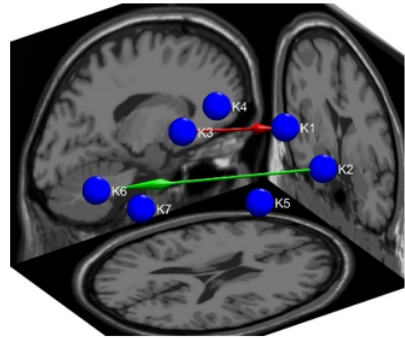
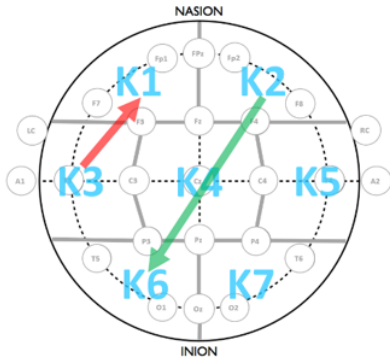
	K1	K2	K3	K4	K5	K6	K7
K1	NaN	1.4316	1.5772	-0.9515	-3.1065**	-1.0458	1.298
K2	0.7258	NaN	1.4791	-0.687	0.3406	-0.1347	-0.4229
K3	-0.3053	1.9333	NaN	1.3013	0.7441	0.7465	1.1244
K4	-1.4704	-0.8596	-1.1851	NaN	-0.0273	1.1527	-1.5855
K5	-0.7932	0.5625	-0.3509	1.1693	NaN	0.8198	-1.7789
K6	-0.7253	0.9124	2.9045**	0.6578	0.8425	NaN	-0.2845
K7	1.2404	-0.585	0.4952	0.8784	-1.315	1.0403	NaN

Notes: **p* < 0.05 ***p* < 0.01 ****p* < .0001.

RR refers to the resolution-reaching phase; NI refers to the numerical intelligence task.

Compared with their counterparts, the engineering students used more cognitive resources for transferring information from verbal comprehension and calculation ability (the left temporal region) to verbal perception (the left parieto-occipital region) in the resolution-reaching phase. By contrast, the liberal arts students used more cognitive resources for transferring information from number recognition and nonverbal communication (the right temporal region) to mathematical cognition and analogical reasoning (the left frontal region) (Aichelburg et al., 2016; Arsalidou & Taylor, 2011) in the same phase. These results suggest that the engineering students shifted their focus to answer selection, whereas the liberal arts students still focused on logical thinking in this phase.

Spatial intelligence. In the problem-identifying phase of spatial intelligence tasks (Figure 8), the mean f value of the link with unidirectional information transfer from K2 (the right frontal region) to K6 (the left parieto-occipital region) was significantly higher among the engineering students than among the liberal arts students. In addition, the mean f value of the link with unidirectional information transfer from K3 (the left temporal region) to K1 (the left frontal region) was significantly higher among the liberal arts students than among the engineering students. The results of the two-sample t test are listed in Table 4.



8a. Graphical view

8b. Anatomical view

Figure 8. Estimated brain connectivity in the problem-identifying phase for spatial intelligence tasks.

Note: Arrows represent causality directions (green arrow: engineering > liberal arts; red arrow: liberal arts > engineering).

Table 4

Two-sample t test during PI in the SI task.

	K1	K2	K3	K4	K5	K6	K7
K1	NaN	0.181	-2.4434*	2.0338	0.0689	0.4458	0.3108
K2	-0.9914	NaN	-1.4304	1.0794	0.7705	-0.4572	-0.9455
K3	-0.7294	-0.2413	NaN	-1.4627	0.4938	1.1515	1.2212
K4	0.8548	0.0122	-1.7075	NaN	-0.0071	0.1523	-0.2069
K5	0.4456	1.6171	-0.1733	0.1819	NaN	0.1688	0.6987
K6	0.034	2.2739*	0.9924	0.3756	1.1798	NaN	0.2915
K7	0.4022	-1.5419	1.1718	1.8707	-0.5287	2.0504	NaN

Notes: *p < 0.05 **p < 0.01 ***p < .0001.

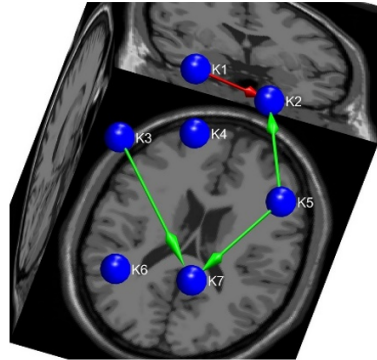
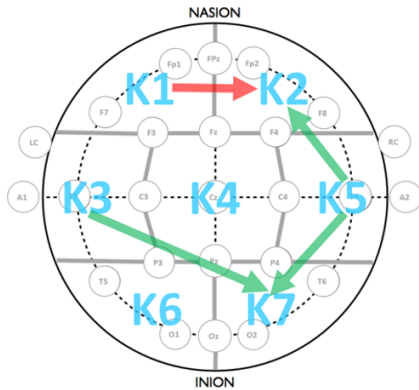
PI refers to the problem-identifying phase; SI refers to the spatial intelligence task.

Regarding brain activation during spatial intelligence tasks, Burgess (2008) indicated that to construct spatial cognitions, the hippocampus and medial temporal lobe provide allocentric environmental representations, the

parietal lobe provides egocentric representations, and the retrosplenial cortex and parieto-occipital sulcus enable the representations to interact. Generally, the spatial processing network of all participants in this study was activated during the experiment.

Compared with their counterparts, the engineering students used more cognitive resources transferring information from spatial relation integration and emotional thought (the right frontal region) to verbal perception (the left parieto-occipital region) in the problem-identifying phase. By contrast, the liberal arts students used more cognitive resources for transferring information from verbal comprehension (questions) (the left temporal region) to analogical reasoning (the left frontal region) in the same phase. These results indicate that the engineering students in this study resolved verbal-form questions based on spatial relation integration (Han, Cao, Cao, Gao, & Li, 2016), whereas the liberal arts students attempted to retrieve spatial context memory by comprehending questions in verbal form (Slotnick, Moo, Segal, & Hart, 2003). Increasing evidence suggests that playing with spatially oriented toys (e.g. puzzles and blocks) correlates with spatial development (e.g. Jirout & Newcombe, 2015), and innovative technologies, such as virtual and augmented reality, add promising possibilities to improve spatial problem-solving ability (Dominguez, Martin-Gutierrez, Gonzalez, & Corredeaguas, 2012).

Analysis of the resolution-reaching phase (Figure 9) revealed critical roles of K5 and K7. The mean f values of the links K5 to K7, K5 to K2, and K3 to K7 were significantly higher among the engineering students than among the liberal arts students. We found that the hub was located in K5 (the right temporal region) with unidirectional information transfer to K2 (the right frontal region) and K7 (the right parieto-occipital region). In addition, K7 was observed to play a critical role with unidirectional information transfer from K3 (the left temporal region) and K5. Furthermore, the mean f value of the link with unidirectional information transfer from K1 (the left frontal region) to K2 was significantly higher among the liberal arts students than among the engineering students. The results of the two-sample t test are listed in Table 5.



9a. Graphical view

9b. Anatomical view

Figure 9. Estimated brain connectivity in the resolution-reaching phase for spatial intelligence tasks.

Note: Arrows represent causality directions (green arrow: engineering > liberal arts; red arrow: liberal arts > engineering).

Table 5

Two-sample *t* test during RR in the SI task.

	K1	K2	K3	K4	K5	K6	K7
K1	NaN	0.181	-2.4434*	2.0338	0.0689	0.4458	0.3108
K2	-0.9914	NaN	-1.4304	1.0794	0.7705	-0.4572	-0.9455
K3	-0.7294	-0.2413	NaN	-1.4627	0.4938	1.1515	1.2212
K4	0.8548	0.0122	-1.7075	NaN	-0.0071	0.1523	-0.2069
K5	0.4456	1.6171	-0.1733	0.1819	NaN	0.1688	0.6987
K6	0.034	2.2739*	0.9924	0.3756	1.1798	NaN	0.2915
K7	0.4022	-1.5419	1.1718	1.8707	-0.5287	2.0504	NaN

Notes: **p* < 0.05 ***p* < 0.01 ****p* < .0001.

RR refers to the resolution-reaching phase; SI refers to the spatial intelligence task.

Compared with their counterparts, the engineering students used more cognitive resources for transferring information from nonverbal communication (the right temporal region) to spatial relation integration and emotional thought (the right frontal region) and

spatial attention (the right parieto-occipital region) as well as from verbal comprehension (the left temporal region) to spatial attention and visual perception (the right parieto-occipital region) (Corbetta & Shulman, 2002; Malhotra, Coulthard, & Husain, 2009) in the resolution-reaching phase. By contrast, the liberal arts students used more cognitive resources for transferring information from spatial thinking and analogical reasoning (the left frontal region) to spatial relation integration and emotional thought (the right frontal region) in the same phase. These results suggest that the engineering students activated their spatial processing network to recognise spatial configurations, maintain spatial awareness, and integrate spatial relationships (Malhotra, Coulthard, & Husain, 2009; Sakurai, Hamada, Tsugawa, & Sugimoto, 2015), whereas the liberal arts students built spatial relationships through contextual information and reasoning in this phase.

Research limitations. The use of EEG generated several research limitations. First, problem-solving is a complex process; however, neuroscience studies have typically inspected small-scale and simple cognitive processes. Complicated connections and patterns of brain activity render logical conclusions difficult. Second, the small number of participants limits the generalisability of the current findings. Thus, whether the results and conclusions would be the same for a general population, including different levels of academic performance and diverse disciplines, remains unclear. Third, the three types of intelligence test questions used in this study limit the experimental findings. Additional types of IQ test questions and supplementary items can help increase validity.

Conclusions and Reflections

Despite the aforementioned limitations, three broad conclusions can be drawn. (i) Regarding brain activation during verbal intelligence tasks, major differences between the engineering and liberal arts students were observed in the information flows of verbal message comprehension and contextual familiarity detection in the problem-identifying phase. However, no significant difference was observed between the two groups in the resolution-reaching phase. (ii) Regarding brain activation during numerical intelligence

tasks, major differences between the two groups were observed in the information flows of mental calculations and message comprehension in the problem-identifying phase and those of verbal perception and analogical reasoning in the resolution-reaching phase. (iii) Regarding brain activation during spatial intelligence tasks, major differences between the two groups were observed in the information flows of spatial relation integration and spatial context memory retrieval in the problem-identifying phase and those of spatial attention and contextual relation integration in the resolution-reaching phase.

The aforementioned research findings indicate the differences in problem-solving processes between engineering and liberal arts students. Broadly speaking, the engineering students in the experiment tended to focus on certain tasks, whereas the liberal arts students favoured the contextual aspects of a task. Each can benefit from the other in terms of professional cultivation; that is, engineers should think about how invented technologies can be used in diverse sociocultural contexts and refine them accordingly, whereas liberal arts professionals should learn how engineers realise unusual ideas. Few studies have examined differences in problem-solving processes between students of distinct disciplines, but the importance of integrative intelligence to neuroscience research should be highlighted. This original provides potential for future inquiries on this research theme.

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Family Orientation and Achievement Goal Orientations Among the Children of Immigrant and Non-Immigrant Families

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Family Orientation and Achievement Goal Orientations among the Children of Immigrant and Non-Immigrant Families

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Abstract

The current study examined the role of family orientations on the achievement motivations (i.e., achievement goal orientations and intrinsic motivation) of high school youths of different generational status (i.e., from immigrant or non-immigrant families) when their perception of their parents' goals and classroom goal structures were tested simultaneously as predictors. A total of 331 high school students (ninth grade; ages 13–16, with 96% of the students in the ages of 14 or 15; 141 boys and 187 girls) from one high school in the United States participated in the study, completing a series of assessments with regard to their math classes. The findings show the complex role of the family contexts (parent goals and family orientations) on the adaptive mastery goals for children of immigrant families, going beyond previous studies that reported the relationships between family orientation and performance-approach or less adaptive performance-avoidance goals. This study still found that students' family orientations strongly predicted their desire to win over their peers with certain levels of internal pressure in order to meet their parents' expectations, aligned with previous literature. Through examining a context beyond the classroom context, studies should continue to examine the larger family and cultural context in understanding students with diverse backgrounds.

Keywords: family orientation, achievement goal orientation, children of immigrant families, parents' goals, classroom goal structures

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Orientación Familiar y Orientación al Logro de Objetivos entre los Hijos de Familias Inmigrantes

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Resumen

El estudio actual examinó el papel de las orientaciones familiares en las motivaciones de logro (es decir, orientación al logro de objetivos y motivación intrínseca) de jóvenes de escuela secundaria de diferente estatus generacional (es decir, de familias inmigrantes o no inmigrantes) cuando perciben los objetivos de sus padres y las estructuras de los objetivos del aula fueron probadas simultáneamente como factores predictivos. Un total de 331 estudiantes de secundaria (noveno grado; edades 13–16, con el 96% de los estudiantes de 14 o 15 años de edad; 141 niños y 187 niñas) de una escuela secundaria en los Estados Unidos participaron en el estudio, completando una serie de evaluaciones con respecto a sus clases de matemáticas. Los hallazgos muestran el complejo papel de los contextos familiares (objetivos de los padres y orientaciones familiares) en los objetivos de dominio adaptativo para los hijos de familias inmigrantes, yendo más allá de los estudios previos que reportaron la relación que existe entre la orientación familiar y el desempeño-rendimiento o los menos adaptables objetivos de desempeño-rendimiento. Aún encontramos que las orientaciones familiares de los estudiantes predijeron fuertemente su deseo de ganar a sus compañeros con ciertos niveles de presión interna para cumplir con las expectativas de sus padres, en línea con los estudios anteriores. Al examinar un contexto más amplio, más allá del contexto del aula, los estudios deben continuar examinando el contexto familiar y cultural más amplio para comprender a los estudiantes con antecedentes diversos.

Palabras clave: orientación familiar, orientación al logro de objetivos, hijos de familias inmigrantes, objetivos de los padres, estructuras de los objetivos del aula

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According to the U.S. Census Bureau (2012), approximately 25% of children in the United States have at least one foreign-born parent; for the most part, the parents are from Latin America or Asia. With such a large percentage of children coming from diverse backgrounds, it is unsurprising that there has been an increasing number of studies involving children from immigrant families. Observed differences in educational attainment among some immigrant youth have been followed by studies on how children from immigrant families may experience achievement motivation differently (e.g., [Esparza & Sánchez, 2008](#); [Fuligni, 2011](#); [Perreira et al., 2010](#)). Of particular interest has been how the strength of children's family orientation ([Urdan, 2004](#); also called family obligation, [Fuligni et al., 1999](#)) connects to children's different types of achievement motivation (e.g., [Fuligni, 2001](#); [Perreira et al., 2010](#); [Urdan, 2004](#)). These studies have reported different connections between children's family orientation and their different types of achievement motivation, but more studies are needed to better understand how the family orientation of children from immigrant and nonimmigrant families predict different types, or qualities, of achievement motivation in the contexts of the broader classroom and family.

Using the achievement goal orientation theory framework, the current study aims to expand on past research by examining the role of family orientations on the different types of adaptive or less adaptive achievement motivations for the high school youths of different generational status (i.e., from immigrant or nonimmigrant families). The current study further examined the mediating role of high school students' family orientation in the relationships between their perceptions of parental goals and their different types of achievement goal orientations and intrinsic motivations in the broader context of goal-related messages, such as messages from the classroom or from one's parents.

Theoretical Framework

Achievement Goal Orientations

Achievement goal orientations and consequences. As one of the major theories of achievement motivation, the achievement goal orientation theory has been used to explain the various purposes behind individuals' engagement in achievement settings (Elliot & McGregor, 2001; Linnenbrink, 2005; Urdan, 2004). Through examining different types or qualities of achievement goal orientations, this theoretical framework aimed to explain different outcomes of pursuing goal orientations. For example, when students pursue mastery goals, they focus on developing competence through engagement and often prefer tasks that challenge them and help them learn and improve. The rewards students seek are more likely to be internal rather than external. Students' pursuit of mastery goals has been connected to adaptive outcomes such as intrinsic motivation, positive emotion, higher persistence, and self-regulation (Linnenbrink, 2005).

On the other hand, students pursuing performance-approach goals focus on demonstrating competence and desire to achieve high grades or to appear better than their peers. They typically prefer tasks that fit well within their ability. Students' pursuit of performance-approach goals has been connected to higher grades and both positive and negative emotions (Linnenbrink, 2005). Lastly, students pursuing performance-avoidance goals would seek to avoid the appearance of being incompetent and an undesirable outcome. This goal orientation has predicted negative emotion (e.g., anxiety) or maladaptive behaviors (e.g., self-handicapping), which could impede one's own success by providing an excuse for a lack of achievement (Urdan, 2004). Eventually, the theory developed into a multiple goal perspective in which a combination of different types of goal orientations, such as both mastery and performance-approach goals (but not performance-avoidance goals, which are considered less adaptive), can be beneficial for achievement outcomes (e.g., Linnenbrink, 2005).

Antecedents of achievement goal orientations. According to achievement goal orientation theory, social expectations—such as from teachers and parents—have been shown to be related to the development of different types of goal orientations (Bong, 2008; Friedel et al., 2007; Wolters, 2004). Research has shown that students adopt similar achievement goal orientations to the goals or messages that their teachers and parents are communicating in their particular context. For example, when students

believe their parents value mastery of a task and the associated deep understanding, the students reflect a similar goal (e.g., Bong, 2008; Friedel et al., 2007). On the other hand, when students feel that a classroom culture fosters a competitive environment, students adopt performance-approach or performance-avoidance goals (Wolters, 2004).

Achievement Goal of Immigrant Youth: Role of Family Orientation

Immigrant family context and development of family orientation.

There has been increasing attention to examine the role of family in achievement motivation, particularly with regard to the growing number of youths who come from immigrant families. Fuligni and Yoshikawa (2004) contended that, regardless of their country of origin, immigrant families usually consider immigration to be an investment in a better life and expect higher returns from their children's educational attainment (e.g., Portes & Rumbaut, 2001). Fuligni and Yoshikawa (2004) also pointed out that immigrant families tend to have mutually interdependent goals for the children and the larger family, and the parents of these families consider their children's education to be an investment for the entire family, not just the children. As the children understand their parents' investment and sacrifices during immigration, the immigrant students would demonstrate respect for their parents' sacrifices by wanting to do well in school, which can be seen in the immigrant students' experiences of achievement motivation.

In turn, immigrant youths have been reported to hold a higher sense of *family obligation* (defined as a child's duty to assist, respect, and support his or her family; Fuligni et al., 1999) than do their nonimmigrant peers (Fuligni, 2001; Fuligni et al., 1999; Perreira et al., 2010). According to Fuligni (2011), membership in this family implies certain obligations in order to be a relevant member, and adolescents would tend to develop more behaviors that involve "willingness to support, assist, and respect the authority of the family" (Fuligni, 2011, p. 103). A few years later, Urdan (2004) developed a shorter scale to measure the construct of Fuligni et al. (1999), which Urdan referred to as *family orientation*. Urdan (2004) defined family orientation as "students' desires to please or provide for family members through academic

achievement” (p. 255), as with the parallel construct of family obligation. Through the emphasis on academic orientation that aim to support family (e.g., “I want to do well in school so that I can be better prepared to take care of my family”; [Urdan, 2004](#)), compared to the students’ expectations of how often they should assist family or beliefs about the importance of respecting family members (i.e., family obligation: [Fuligni, 2001](#)), [Urdan \(2004\)](#) similarly reported a higher sense of family orientation in immigrant youths compared to their nonimmigrant peers.

Family orientation as antecedents of different types of achievement motivation. There has also been evidence that greater levels of the beliefs of family obligation that immigrant students hold are connected to general academic motivation. For example, [Fuligni and his colleagues \(1999\)](#) found a connection between students’ sense of family obligation and their aspiration and expectation for educational attainment among students with various ethnic backgrounds. Likewise, [Urdan, Solek, and Schoenfelder \(2007\)](#), through qualitative study, reported that children with a stronger sense of obligation to their families valued academic success more and had higher goals in education, particularly first- and second-generation students. Particularly for Latino immigrant and nonimmigrant high school students, [Esparza and Sánchez \(2008\)](#) reported that students’ reported familism (measured by students’ beliefs and attitudes toward general filial attitudes) predicted greater academic effort and class attendance but not expectancies for success or the intrinsic value. [Loera, Rueda, and Oh \(2015\)](#) similarly reported that Latino immigrant and nonimmigrant high school students’ family orientations were significant predictors of their academic engagement and learning strategies.

Researchers have further questioned and examined whether students’ family orientations predict different types, or qualities, of achievement motivation and their achievement. Interestingly, [Fuligni’s \(2001\)](#) earlier study reported that family obligations of students with immigrant and nonimmigrant backgrounds predicted the students’ self-reported utility value of education, math, or English but not the intrinsic value of math or English (from expectancy×value theory; [Eccles & Wigfield, 2002](#)). However, [Perreira et al. \(2010\)](#) further reported that a greater sense of family obligation of Latino students, who were mostly from immigrant families, predicted a more positive

view of school environments, and a positive school climate was associated with greater academic motivation of every dimension: importance, usefulness, future value, and intrinsic value of education.

Using the achievement goal orientation theory framework, which is the major framework of our study, Urdan (2004) reported that family orientation of students with immigrant and nonimmigrant backgrounds is connected to their performance goals with self-handicapping behavior and that their family orientation also partially moderates the relationships between the students' classroom performance-goal structure and performance-avoidance goals. Urdan and Mestas (2006) similarly reported that some described a desire to please their parents as one of the reasons to adopt the performance-approach goals. In these studies, Urdan and colleagues (2004; 2006), however, did not include mastery goal orientations in the study. When Urdan (2004) also found mean differences between the generational groups on the measures of performance goals, classroom performance-goal structure, family orientation, and achievement, all the differences were removed when family orientation was included as a covariate. This indicates that family orientation may be a mechanism explaining some of the differences between generational groups in the development of different goal orientations.

The Current Study

Expanding on these studies, we examined the role of family orientations on the achievement motivations of high school youths of different generational status (i.e., from immigrant or nonimmigrant families), when their perception of their parents' goals and classroom goal structures were tested simultaneously as predictors. The achievement motivations described in this study are intrinsic motivation and three types of goal orientations (i.e., mastery-approach, performance-approach, and performance-avoidance). Expanding on previous studies that examined the role of family orientation in performance goal orientations (e.g., Urdan, 2004; Urdan et al., 2007), our study included mastery goals in the scope of examining the roles of family orientations in achievement motivations. The current study chose to collect our data and based our questions in the math classroom context because every

high school student is required to take a math class, thus helping to ensure our data is representative of the school's population. STEM (Science, Technology, Engineering, and Math) classes are known to be areas in which students often experience struggle and wide ranges of motivation (Gafoor & Kurukkan, 2015; Nurmi & Aunola, 2005; Saad, 2005). Below we list the specific research focus that guided the current study and hypotheses tested.

Family orientations and students' adaptive and less adaptive goals. High school youths' family orientations have been reported to predict the students' own performance goal orientation (Urduan, 2004). Would family orientation be connected to youths' adaptive motivations (that is, mastery goal orientation and then intrinsic motivation), in addition to performance goals? Fuligni (2001) reported that students' family orientation predicted the utility value, or usefulness, of their education. Utility value would include students' understanding of the underlying value of the task either currently or in the future (Eccles & Wigfield, 2002), and students' motivation through understanding the underlying value of the task was reported to predict mastery goals (Kim et al., 2010). More recently, Perreira et al. (2010) reported the connection between the family obligation of Latino students and academic motivation of various dimensions: importance, usefulness, future value, and intrinsic value of education. In turn, we hypothesized that family orientation would predict mastery goals and then intrinsic motivation (see Figure 1). According to Urduan et al. (2007), students could perceive family obligation as either pressure or as an opportunity to show gratitude for their parents' sacrifice, which could predict different types of motivation.

The mediating role of family orientations between parents' goals and students' goal orientations. Next, high school students' goal orientation has been reported to be predicted not only by family orientations (Urduan, 2004) but also by the parents' goals of similar kinds (e.g., Friedel et al., 2007). Then, would high school youths' family orientation predict the different types of adaptive and less adaptive goal orientations, particularly as a mediator between their perceptions of parental goals and the different types of achievement goal orientations (and then intrinsic motivations)? Will the prediction of family orientation on their goal orientations in the classroom context remain significant even when their perceptions of classroom goal structures as a strong predictor of students' goal orientations were tested

simultaneously as predictors? Considering that family orientation is students' "desires to please or provide for family members through academic achievement" (Urduan, 2004, p. 255), the youths' family orientation was hypothesized to be predicted by their perceptions of their parents' goals for them and then predict their own goal orientations (see Figure 1).

The moderating role of generational status on relationship between parent's goals, family orientation, and students' goal orientations. Will the relationships between the predicting variables (i.e., parental goals, family orientation) and the students' goal orientations be dependent on the students' generational status? According to Fuligni and Yoshikawa (2004), immigrant families show interdependence, so for the children of immigrant parents, their connection between parental goals and their own achievement goals (e.g., among parental goals, family orientation, and one's own goals of a similar kind) could be stronger. According to Urduan et al. (2007), students with collectivist cultural backgrounds strive to please family members by succeeding academically more as an internal, rather than external, motivational orientation. To test the hypotheses, we included interaction terms to test the moderating effect of students' generational status on the relationships among their perceptions of parents' goals, family orientations, and achievement goals of a similar kind.

The moderating role of generational status on relationship between classroom goal structures and students' goals. Will the relationships between classroom goal structures and students' individual goal orientations be also dependent on the students' generational status? We could not develop a specific hypothesis for this question with the limited research examined in previous studies. Instead, Perreira et al. (2010) reported that having a greater sense of family obligation predicted a more positive view of school environments and that a more positive school climate, feeling respected and valued by the school, was associated with greater academic motivation: thus, in the current study, we hypothesized that high family orientation helps students perceive their classroom environment more positively (e.g., high classroom mastery goal structure).

Generational status, family orientation, and achievement goal orientations. Lastly, would students' immigration status explain their mean

differences of achievement goal orientations? As was reported in Urdan (2004), we hypothesized the mean differences in performance-goal orientations and students' perceptions of classroom performance-goal structures between the children of immigrant parents and those of nonimmigrant parents and that any such differences would be reduced when students' family orientation was included as a covariate.

Methods

Participants and Procedure

A total of 331 high school students (ninth grade; ages 13–16, with 96% of the students in the ages of 14 or 15; 141 boys and 187 girls) from one high school in the United States participated in the study, completing a series of assessments with regard to their math classes. The school had high attendance and low dropout rates (95% and <1%, respectively) and had 30% of the school population who were eligible for the free or reduced-price lunch program. Approximately, 5% of the school population were English language learners.

This high school was situated in the western United States and had a highly diverse immigrant population. Based on the students' self-reported pan-ethnic (e.g., Asian) and ethnic (e.g., Chinese) identifications, their identifications of their parents' ethnic (e.g., Chinese) background, and their reported generational status, we found the sample decomposition as shown in Table 1. We followed Fuligni (1997) and defined and coded *first generation* as students who were born outside of the United States but moved to America with their parents, *second generation* as students who were born in the United States but whose parents were born in another country, and *third+ generation* as students who were born in the United States to parents who were both also born in the United States.

For the current study, we considered the “children of immigrant families” as including the first-generation and second-generation categories into a group and the “children of nonimmigrant families” included the third-generation and all later generations. The proportion of generational status varied across students from various ethnic backgrounds (Table 1), similar to various studies reported earlier (e.g., Fuligni, 1997) and was consistent with both national and

local figures. For example, a majority of the students with Mexican or Chinese backgrounds were either first- or second-immigration generation, whereas few students of European backgrounds were of these two generations.

Table 1.
Sample Decomposition According to Ethnic Background and Generation Status.

Ethnic background	Generations			Total
	First	Second	Third+	
Asian-American	22	52	8	82
African-American	1	4	10	15
Latin-American	12	52	24	88
European-American	4	9	58	71
Multiple Heritage	1	7	30	38
Middle East Asian-American	4	17	0	21
Total	44	141	130	315

Measures

All items used a 7-point Likert scale. We calculated Cronbach’s α for scale reliabilities and performed a confirmatory factor analysis for each scale to identify distinct but correlated latent factors. We used the cut-off criteria based on a comparative fit index of $CFI > .95$ and $RMSEA < .08$ (Kline, 2015), and the fit indices of each scale were acceptable.

Personal achievement goals. We used the Patterns of Adaptive Learning Survey (PALS; Midgley et al., 2000) to measure the mastery (e.g., “It’s important to me that I learn a lot of new concepts this year”; 5 items; $\alpha =$

.87), performance-approach (“It’s important to me that other students in my class think I am good at my classwork”; 5 items; $\alpha = .87$), and performance-avoidance (“It’s important to me that I don’t look stupid in class”; 4 items; $\alpha = .74$) goal orientations.

Perceptions of classroom goal structure. We used the PALS (Midgley et al., 2000) for classroom mastery goal structure (e.g., “In our class, really understanding the material is the main goal”; 5 items; $\alpha = .83$) and classroom performance goal structure (e.g., “In our class, showing others that you are not bad at classwork is really important”; 7 items; $\alpha = .84$).

Perceptions of parents’ goals. We also used the PALS (Midgley et al., 2000) for parental mastery goals (“My parents want me to understand my classwork, not just memorize how to do it”; 4 items; $\alpha = .68$) and parental performance goals (“My parents would like me to show others that I am good at classwork”; 5 items; $\alpha = .81$).

Family orientations. We used items from Urdan (2004; “The main reason I try to do well in school is to bring honor to my family”; 4 items; $\alpha = .79$), a shortened version of Fuligni et al. (1999).

Intrinsic motivation. We used Ryan and Connell’s (1989) Self-Regulation Questionnaire–Academics to measure intrinsic motivation (“because I enjoy math”; 6 items; $\alpha = .87$).

Demographic questionnaire. The demographic questionnaire included information about age, grade, gender, languages spoken at home, race/ethnicity, generational status, and place of birth of participants, their parents, and their grandparents.

Plan of Analyses

First, as preliminary analyses, the two generational groups (children of immigrant families or children of nonimmigrant families) were compared to determine whether there were mean differences on the measures of major variables. Family orientation was used as a covariate (one-way analysis of covariance) to determine whether family orientation may operate as the mechanism that produces significant differences between generational groups on these dependent variables. Then a correlation matrix with the bivariate correlations among all measured variables was constructed.

Then, to address the major aim of the study, we tested the hypothesized path model using *MPlus* version 8.2 (Muthén & Muthén, 1998–2018) and based the goodness of fit index on the cutoff criteria of Hu and Bentler (1999). The path model (Figure 1) included classroom goal structures and parent goals as predictors of the students’ own goal orientation, and students’ family orientation was hypothesized to be mediating the relationships between parents’ goals and students’ own goal orientation of a similar kind. Demographic variables such as generational status and sex were included in the path model, and interaction terms were included to test if the relationships between the predicting variables (i.e., classroom goal structures, parental goals, family orientation) and the youths’ individual goal orientations were dependent on the youths’ generational status.

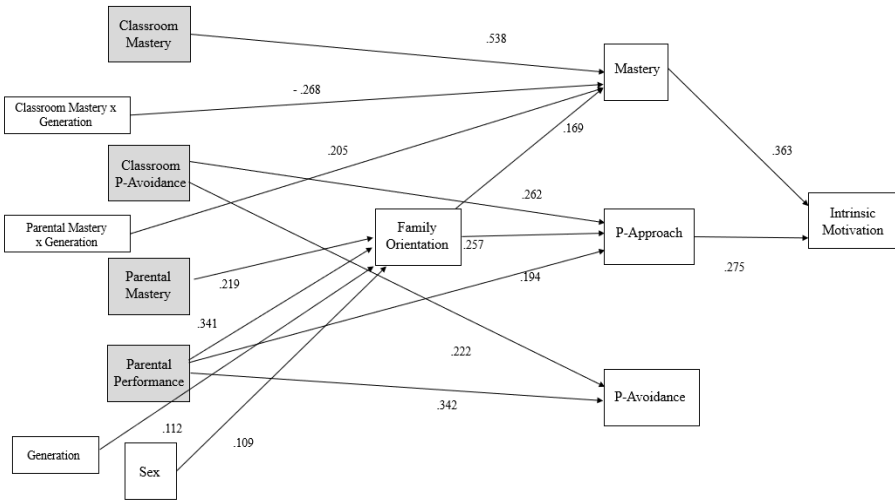


Figure 1. Path analysis results with significant standardized path coefficients. This shows the associations among students’ perceptions of classroom goal structures, parental goals, family orientations, personal goals, and intrinsic motivations.

Note. All paths presented in Figure 1 are significant at the $p < .05$ level.

Results

Preliminary Analyses

We found significant mean differences between these generational groups: compared to the children of nonimmigrant families, the children of immigrant families had significantly higher scores for family orientation, parental performance goals, and classroom performance goals. When controlling for family orientation, for classroom performance goals, the differences between the children of immigrant families and the children of nonimmigrant families were nonsignificant: $F(1, 290) = 3.33, p = .07$ ($M_s = 4.11$ and 3.84 , respectively). For parental performance goals, the differences remained significant even when controlling for family orientation: $F(1, 290) = 6.62, p = .01$ ($M_s = 4.55$ and 4.12 , respectively).

A correlation analysis was conducted using Pearson’s correlation to explore the relationships between variables (see Table 2).

Table 2.
Correlations Between Variables.

	1	2	3	4	5	6	7	8	9	10	11
Mastery goals	-										
Performance-approach goals	.25**	-									
Performance-avoidance goals	.21**	.76**	-								
Intrinsic motivation	.42**	.31**	.21**	-							
Parents' mastery goals	.41**	.19**	.18**	.32**	-						

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Parents' performance goals	.16**	.44**	.43**	.20**	.34**	-						
Family orientation	.31**	.45**	.31**	.26**	.35**	.43**	-					
Classroom mastery goals	.46**	.22**	.18**	.30**	.33**	.05	.26**	-				
Classroom performance goals	.21**	.43**	.37**	.24**	.16**	.48**	.34**	.16**	-			
Sex	.06	-.03	-.09	.07	.04	-.10	.08	.08	-.06	-		
Immigrant generation status	.07	.09	.07	-.00	.05	.18**	.18**	-.00	.17**	-.01	-	
<i>M</i>	5.78	3.77	4.01	2.60	5.47	4.38	5.28	5.44	4.00	1.57	0.59	
<i>SD</i>	1.06	1.52	1.53	1.30	1.17	1.58	1.47	1.32	1.32	0.50	0.49	

Note. * $p < 0.05$, ** $p < 0.01$

Primary Analyses

When tested as a hypothesized path model, the fit indices were acceptable: $\chi^2(df=29) = 46.46$, $p < .02$, CFI = .98, TLI = .96, RMSEA = .04 [.02, .07], SRMR = .03 (see Figure 1). Please see Table 3 for more detailed information on standardized direct, indirect, and total effects. Note that we found minimal between-class differences across the various math classes (i.e., the intraclass correlations for the variables were no greater than .08) and thus conducted a one-level path analysis (Wolters, 2004).

Table 3.

Standardized Direct and Indirect Effects (for Paths with Significant Effects Only).

Path	Direct	Indirect
<i>To Mastery goals from</i>		
Classroom mastery goals	0.54	--
Classroom mastery goals x Generation	- 0.27	--
Parents' mastery goals x Generation	0.21	--
Parents' mastery goals (via Family orientation)	--	0.04
<i>To Performance-approach goals from</i>		
Classroom performance goals	0.26	--
Parents' performance goals	0.19	--
Parents' performance goals (via Family orientation)	--	0.09
<i>To Performance-avoidance goals from</i>		
Classroom performance goals	0.22	--
Parents' performance goals	0.34	--
<i>To Intrinsic motivation from</i>		
Classroom mastery goals (via Mastery goals)	--	0.20
Classroom mastery goals x Generation (via Mastery goals)	--	- 0.10
Parents' mastery goals x Generation (via Mastery goals)	--	0.08
Parents' mastery goals (via Family orientation and Mastery goals)	--	0.01
Parents' mastery goals (via Family orientation and Performance-app. goals)	--	0.02
Classroom performance goals (via Performance-app. goals)	--	0.07
Parents' performance goals (via Family orientation and Performance-app. goals)	--	0.02

Parents' performance goals (via Family orientation and Mastery goals)	--	0.02
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Note. Only statistically significant path are reported at $p < 0.05$.

Mastery goals and testing moderation. Students' perceptions of the classroom mastery goals directly predicted their own mastery goals. Students' perceptions of their parental mastery goals did not directly predict their own mastery goals, but there was an indirect effect between the two variables via their family orientation. Interestingly, when predicting students' own mastery goals, we found interaction effects between classroom mastery goals and generation, as well as between parents' mastery goals and generation.

To further explore the interaction between students' classroom mastery goals and their own mastery goals, a simple slopes analysis was conducted (Aiken & West, 1991). Participants were divided into two different immigration generation groups (i.e., the children of nonimmigrant families and the children of immigrant families) and two levels of classroom mastery goals (low = 1SD below the mean and high = 1SD above the mean). The results of the simple slopes analysis are presented in Figure 2. Results showed that the immigration generation moderated the effects of the classroom mastery goals on students' own mastery goals. Specifically, for the children of nonimmigrant families, the association between classroom mastery goals and students' own mastery goals was stronger ($r = .56$) compared to the children of immigrant families ($r = .40$).

In addition, the interaction between parents' mastery goals and students' own mastery goals was investigated. The results of the simple slopes analysis are shown in Figure 3. Results indicated that immigration generation groups moderated the effects of the parents' mastery goals on students' mastery goals. Moreover, for the children of immigrant families ($r = .50$), compared to the children of nonimmigrant families ($r = .32$), the association between parents' mastery goals and students' own mastery goals were stronger.

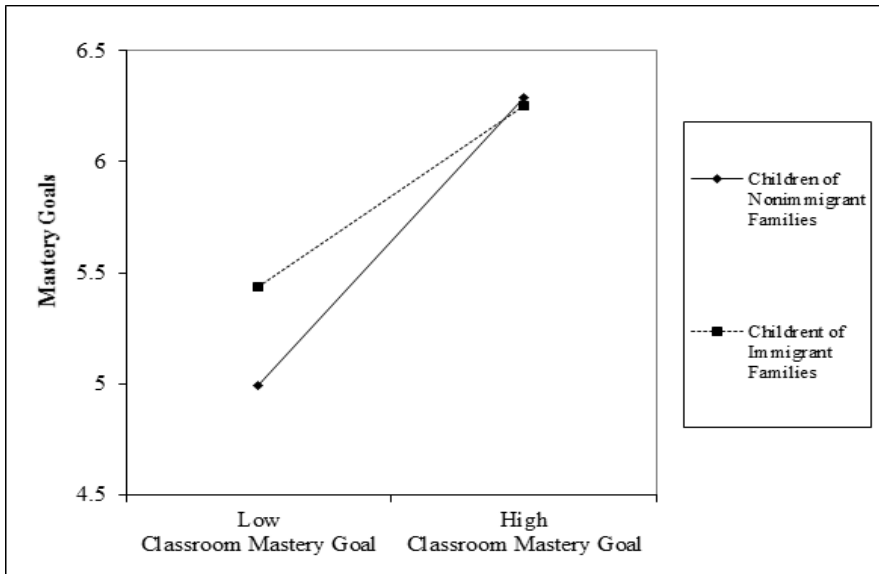


Figure 2. Students' own mastery goals as a function of immigration groups and classroom mastery goals.

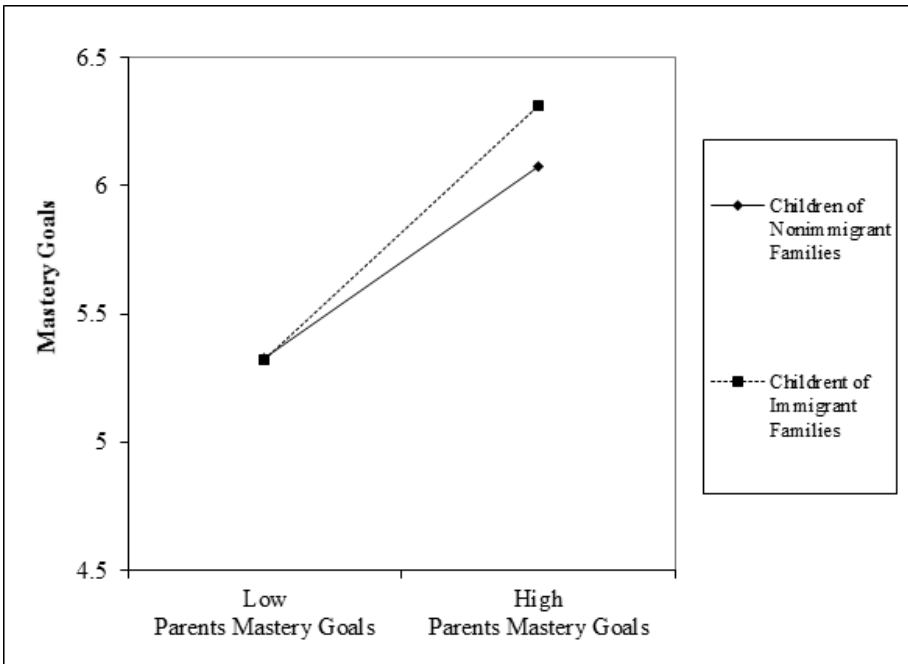


Figure 3. Students' own mastery goals as a function of immigration groups and parents' mastery goals.

Lastly, between students' family orientations and students' classroom mastery goal structures, the association was statistically significant ($r = .41$) for the children of immigrant families; although, for the children of nonimmigrant families, the relationship was not statistically significant.

Performance-approach and performance-avoidance goals. Students' perceptions of classroom performance goals directly predicted their own performance-approach and performance-avoidance goals. Students' perceptions of parental performance goals also directly predicted their own performance-approach and performance-avoidance goals. Family orientation mediated students' perceptions of their parents' performance goals and their

own performance-approach goals, but it did not mediate their own performance-avoidance goals.

Intrinsic motivation. Both the students' mastery and their performance-approach goals directly predicted their intrinsic motivation. In turn, we observed that the students' perceptions of classroom and parental goals had indirect effects on their intrinsic motivation, as mediated by their own mastery or performance-approach goals.

Discussion and Implications

The current study examined the complex role of the family orientations of high school youths from immigrant or nonimmigrant families on their own achievement goal orientations and intrinsic motivation. These relationships were examined when the students' perception of their parents' goals and classroom goal structures were tested simultaneously as predictors.

Family Orientations and Students' Adaptive and Less Adaptive Goals

The results supported students' family orientation as connected to adaptive goal orientations—mastery goal orientation, in addition to the performance goal orientations that have been reported earlier (Urda, 2004). Students' pursuit of the mastery and performance-approach goal orientations then predicted the intrinsic motivation of the students. The study results are aligned with Perreira et al. (2010) that connected family respect and various kinds of achievement motivations, such as importance, usefulness, future value, and intrinsic value of education. Still, the strength from family orientation to goal orientation was more firmly connected to the one of performance-approach than to the one of mastery goals, indicating family orientation in itself could be felt by students more as internal pressure, but less as fully internalized values—as a chance to show gratitude to parents who have sacrificed for their children.

Interestingly, the family orientation did not connect to their performance-avoidance goals, which are considered as maladaptive. Earlier reports (Urda, 2004) also showed students' family orientation predicted more strongly their performance-approach than their performance-avoidance goals. As a whole,

the findings indicate the youth's family orientation would support their willingness to *approach* toward the achievement task (instead of *avoidance* of the task). More examination of the current cultural and familiar values on adaptive motivation is needed.

Mediating Role of Family Orientations Between the Parents' and Students' Goals

As we hypothesized, high school students' own desires to please or provide for family members through academic achievement partially mediated the relationship between their perceptions of their parents' goals and their mastery and performance-approach achievement goal orientations (and consequently intrinsic motivations). The family orientation significantly predicted students' achievement goal orientations for learning math in their math classroom context, even when their perceptions of classroom goal structures, which Wolters (2004) reported as a strong predictor of students' goal orientations, were tested simultaneously as predictors. This result suggests that although students' achievement motivation is shaped by the classroom culture they experience from year to year, their achievement motivation could be rooted in their perceptions of and values from their families. Educators should be intentional in guiding classroom goal structures but should also consider that students could bring certain values to the classroom context from their home contexts. Ideally, educators would also potentially connect and collaborate with parents in supporting students' quality of motivation in the classroom.

Notably, strength of family orientation was more strongly based on students' perceptions of their parents' performance goals than on their perceptions of their parents' mastery goals. This indicates that family orientation could be perceived more strongly when students perceive their parents as focusing on achievement outcomes—expecting higher returns for their immigration as an investment (e.g., Fuligni & Yoshikawa, 2004; Portes & Rumbaut, 2001)—rather than the learning process itself. In this way, students' family orientation seems to strongly mediate between their internal pressure to win over their peers and their parents' goal related messages of a similar kind (Fuligni, 2001; Urda, 2004; Urda & Mestas, 2007). Although

the familiar value of students seems to be connected to both mastery and performance-approach goal orientations, educators should consider how the cultural and familiar values students bring might also shape their internal pressure to do well and could be better prepared to support students' pursuit of mastery goal orientations through potential collaboration with parents.

In this study, family orientation functioned as a mediator when we examined youths of both immigrant and nonimmigrant backgrounds as whole groups (e.g., Fuligni, 2001; Urdan, 2004). However, a few relationships between the predicting variables (i.e., parental goals, family orientation) and the youths' individual goal orientations were dependent on the youths' generational status, which is to follow in the section below.

Moderating Role of Generationals Status on the Relationships

In comparison of children from immigrant and nonimmigrant families, immigrant families' mutual interdependence between the children and the larger family (Fuligni & Yoshikawa, 2004) seemed to contribute to stronger connections between parents' and children's own mastery goals. Interestingly, this moderating effect of generation was the case for mastery but not performance goals (i.e., relationships between parental performance goals and children's performance-approach goals). Informed by Urdan et al. (2007), the current study also tested the hypothesis that for immigrant students with largely collectivist cultural backgrounds, striving to please family members by academic success could be considered more as an internal than an external motivational orientation. The hypothesis was not supported, however, because the relationship between family orientation and mastery goals was not stronger for children of immigrant families.

Perreira et al. (2010) earlier reported that students—mostly children of immigrant families—with high family orientation (focusing on family respect) perceived their school climate more positively through feeling respected and valued by the school, which was consequently associated with greater academic motivation. Aligned with their conclusion, we found statistically significant relationships between students' family orientations and their classroom mastery goal structures for children of immigrant families, but not for children of nonimmigrant families. The finding also

indicates more complex parental and familial roles (i.e., parent mastery goals and family orientation) in mastery goals among children from immigrant families. In other words, educators should appreciate how ethnically diverse immigrant students' family orientations serve as an important contributor to a classroom culture that emphasizes the value of mastery goals.

Generational Status, Family Orientation, and Achievement Goal Orientations

Aligned with previous reports, we found that the children of immigrant families had significantly higher scores for family orientation (e.g., Fuligni et al., 1999; Urdan, 2004) and performance goal-related constructs (e.g., Urdan, 2004) compared to children of nonimmigrant families. The differences were reduced for classroom performance goals when family orientation of students was included as a covariate (aligned with Urdan, 2004), although the differences for parent performance goals (which were not tested in Urdan, 2004) were not reduced. This suggests that family orientation explains a large portion of the differences between children of immigrant and nonimmigrant families in their construction of performance goals. Understanding students' family orientations could help educators understand students' performance goals in class.

There were no statistically significant mean differences between children of immigrant and of nonimmigrant parents in the mastery goal orientations or students' perceptions of classroom mastery-goal structures. This implies that children respond similarly to perceived classroom mastery goals regardless of generational status.

Limitations and Future Studies

Future studies could examine longitudinal relationships, particularly including other family-related demographic variables (e.g., parental level of education, socioeconomic status), as we only examined one-time data collection. Moreover, in our study, students from immigrant families versus nonimmigrant families differed both in ethnicities not just generational status

(i.e., confounded), so future studies could have a sample decomposition controlling the ethnic background of students of both groups. Importantly, the connection between family orientation and mastery goals of students from immigrant families was more complex than was expected, and more studies could examine the role of family- or parent-related constructs on adaptive motivations of students from immigrant families.

Conclusion

In this study, we showed the complex roles of family contexts (parents' goals and family orientations) on adaptive mastery goals for children of immigrant families, going beyond researchers who had a major focus on performance-approach or less adaptive performance-avoidance goals. Developing awareness and understanding of the various cultural and familiar sources of students' mastery, performance-approach, or performance-avoidance goals (which go beyond the classroom) could be an integral component of classrooms for the appreciation of students' diverse ethnic, cultural, and immigrational backgrounds. The findings in this study underscore the need for educators who often do not share a cultural background with many of their students—particularly in ethnically diverse areas—to develop awareness and understanding of the various cultural and familiar sources of students' achievement motivation. Assumptions regarding students' motivation and their cultural and familiar values may be counterproductive and dismissive of students' needs, values, and goals for achievement.

Teachers could be aware of not only their own goals for their students but also their students' family orientations and perceptions of their parents' goals, as these factors can potentially shape student achievement motivation. This potential might indicate that schools and classroom teachers, through better understanding of these dynamics, could place greater emphasis on collaborating with parents and families to shape students' quality of motivation (e.g., mastery and performance-approach) and support students with diverse backgrounds in the classroom. Scholars and educators in the field of research should also continue to examine larger family and cultural contexts beyond the classroom context (such as students' perceptions and

orientations constructed from their family contexts) for the purpose of understanding students with diverse backgrounds.

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“Einstein Worked his Socks off”. Conceptions of Intelligence in University Teaching Staff

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“Einstein Worked his Socks off”. Conceptions of Intelligence in University Teaching Staff

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Abstract

There is vast amount of research that links implicit theories of intelligence with several learning-relevant variables in both learners and teachers alike. However, there is a gap in the literature, as there is almost no research done with university teachers. Furthermore, most scientific research polarizes incremental and fixed views of intelligence in spite of data that show there is heterogeneity in participants' views. This study explores the implicit theories of intelligence of university teachers (N = 20), employing a category system for the analysis of semi-structured interviews designed to capture heterogeneity. Participants were asked to express their opinion about several small vignettes regarding intelligence. The number of participants' explanations related to intelligence and the complexity in their argumentation was considered. Results show differences in both measures among different fields of knowledge and gender, but not in relation to years of teaching experience. Future implications for research, intervention, and implicit theories measurement are discussed.

Keywords: university teachers, higher education, implicit theories of intelligence, fields of knowledge, teaching experience, gender



“Einstein se Hartó de Trabajar”. Concepciones de Inteligencia del Profesorado Universitario

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Resumen

Existe una amplia investigación que relaciona las teorías implícitas de inteligencia con diversas variables vinculadas con el aprendizaje, tanto en estudiantes como en profesores. Sin embargo, encontramos un vacío en la literatura, debido a que no existe apenas investigación realizada con profesores universitarios. Además, la mayor parte de la investigación científica polariza las concepciones incrementales y fijas de la inteligencia, a pesar de los datos que demuestran la existencia de heterogeneidad en las concepciones de los participantes. Este estudio explora las teorías implícitas de inteligencia de profesores universitarios ($N = 20$), empleando un sistema de categorías para el análisis de entrevistas semiestructuradas diseñadas para captar heterogeneidad en las concepciones. A los participantes se les pedía que expresaran su opinión sobre varias viñetas relacionadas con la inteligencia. Se consideró el número de explicaciones de los participantes que guardaban relación con la inteligencia y la complejidad de su argumentación. Los resultados muestran diferencias en ambas mediciones entre la rama del conocimiento y el género, pero no en cuanto a los años de experiencia en la enseñanza del profesorado universitario. Se discuten las implicaciones futuras de cara a la investigación, intervención y la medida de las teorías implícitas de la inteligencia.

Palabras clave: profesores universitarios, educación superior, teorías implícitas de inteligencia, rama del conocimiento, experiencia en la enseñanza, género



Implicit theories are personal beliefs that are formed through one's own personal and cultural experience (Sternberg & Davidson, 1986). The propositions of implicit theories are not accessible to individuals, and, therefore, they do not use them to consciously analyze reality. Rather, they understand reality through them (Cubero, 1996). Implicit beliefs about intelligence are related to how individuals understand their own capacities, and, therefore, constitute certain types of control beliefs (Skinner & Zimmer-Gembeck, 2011). These control beliefs influence the perceived control that individuals have about the activities they are involved with and, therefore, regulate behavior, motivation, and coping mechanisms under conditions of challenge (Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013; Skinner & Zimmer-Gembeck, 2011).

Dweck identifies two types of beliefs on intelligence: the *incremental theory of intelligence* (or growth mindset) postulates that intelligence can be modified through continuous effort and work, while the *entity theory of intelligence* (or fixed mindset) argues that intelligence is innate and cannot be modified over the course of a person's life (Dweck, 1986; Dweck, 2000; Yeager & Dweck, 2012).

Many studies have been conducted in relation to these two types of beliefs and the repercussions that they have on people's behavior, motivation, and coping mechanisms related to the academic domain. The adscription to an incremental theory of intelligence is related to greater persistence against failure (Dweck, 1986; Renaud-Dube, Guay, Talbot, Taylor & Koestner, 2015; Yeager & Dweck, 2012), enhanced intrinsic motivation (Renaud-Dube et al., 2015), better academic achievement (Park et al., 2016; Yeager & Dweck, 2012), and resilience (Yeager & Dweck, 2012). The prior level of expertise in tasks in these individuals is not important, as they will eventually improve, attributing their successes to their efforts (Dweck, 1986; Hong, Chiu, Dweck, Lin & Wan, 1999; Renaud-Dube et al., 2015; Robins & Pals, 2002).

Belief in an entity theory of intelligence, on the other hand, has been linked to less achievement and persistence in difficult, initially confusing, or qualitatively new tasks (Dweck, 1986; Licht & Dweck, 1984; Lawson, 2011; Robins & Pals, 2002), greater extrinsic motivation (Lawson, 2011), and avoidance of difficult tasks (Dweck, 1986). In these individuals, the prior skill level will influence the tasks they engage in. They will avoid difficult tasks in

order not to fail, as they are more concerned with demonstrating their skill level than about improving it (Dweck, 1986; Lawson, 2011; Robins & Pals, 2002).

These results are supported by several meta-analyses. Burnette et al. (2013) reported significant correlations between mindsets and self-regulatory processes, which, in turn, predicted achievement, especially in the presence of ego threat. A small direct link between mindsets and achievement have also been demonstrated in middle, high school, and college students, although it is also influenced by the cultural background of participants (Burnette, et al., 2013; Costa & Faria, 2018; Sisk, Burgoyne, Sun, Butler, & Macnamara, 2018). Systematic reviews and meta-analyses of mindsets interventions have shown how they are effective to improve motivation, academic achievement, and brain activity, especially in high-risk and low socioeconomic status students (Sarrasin et al., 2018; Sisk, et al., 2018).

Since these concepts guide students' learning and development, their healthy construction is of vital importance. The development of these conceptions of intelligence is influenced by the relationships and tasks students experience in their environment, right from a very young age, by means of parental or teachers' influence (Dweck, 2000; Gunderson et al., 2013; Moorman & Pomerantz, 2010; Park et al., 2016; Yeager & Dweck, 2012).

The Concept of Intelligence among Teachers

Teachers play an active role in the development of their student's implicit theories of intelligence. In Park et al. (2016)'s longitudinal study, the higher the teachers valued performance and final results, praising the most successful students in front of the whole class, the more students developed entity theories of intelligence. The association between teachers who placed more emphasis on learning and mastery of the topic in question, and the development of incremental theories, however, while positive, was not significant.

Teachers' theories of intelligence are also related to their teaching practice. Teachers who subscribed to an entity theory of intelligence were found to feel less responsible for the academic achievements of their students (Patterson,

Kravchenko, Chen-Bouck, and Kelley, 2016). They are also more likely to have an outcome-based teaching style (Park et al. 2016) and to react to students' failures by consoling them for their low natural capacity, lowering both their motivation and self-efficacy (Rattan, Good & Dweck, 2012). However, there is a positive correlation between teacher self-efficacy and incremental theories of intelligence (Stroscher, 2003). This variable, which refers to teachers' confidence in their own capacity to motivate their students and help them learn and improve, is related to numerous positive results, such as persistence when dealing with students' difficulties (Gibson & Dembo, 1984), better academic outcomes (Katz & Stupel, 2016), and less stress in relation to teaching (Greenwood, Olejnik & Parkay, 1990; Helms-Lorenz & Maulana, 2016; Senler, 2016), among others.

Some research conducted in this field has found that most teachers tend to view intelligence as a modifiable characteristic (Patterson et. al., 2016; Stroscher, 2003), while other articles show that teachers grant more importance to genetic influences (Antonelli-Ponti & Crosswaite, 2019; Antonelli-Ponti, Versuti, & da Silva, 2018), revealing inconsistent results. Science and more experienced teachers are more likely to subscribe to an entity theory of intelligence (Jonsson, Beach, Korp & Erlandson, 2012; Lynott & Woolfolk, 1994; Mascret, Roussel & Cury, 2015; Stroscher, 2003), although there are also inconsistencies in literature in relation to teaching experience (Patterson et. al., 2016). Regarding gender, Stroscher (2003) found no significant differences between male and female teachers.

All the studies described so far were carried out with primary and secondary school students and teachers. There is a major gap in the literature as regards university teaching staff, who have, in general, followed a different career and training path from teachers working in other areas. Given the competitiveness of the university field and its specific interest in the academic world and scientific research, the profile of university teaching staff is probably different from that of primary, secondary, or high school teachers. Furthermore, university teachers are not required to gain any teacher training in order to access a teaching position, since many of them begin lecturing while still earning their PhDs. Nevertheless, they represent an important part of the educational community, and have a major influence on students' development throughout their university studies. It is also important not to

forget their role as learners, since the vast majority of university teaching staff conduct scientific research, and the acquisition and integration of new knowledge forms part of their everyday activities.

We have only found one study which explores the characteristics of implicit theories of intelligence among university faculty. Villamizar & Donoso (2014) evaluated the implicit theories of 22 university teachers at a private university in Bucaramanga, Colombia. In this qualitative study, the authors employed individual interviews to explore teachers' views on intelligence, asking a series of direct questions about what they thought. The results revealed a wide variety of opinions related to what intelligence actually is, as well as a slight tendency to believe that it is a multiple construct. The study also found descriptions related to the idea that intelligence is something more than the results of a test. Finally, it concluded that there are no gender differences, and that the predominant view is that intelligence can be improved over time, although adults are not more intelligent than children.

Measuring Implicit Theories of Intelligence

In most of the studies found in the literature, implicit theories of intelligence are measured by means of a questionnaire containing a small number of items rated on a Likert-type scale. Respondents are asked to state the extent to which they agree with statements such as *“Everyone has a certain amount of intelligence, and they can't really do much to change it”* (Stroscher, 2003, Bahník & Vranka, 2017). General items like these do not seem to capture the complex nature of implicit theories of intelligence. In the meta-analysis developed by Costa & Faria (2018), specific implicit theories of intelligence scales showed greater association to student's academic achievement than general implicit theories of intelligence scales. Thus, contextualized assessments seem to be stronger predictors, as they are closer to the experience of participants.

Furthermore, most of the studies on this topic measure participants' adherence to one of the two types of implicit theories, as if it were a binary choice, often using a single piece of data (a number) as a measure of this adherence. This has also been highlighted by other researchers (Lüftenegger, & Chen, 2017). In our literature review, examples of this include the studies

by Stroscher (2003), Park et al., (2016), and Bahník & Vranka (2017), among others. In our opinion, views on intelligence do not necessarily have to conform to one of these two opposed extremes; rather, it is entirely possible to adhere to both theories simultaneously and treat them as separate factors. In fact, according to Lüftenegger & Chen (2017), correlations between both implicit theories vary widely (ranging from -.02 and -.78) and are generally too weak. Exploratory factor analysis has also revealed two distinct factors regarding both mindsets (Dupeyrat & Mariné, 2005).

Some authors, then, recommend using specific and contextualized Likert scales and treat both mindsets as separate factors (Costa & Faria, 2018; Lüftenegger & Chen, 2017). Furthermore, we also believe that views on intelligence should be considered as a dynamic element which may differ from situation to situation, even within a single contextualized domain of knowledge (Cubero, Contreras, & Cubero, 2016; Cubero, de la Mata, & Cubero, 2008; Matias-Garcia & Cubero-Perez, 2020), as several papers also point to. In another study using the same population and interview regarding intelligence conceptions, Matias-Garcia & Cubero-Perez (2020) demonstrated that participants employed both incremental and entity discourse depending on the discursive context, both elicited by the interview vignettes and constructed by the participants own talk. During the course of their interviews, the university teaching staff made contradictions in their discourse, such as expressing that learning could both improve intelligence or have no relation whatsoever to it. In a series of studies conducted by Leith et al. (2014), the authors found that people strategically modified their implicit theories in accordance with specific aims and social situations, guiding the circumstances to the preferred conclusion. In another study, teachers also dynamically changed their implicit theories in accordance with the context in which children or the person assessing them were presented (Murrone and Gynther, 1991). Finally, events such as the presentation of scientific G factor theory to future teachers could increase their adherence to an entity theory of intelligence (Jonsson & Beach, 2010).

If implicit theories of intelligence are understood as dynamic and interactive constructs which may be influenced by context, personal objectives, and even different events, then it is difficult to see how they can be faithfully reflected in a measure that is as simple as a Likert-type scale or

even a direct question about what the respondent thinks about intelligence. According to some perspectives on discursive interaction, it is necessary to analyze implicit theories from an approach of talk as contextualized actions (Cubero & Ignacio, 2011). Both interaction and contextualization are needed for the study of implicit theories.

The Present Study

In our study, our aim was to help fill in the gap which exists in the literature regarding teaching at university, conducting a qualitative analysis of the descriptions of intelligence offered by university teaching staff during a semi-structured interview in which participants were asked to give their opinion on a series of specific vignettes. Given that we view implicit theories of intelligence as being both interactive and contextualized, the specific aims of this study were as follows:

1. To explore university teaching staff's views and descriptions of intelligence.
2. To analyze the possible existence of differences in university teaching staff's discourse in accordance with their specific field of knowledge, teaching experience, and gender.

Method

Participants

Participants were selected according to three criteria: field of knowledge in which they lecture, years of teaching experience, and sex. The sample comprised 20 university teachers (10 men and 10 women) from the University of Seville. Four participants were selected from each field of knowledge, according to the category system in place at the university in question, namely: Arts and Humanities (A&H), Sciences (S), Health Sciences (HS), Social and Legal Sciences (S&LS), and Engineering and Architecture (E&A). Also, the selection process ensured that half the participants had less than 15 years' teaching experience at the university and the other half more than 15 years' experience. The characteristics of the sample group are given in Tables 1 and

2. The only inclusion criterion used was that the university teaching staff had to be currently lecturing at the university, regardless of their position or training.

Table 1.
Participants, variables and degrees.

Field of Knowledge	Men		Women	
	>15	<15	>15	<15
Arts and Humanities	History	Fine Arts	English Studies	Hispanic Filology
Science	Biology	Chemistry	Physics	Math
Health Science	Psychology	Optometry	Medicine	Pharmacy
Social and Legal Sciences	Law	Primary Education	Labor Relations	Journalism
Engineering and Architecture	Aerospace Engineering	Computer Engineering	Architecture	Materials Engineering

Table 2.
Age and teacher experience in university.

Group	Age		Teacher Experience	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Arts and Humanities	40.75	4.99	13.50	4.43
Science	39.25	17.56	13.75	17.75
Health Science	43.5	14.11	16.75	13.30
Social and Legal Sciences	49.25	11.81	20.25	17.29
Engineering and Architecture	41	3.92	13	4.97
<15 years' experience	34.80	5.96	6.66	4.43
>15 years' experience	50.70	8.98	24.30	10.07
Men	44.80	11.99	16.10	13.88
Women	40.70	10.18	14.80	10.08
Whole Sample	42.75	11.03	15.45	11.82

Instruments and Materials

A semi-structured interview was designed, called "Views on Intelligence within the Educational Field" (VIEF, Agudelo, 2015, Camas, Caro, Matías, & Cubero, 2015). The instrument comprises short cases or vignettes (Åkerlind, 2005; Kandemir & Budd, 2018), highlighting different dimensions of intelligence. We identified 12 relevant dimensions in which a view on intelligence could be expressed and contextualized. They were: Control, Heredity, Effort, Culture, Training, Critical Period, Context, Expectations, Associated Qualities, People, Gender, and Diversity of Intelligence. These dimensions were selected as they have been found to be central to the scientific study of intelligence (Brinch & Galloway, 2012; Plomin & Von Stumm, 2018; Protzko, Aronson, & Blair, 2013). They are also relevant in the everyday use of the concept in different contexts, such as media, family, school, etc. In total, 24 short statements about intelligence were developed, two for each of the dimensions (see Appendix A).

Authenticity in the interview is achieved by naming neutral authors and phrasing the statements in a simple way - as commonly uttered statements. The vignettes presented all followed the same structure: "*A source says + a statement related to intelligence*". In order to avoid making it difficult for participants to contradict the statement, sources were never experts in the issue being analyzed. Examples of sources include "a blog", "a politician", "a mother", and "a popular saying". Sources were never repeated and both sexes were equally represented within a wide variety of everyday contexts. All statements contained the word "intelligence" or "intelligent", in order to elicit responses related to this concept. Finally, all statements were phrased as something that could be said by a normal person, with no specific concepts or terms from psychological literature being used. They were as similar as possible to the statements and assertions that participants would have already heard in their everyday social interactions. The instrument was designed to ensure that the responses elicited were as closely linked as possible to their everyday life.

The instrument was tested with two university professors from the Psychology Faculty and other adults from outside the teaching field. Following the pilot test, the initial position of two items and the

phrasing of one question were modified. All interviews were digitally recorded.

The Atlas.Ti V.7 software program was used to systematize the data gathered from the interviews. This software package facilitates the analysis of complex phenomena in unstructured data sets. This program allowed us to codify our categories directly onto the interview recordings. Therefore, no prosodic information was lost, and no transcription was needed.

Procedure

In order to establish and select the sample group, potential participants were contacted through their university email addresses. All addresses were taken from the University of Seville website. Participants agreed to collaborate in the study after being informed of the objectives and the content of the interview in general terms; they did not receive any incentives. All the interviews were held in the teachers' own offices in Spanish, as it was their mother language, and lasted as much as one hour. All participants were interviewed by the same researcher, first author of this research.

Participants were asked what they thought about each vignette of the interview. In a few situations, if the response was too short or ambiguous in the interviewer's opinion, participants were asked to clarify or to expand. All participants were encouraged to freely express their opinion about each statement.

Results

A category system was built taking into account the responses of the recorded interviews. The utterances were segmented and analyzed considering the unit of meaning as the unit of analysis. A unit of meaning is a unit of discourse that contains an idea or a theme, which may or may not concur with the syntactic unit of the sentence or sentences being presented. During discourse, a new unit starts when there is a change in the theme of the content being expressed, i.e. that which is being spoken about. A sentence can contain more than one unit of meaning.

From the units of meaning extracted from the participant's responses, we constructed 116 different categories related to intelligence. These categories were later organized into 18 different topics, as several themes arose from the interviews. These topics were: Effort, Genetic Influence, Development in Non-Specific Terms, Global Environment, Formal Education, Culture, Activities, Teacher Influence, Parental Influence, Developmental Characteristics, Motivational and Emotional Influence, Others' Expectations Influence, Own Expectations Influence, Other Personal Characteristics Influence, Characteristics Associated to Intelligent People, Gender, Presence of Intelligence in Activities Outside Academic Fields, and Social and Emotional Intelligence. Most categories in this system were developed considering the participants' explicit expression of the influence or lack thereof on intelligence development of a certain activity, personal characteristic, or contextual factor. Most relevant dimensions were included in the study. The first author of the study codified all interviews. A second experimented researcher also codified 20% of the interviews in order to obtain an inter-rater reliability measure of the categorization. The Kappa Index was calculated, obtaining a value of 0.861.

Finally, an upper-level hierarchical categorization was developed, where different categories were put together taking into account different criteria in order to obtain global results. These categories are Global Influences of Change (all categories that relate to modifiability of the intelligence), Specific Influences of Change (all categories that expresses the relation of something specific on intelligence), Non-Specific Influences of Change (all categories that expresses that intelligence can or cannot be modified, but not telling how), Individual Influences of Change (all categories related to the individual's actions and characteristics linked to intelligence malleability), Environmental Influences of Change (all categories related to the environment that may or may not affect the development of intelligence), and Total Genetic Influence (all categories related to genetic influence).

Research Data

Participants' descriptions identified influence on intelligence from several sources. Effort (70% of participants), formal education (65%), means and

culture of a country (60%), non-specific actions (they express you can do things to improve your own intelligence, but they don't specify what) (70%), learning (75%), instruments developed to improve your intelligence (70%), teachers (50%), and parents (55%).

For instance, an A&H participant answered in vignette 8, "I have always been told that if you set it as a goal, you can become more intelligent":

"Always, constancy and perseverance in wanting to advance and continue will always put you in a much higher spot than before."

A S participant said in vignette 16, "A child says he feels intelligent after having learned to do a new school task":

"Well, it's a way... I believe it is a way of growing your intelligence, being able to answer to new challenges. Then, if you are able to face a new challenge, a new activity, then I think you are growing an increment of your intelligence. It forms part of learning."

However, they also explicitly expressed there is not an influence from other or even the same sources, such as effort (55%), means and culture of a country (50%), good behavior during formal education (80%), learning (80%), participation in different types of activities (not related to school) (55%), motivation and emotions (55%), or your own expectations (55%).

For example, an E&A participant said in vignette 1, "A boy in his school says that his friend is very intelligent because she puts a lot of effort in everything":

"The sentence is not correct. Effort and intelligence have nothing to do with one another (...)"

A S&LS participant said in vignette 9, "In a YouTube video it was said that people are born with a particular intelligence that can be improved or made worse depending on what happens to them during their infancy":

"I don't think so. I believe your education during infancy can have an influence in your ability to interact with other people, in your emotions, in the way you can express ideas... but your intelligence... I don't think so. You can improve what you already have. If you are motivating a child since infancy, he will more likely be interested in culture, but if he has a limit... it doesn't matter how much you stimulate him. Yes, he will improve from his limit, but... I don't think his intelligence would develop."

Regarding the breadth of the concept of intelligence, 80% of participants associated good performance on an activity outside formal educational settings to being intelligent, while 65% of participants attributes some of those activities to simply learning or ability. Single-category data can be found in Table 3.

Table 3.

Global data of university teaching staff. Data refer to percentages of participants across the whole samples.

Dimension	Identified Factor	Explicit affirmations	Explicit negations
Effort	Influence of Effort in Intelligence Development	70%	55%
	An Intelligent Person does not Necessarily Need to Make an Effort	95%	0%
Development in Non-Specific Terms	Development of Intelligence in Non-Specific Terms		
	• Intelligence can be developed (in general)	45%	25%
	• Intelligence can be developed with limits	30%	
	• Intelligence is constructed	10%	
Global Environment	Influence of General Environment in Intelligence Development	35%	5%
Formal Education	Formal Education Influence in Intelligence Development	65%	35%
Culture	Influence of the Means and Culture of a Country or Context	60%	50%
	Each Intelligence is Related to the Context in which It is Used	25%	0%
Activities	Influence of Actions (Non-Specific) in Intelligence Development	70%	40%
	Influence of Good Behaviour in Intelligence Development	20%	80%
	Influence of Learning New Knowledge or New Abilities in Intelligence Development	75%	80%

	Influence of Participation in Different Types of Activities in Intelligence Development	35%	55%
	Different Kind of Intelligences are Developed in Relation to the Type of Activity that is Done	15%	0%
	Use of Instruments Developed for Improving Intelligence Influence	70%	15%
Teacher Influence	Influence of Teachers in Intelligence Development		
	• Cognitive Influence in Intelligence	50%	25%
	• Emotional Influence in Intelligence	40%	
Parental Influence	Influence of Fathers and Mothers in Intelligence Development		
	• Cognitive Influence in Intelligence	55%	30%
	• Emotional Influence in Intelligence	30%	
	• Material Influence in Intelligence	5%	
Developmental Characteristics	Possibilities of Development of Intelligence Along the Whole Vital Cycle	60%	15%
	Infancy is an Important Period in Intelligence Development	40%	0%
Motivational and Emotional Influence	Influence of Motivation and Emotions in Intelligence Development	35%	55%
Others' Expectations Influence	Others' Expectations Influence in Intelligence Development	30%	5%
	Verbal Positive Reinforcement Influence in Intelligence Development	45%	40%
Own Expectations Influence	Influence of Your Own Expectations in Intelligence Development	20%	55%
Other Personal Characteristics Influence	Influence of Personality in Intelligence	15%	10%

Data of upper-level categories can be found in Table 4. Regarding Global Influences of Change, we can see that participants tended more towards

modifiability than to considering intelligence as a fixed entity. Specific Influences of Change was more frequent than Non-specific Influences of Change. Both of them tended towards modifiability. Individual Influences of Change percentages of explicit affirmations is similar to that of Environmental Influences of Change. However, the percentage of explicit negations related to Individual Influence of Change is higher, almost reaching the explicit affirmations utterances percentage and exceeding the explicit affirmations participants percentage. Almost all participants believed there is a relation between genetics and intelligence.

Table 4.
Upper-level categories. Dara related to the whole sample.

Upper-Level Categories	Explicit affirmations		Explicit Negations	
	Percentage of Utterances	Percentage of Participants	Percentage of Utterances	Percentage of Participants
Global Influences of Change	32%	100%	17%	95%
Specific Influences of Change	23%	95%	15%	95%
Non-Specific Influences of Change	9%	85%	2%	50%
Individual Influence of Change	14%	90%	12%	95%
Environmental Influence of Change	12%	90%	4%	60%
Total Genetic Influence	8%	95%	1%	20%

Most relevant data related to fields of knowledge, years of teaching experience, and sex is presented. Regarding the most global upper-level category, Global Influence of Change, the A&H, S, and HS groups showed similar profiles according to the percentages of explicit affirmative and negative utterances (39% and 11%, 44% and 14%, and 39% and 12%, respectively). The S&LS and E&A groups presented mixed profiles, being the E&A group more oriented to the absence of change (25% and 21%, and 18% and 25%, respectively). Concerning the upper-level category Total Genetic Influence, the HS and S&LS groups displayed the lowest values of percentage of affirmative utterances (5% and 5%, respectively), the E&A group those highest (12%), and the A&H and S groups exhibited intermediate values (9% and 8%, respectively). Only in the HS and S&LS groups ever appeared explicit negative utterances that expressed there is not a direct relation of genetics on intelligence (1% and 2%, respectively).

Differences between more and less than 15 years' experience in global terms were minimal in the percentage of explicit affirmative and negative utterances in Global Influence of Change (32% and 15%, and 33% and 18%, respectively) and Total Genetic Influence (8% and 1%, and 8% and 1%, respectively).

However, there were differences between men and women in both upper-level categories. The men expressed more explicit affirmative utterances and less explicit negative utterances towards modifiability of intelligence than women (42% and 13%, and 23.5% and 20%, respectively). They also presented fewer affirmative utterances related to the role of genetic influence than women (6% and 1%, and 9% and 1%, respectively).

Finally, in order to analyze the complexity and width of the responses of the participants, the Frequency of Different Categories will be considered regarding the widest upper-level category, Global Influence of Change, which refers to the stability or modifiability of intelligence in all categories related to intelligence. A bigger number in this variable meant more different descriptions were presented and more elements were identified in their interviews as related or not with intelligence, thus presenting more complexity in their discourse. In general, all groups displayed higher complexity towards modifiability than to non-modifiability, except for the E&A group. The A&H,

S, and HS groups showed high complexity towards change, while S&LS and E&A groups exhibited high complexity towards non-modifiability. Considering teaching experience, results were similar for both groups. Regarding sex, the women tended to have less complexity towards change and more towards non-change than men. Table 5 shows all data of our groups' Frequency of Different Categories.

Table 5.

Means and standard deviations of the frequency of different categories in groups.

Groups	<i>Explicit affirmations</i>		<i>Explicit Negations</i>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Arts and Humanities	15,25	6,70	5,5	4,20
Science	15	5,29	6	2,94
Health Science	15,5	7,55	5,25	4,57
Social and Legal Sciences	11	8,76	7,25	7,5
Engineering and Architecture	5,75	8,18	9,75	4,57
Less than 15 Years Exp.	12,7	7,65	7,3	5,06
More than 15 Years Exp.	12,3	8,00	6,2	4,61
Men	14,4	7,57	5,4	4,20
Women	10,6	7,56	8,1	5,09
Global	12,5	7,62	6,75	4,74

Discussion

This study analyzed the views held by university teaching staff regarding intelligence, using a semi-structured interview which presented a series of vignettes upon which participants were invited to freely comment. The content of the interviews was later analyzed using a category system. Implications for university teachers' implicit theories understanding, intervention, and measurement will be discussed next.

When the results were compared in accordance with the field of knowledge, it was found that, at a global level, participants from the A&H, S,

and HS fields gave more numerous and more complex explanations and descriptions linked to the change or modification of intelligence, while those from S&LS field gave mixed descriptions. This may be due to the fact that this last group itself was very heterogeneous. S&LS includes degrees whose content is closely linked to the issue being studied here, such as Primary Education studies, as well as degrees focusing on areas far removed from human development and learning. Lastly, those from the field of E&A gave more numerous and more varied explanations for the lack of change in intelligence. As regards genetic influence, those from the HS and S&LS fields tended to minimize the importance of this aspect, since it was mentioned less often by these participants. Those from the field of E&A attached most importance to genetic influence. The category "Genetics does not directly determine intelligence", which refers to statements about total potential for any activity from birth, or the interaction between genetics and environment, reaffirms these findings, since it was only mentioned by some participants from the HS and S&LS fields. These results coincide with those found by previous studies, which reported that individuals studying degrees related to mathematics and science are more likely to subscribe to an entity theory of intelligence (Jonsson et al., 2012; Mascret et al., 2015).

As explained before in Research Data, at a global level, the different groups formed on the basis of years of teaching experience were fairly similar as regards the strength of the relationship and the complexity of the arguments posed. This finding complements those reported by previous studies of teachers from different educational levels, where some of them found differences regarding teaching experience (Lynott & Woolfolk, 1994; Strosher, 2003), while others did not (Patterson et. al., 2016).

However, major differences were found between men and women. In general, women systematically demonstrated a greater tendency than men to subscribe to an entity theory of intelligence in all the variables studied. Complexity towards change was lower, while complexity towards no change was higher (Table 5). Categories related to genetic influence also appeared more often in women's discourse. These findings contradict those that reported for secondary school teachers by Strosher (2003) and university teachers by Villamizar & Donoso (2014), who found no differences between men and women. Additional research is needed to clarify why these

differences might occur, as there are no studies that further analyze these gender differences. However, some studies have found an association between academically brilliant female students and entity beliefs of intelligence, but not in academically brilliant male students (Leggett, 1985; Licht & Dweck, 1984), which could be related to these results. Also, we could refer to gender stereotypes in STEM areas (Kim, Sinatra, & Seyranian, 2018) and the attributional gender bias regarding effort and ability, by which teachers (Espinoza, Fontes, & Arms-Chavez, 2014; Tiedemann, 2000), parents (Yee & Eccles, 1988), and students (Dickhäuser & Meyer, W., 2006) attribute successes and failures differently to boys and girls. This is a line of research that needs to be further developed.

The results of the study also revealed which aspects interventions regarding university teaching staff's intelligence beliefs should concentrate on. Working on elements that, in scientific research, are related to a greater development of intelligence would enable university teachers to become more aware of what is relevant to their own learning and development, as well as the learning and development of their students. As mentioned before, teachers' theories of intelligence are related to their teaching practice, instructional approach, and didactical conceptions (Park et al., 2016; Patterson et al., 2016; Rattan et al., 2012; Stroscher, 2003). An intervention would enable them to achieve greater perceived control over the activities in which they participate on a daily basis regarding their role as teachers, learners, and researchers (Burnette et al., 2013; Sarrasin et al., 2018; Skinner & Zimmer-Gembeck, 2011; Stroscher, 2003).

One clear and relevant focus of attention in our participants is a seemingly generalized view that emotions and motivation (55%) and one's own expectations (55%) do not influence the development of intelligence. Prior research has shown that these variables are of vital importance to academic and cognitive development (Alesi, Rappo & Pepi, 2016; Kriegbaum, Jansen & Spinath, 2015). Although both individual and environmental positive influence percentages are similar, the increased percentages related to the lack of individual influences on intelligence points to another relevant focus of attention regarding intervention. Although environmental influences are important, individual actions and characteristics are more controllable and modifiable by both students and teachers. Interventions towards this entity

implicit theory discourse would probably result in more perceived control (Skinner & Zimmer-Gembeck, 2011). In addition, those who would benefit most from an intervention on these views are university teaching staff in the field of E&A, due to the many different factors that they rejected as influencing the development of intelligence. It may be possible in this way to improve the academic results obtained in E&A degrees, which have the highest dropout rate in the whole Spanish university system (Ministerio de Educación y Formación Profesional, 2015). Furthermore, female university teaching staff also tended to subscribe more to entity descriptions in our data. If these results are confirmed in future studies, then, gender would also be a variable to be taken into consideration regarding the concept of intelligence among university teaching staff.

Finally, there are relevant implications to implicit theories measurement. First, the way in which the descriptions given are expressed is important to consider. When general or vague statements were made about intelligence (“A not particularly intelligent person may develop their intelligence”, “I simply don’t believe all that about people being born with something static”), these statements were more likely to be oriented towards development than more specific assertions (“Effort has nothing to do with intelligence”, “Schools have a major influence (on intelligence), about 90% I would say”). After asserting that intelligence in general could be developed, when asked to go into more detail, some participants systematically rejected the role of numerous factors, contexts, and activities as having any influence whatsoever. In the case of women, this relationship was even inverted. Women’s percentage of affirmative utterances in Non-Specific Influence of Change (7%) was higher than those that were negative (3%), while in Specific Influence of change negative utterances, it was higher (17%) than those that were positive (16.5%). Most general and non-specific statements made by women about intelligence were more oriented towards change, while their specific assertions were more oriented towards non-modifiability. This inversion was not found in men, although there was also an increase in the negative side of the Specific influence in relation to its Non-Specific counterpart. This has important implications for how the so-called implicit theories should be assessed. As mentioned earlier, much of the research conducted to date has, like Strosher (2003), used questionnaires containing a

series of general statements with no context, rated on a Likert-type scale, similar to those Non-Specific utterances, maybe presenting a bias. Other studies also support our results. As mentioned earlier, Costa & Faria (2018) demonstrated in their meta-analytic review that general scales present weaker correlations to relevant variables such as academic achievement than specific scales. Thus, the instruments used should be as contextualized and specific as possible, in order to determine what kind of ideas emerge in the context being studied.

It should also be noted that, on numerous occasions, when the percentage of participants for both explicit affirmations and negations are added together, the result is more than 100% (Table 3). This is due to the fact that some people expressed one opinion at one point in the interview, and then the opposite opinion later on. One example of this is in the effort related categories, in which 70% of participants explicitly stated that effort influences intelligence, while at the same time 55% of them also explicitly stated that it does not. This happened on multiple occasions and with different categories (Table 3). As mentioned before, people hold a wide range of different views about intelligence, and one idea may exist simultaneously with its complete opposite, its emergence determined by other factors such as discursive context. Nevertheless, in this study it was not necessary to intentionally and experimentally manipulate the theories, as in the studies by Leith et al. (2014). Rather, views emerged naturally throughout the course of a conversation about everyday cases linked to intelligence. By considering implicit theories as separate factors, we did not mask this heterogeneity, as other previous studies might have done. Our data support the idea that both incremental and fixed beliefs constitute separate factors (Lüftenegger & Chen, 2017). In Matias-Garcia & Cubero (2020), further analysis regarding university teaching staff heterogeneous conceptions of intelligence can be found.

Lüftenegger & Chen (2017) claimed that most incremental and entity theories are observed using explicit measures. We believe our methodology constitutes an alternative to these traditional models. By making participants discuss everyday statements or vignettes, they employed their own discourse and previous experiences related to intelligence conceptions. We did not ask them directly what they thought about intelligence or which was their level of

agreement with previously designed items (as in Likert scales). Rather, we asked them to use their implicit knowledge to discuss relevant small stories, answering to specific agents, such as mothers (Vignette 3), teachers (Vignette 24), or politicians (Vignette 11). During the conversation, they were able to introduce their own words and personal anecdotes, which served both as the final study data and as a more ecological contextualization of their subsequent talk, which could not be introduced by researchers. This methodology proved useful for capturing heterogeneity in their conceptions as well, as our participants were able to reflect contradictory views without them even realizing. The interactional nature of the interview, the presentation of different every day stories, and the fact that we did not ask them directly what they thought about intelligence allowed us to research implicit theories in discursive contexts which make use of sentences that could be familiar in participants' everyday life (Cubero & Ignacio, 2011).

As regards the limitations of the study, our participants were only a small sample within a very diverse and broad-ranging population (i.e. university faculty). This, along with the qualitatively descriptive nature of our analysis, makes it difficult to generalize to the whole population of university teaching staff. In order to achieve generalizability, more participants should be studied, and a quantitatively statistical approach should be followed. Specific gender studies must also be developed. The inclusion of new samples must consider different areas of expertise, not only for increasing representation in the university teacher population, but for providing university teachers with data related to their specific degrees. This would improve future interventions as we can give them examples they could recognize in their own experience. Furthermore, studies that address other populations' heterogeneity, such as learners or school teachers, may be useful to better characterize implicit theories of intelligence and how they interact with their environment in more depth.

Conclusions

The present study evaluated ideas regarding intelligence among university teaching staff (a field that has hardly been studied at all) through a semi-structured interview. Detailed profiles were developed for each group, in

accordance with field of knowledge, years of teaching experience, and sex. These profiles may prove useful for broader research studies and future interventions on this forgotten population, whose characteristics are different from those of other educators. Our results highlight the importance of considering both incremental and fixed theories as separate factors, as well as the need for conducting a more specific and contextualized evaluation of descriptions and views of intelligence, given both the heterogeneous and dynamic nature of the participants' beliefs and the key role played by context of meaning.

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Appendix A

PROJECT: “CONCEPTIONS OF INTELLIGENCE IN THE
EDUCATIONAL FIELD. UNIVERSITY TEACHER’S IMPLICIT
THEORIES” (VIEF)

Age: ____ Sex: _____ Field of Knowledge: _____

Teaching experience: _____ Date: _____

Interviewer: _____

We are doing a research about different educational topics. Now, we are going to present you a series of hypothetical cases in which we will ask your opinion about what is being stated in them. We thank your collaboration and your help in the building of knowledge. Once you are ready, we can start the interview.

1. A boy in his school says that his friend is very intelligent because she puts a lot of effort in everything. (Effort Dimension)
2. On television, an educational game for improving intelligence in boys and girls, which consists of doing certain activities, has being announced. (Training Dimension).

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3. My neighbor says that her daughter of 4 years-old is not so intelligent, but as she is going to start infant school, she thinks her daughter will improve. (Context Dimension)
4. A collection of proverbs says that you can't be made intelligent; you need to be born intelligent. (Heredity Dimension)
5. In general, people think intelligent people have many friends. (Associated Qualities Dimension)
6. Praising children by acknowledging their brilliance can make their intelligence to be improved. (Expectations Dimension)
7. My cousin, who works in a motorcycle workshop, says he is very intelligent because he is capable of assembling and disassembling a motorcycle in an afternoon. (Diversity of Intelligence Dimension)
8. I have always been told that if you set it as a goal, you can become more intelligent. (Control Dimension)
9. In a Youtube video, it was said that people are born with a certain intelligence that can be improved or made worse depending on what happens to them during their infancy (Critical Period Dimension)
10. I have watched an interview in which a mother says her son doesn't make any effort, nor study and even so, obtains the best scores in his class because he is very intelligent. (Effort Dimension)
11. A politician says African children who live in impoverished environments will never become as intelligent as children who live in developed countries. (Culture Dimension)

12. A mother says she signs her son up for computer, painting, and horse riding classes so they will make him more intelligent (Context Dimension)
13. My grandma says women can become as intelligent as men if they strive for it. (Gender Dimension)
14. A father says to her daughter that whatever she does won't change her intelligence (Control Dimension)
15. According to my teacher, Einstein was a very intelligent person, and all his achievements were not because of his effort, but because he was born with the gift of intelligence. (Heredity Dimension)
16. A child says he feels intelligent after having learned to do a new school task. (Training Dimension)
17. In the radio, it has been said that Finnish children are more intelligent because they live in a more developed society. (Culture Dimension)
18. My teachers have always told us intelligence and good behavior belong together. (Associated Qualities Dimension)
19. My friend José says that in our species men are more intelligent than women. (Gender Dimension)
20. In Facebook, a secondary education student writes: 'If you believe you are intelligent, you'll finally become an intelligent person, even though you were not'. (Expectations Dimension)
21. An adolescent says he is very intelligent because he knows how to draw very well. (Diversity of Intelligence Dimension)

22. A girl says that thanks to her parents help and support, she was able to become an intelligent person. (People Dimension)

23. I have read in a blog that, as scientists say maturation ends in adolescence; intelligence cannot be improved beyond that moment. (Critical Period Dimension)

24. One of my teachers said: ‘If your teachers support you to become intelligent, you’ll end up being intelligent’. (People Dimension)

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Perfectionism and Academic Self-Handicapping among Gifted Students: An Explanatory Model

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Perfectionism and Academic Self-Handicapped among Gifted Students: An Explanatory Model

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Abstract

This study aimed to examine the relationship between perfectionism and academic self-handicapping strategies among gifted students in Jordan. This study used a mixed-method approach to explore the relationship as well as exploring any other factors associated with using such strategies. The Revised Almost Perfect Scale (APS-R) and the Academic Self-Handicapping Strategies Scale were used to measure perfectionism and academic self-handicapping among 242 gifted students on a high school for gifted learners. Subsequently, the researchers conducted four focus group discussions with 23 gifted students to identify the factors that may lead those students to use self-handicapping strategies. The results showed that Self-handicapped students were 4.58 times more likely to be maladaptive perfectionists than non-self-handicapped students. The results also revealed a combination of environmental, personal, and cultural factors that contributed to the use of these strategies by gifted students. This study has proposed an explanatory model to illustrate the relationship between perfectionism, academic self-handicapping, and factors that might be related. Finally, this study provided a range of educational implications that can be used in the field of gifted education.

Keywords: perfectionism, self-handicapping, maladaptive behaviors, gifted students, Jordan

Perfeccionismo y Auto-Discapacidad Académica entre Estudiantes Superdotados: Un Modelo Explicativo

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Resumen

Este estudio tuvo como objetivo examinar la relación entre el perfeccionismo y las estrategias de auto-discapacidad académica entre los estudiantes superdotados en Jordania. Este estudio utilizó un enfoque de método mixto para examinar la relación, así como otros factores asociados con el uso de tales estrategias. Se utilizaron las escalas Revised Almost Perfect Scale (APS-R) y la Academic Self-Handicapping Strategies Scale con 242 estudiantes en una escuela secundaria para estudiantes superdotados. Posteriormente, los investigadores llevaron a cabo cuatro grupos focales con 23 estudiantes para identificar los factores que pueden llevar a usar estrategias. Los resultados indicaron que los estudiantes con auto-discapacidad tenían 4.58 veces más probabilidades de ser perfeccionistas que los estudiantes sin ella. Los resultados también revelaron una combinación de factores ambientales, personales y culturales que contribuyeron al uso de estas estrategias por parte de los estudiantes. Este estudio ha propuesto un modelo explicativo para ilustrar la relación entre el perfeccionismo, la discapacidad académica y los factores que podrían estar relacionados. Finalmente, este estudio proporcionó una serie de implicaciones educativas que se pueden aplicar en el campo de la educación de superdotados.

Palabras clave: perfeccionismo, self-handicapping, conductas desadaptativas, estudiantes superdotados, Jordania



Students sometimes feel a fear of failure in educational tasks or important exams that may affect their self-concept and lead them to use some academic self-handicapping strategies (Schwinger, Wirthwein, Lemmer, & Steinmayr, 2014; Thomas & Gadbois, 2007). Self-handicapping involves any action, choice, or performance that enhances the opportunity to excuse failure and accept credit for the success (Antony, 2016; Coudevyille, Ginis, Famose, & Gernigon, 2008), such as claiming test anxiety, illness, procrastination, not reading the recommended texts, or any other forms of excuses (Ganda & Boruchovitch, 2015; Schwinger et al., 2014). On the other hand, perfectionism is considered as one of the most common characteristics among gifted students, especially in academia (Mofield & Parker Peters, 2015; Mofield, Parker Peters, & Chakraborti-Ghosh, 2016; Rimm, 2007; Neumeister, Fletcher, & Burney, 2015; Stoeber, 2017). Perfectionism has been linked to many other gifted students' characteristics, such as achievement motivation and self-efficacy (Chan, 2007; Neumeister, 2004; Neumeister & Finch, 2006; Neumeister et al., 2015; Stornelli, Flett, & Hewitt, 2009).

The concept of Giftedness has a wide range of definitions; some of these definitions, such as Lewis Terman, defines gifted students based on their intellectual abilities (Burnett, 2004) while other definitions focus on a combination of special abilities and skills, such as Renzulli and Marland definitions (Marland, 1971, p. 1; Renzulli, 2011). However, there are two significant hypotheses that illustrated the gifted individuals' behaviors compared to their intellectual abilities. The harmony hypothesis argues that gifted students have high mental and social skills; in contrast, the disharmony hypothesis claims that intellectual ability for the gifted could be associated with social and emotional difficulties (Preckel, Baudson, Krolak-Schwerdt, & Glock, 2015). Based on that, gifted students may tend to use academic self-handicapping strategies to protect the gifted label and self-worth (Snyder & Linnenbrink-Garcia, 2013). Therefore, gifted students may mainly use maladaptive behaviors that associated with their beliefs of academic success, which is correlated to their concept of giftedness (Snyder, Malin, Dent, & Linnenbrink-Garcia, 2014).

Similarly, the maladaptive behaviors of gifted students are linked to their high expectations of themselves, their successful image, and their pursuit of

perfectionism in the academic, social, and personal domains (Kiamanesh, Dieserud, Dyregrov, & Haavind, 2015; Tan & Chun, 2014). Hence, this study tries to identify to what extent the self-handicapping strategies are linked to gifted students' high expectations and perfectionism level. In other words, this study seeks to explore whether gifted students are conducting academic self-handicapping strategies as an attempt to be perfect, or these strategies are related to other factors, such as self-image and academic achievement.

Self-Handicapping

Self-handicapping defined as a strategy that people use to keep and raise positive self-image in their own eyes as well as others' eyes (Hobden & Pliner, 1995; Lotar, 2005). Self-handicapping is also placing obstacles in the path of academic performance that students may use to enhance the opportunity of excusing failure or accepting credit for the success (Berglas & Jones, 1978; Lotar, 2005; Want & Kleitman, 2006). Self-handicapping is usually used to draw the attention of others from low performance toward other reasons such as lack of prior study, illness, lack of attention, or any other behavioral and claimed self-handicapping strategies (Berglas & Jones, 1978; Ganda & Boruchovitch, 2015; Harris & Snyder, 1986; Midgley & Urdan, 2001; Urdan, Midgley, & Anderman, 1998).

Even though self-handicapping is used to enhance individuals' self-esteem by providing a real or imagined excuse for low performance (Covington, 2000; Ferradás, Freire, Rodríguez-Martínez, & Piñeiro-Aguín, 2018), chronic self-handicapping is considered as a maladaptive strategy that over time, negatively impact the self-concept and self-efficacy (Gadbois & Sturgeon, 2011; Määttä, Stattin, & Nurmi, 2002; Martin & Brawley, 2002; Stewart & De George-Walker, 2014; Thomas & Gadbois, 2007). In like manner, self-handicapping has been associated with a wide range of adverse outcomes, such as poor adjustment, negative coping strategies, and poor study habits (Knee & Zuckerman, 1998).

Several studies claimed that academic self-handicapping is associated with underachievement among gifted students (Mofield & Parker Peters, 2019; Snyder & Linnenbrink-Garcia, 2013; Snyder et al., 2014). Other studies have

linked the challenge-avoidant beliefs and behaviors among gifted students to other factors, such as gifted labeling and mindset beliefs about intelligence (Mofield & Parker Peters, 2018a). On the other side, some studies have indicated the relationship between culture, gender, and learning model and using self-handicapping strategies by gifted students (Freeman, 2004; Thompson & Richardson, 2001).

Perfectionism

Perfectionism is a common and misunderstood behavior among gifted students (Mofield & Peters, 2015; Silverman, 2007). Perfectionism is generally defined as the tendency to set excessively high standards of performance and rigorous self-evaluation where only total success or total failure exist as outcomes (Curran & Hill, 2019; Gong, Fletcher, & Paulson, 2017; Hewitt & Flett, 1991; Oxtoby, 2018; Sotardi & Dubien, 2019). Adaptive perfectionism is associated with a realistic striving for high standards without psychological maladjustment or distress (Ozbilir, Day, & Catano, 2015; Suddarth & Slaney, 2001), whereas maladaptive perfectionism is predominately linked to unhealthy evaluation concerns, frequent doubts about actions, and preoccupation with avoiding mistakes (Hong et al., 2017; Stoeber & Otto, 2006; Suddarth & Slaney, 2001). Gifted students may turn adaptive (healthy or positive) perfectionism, into achieving excellence performance, but maladaptive (unhealthy or negative) perfectionism may breed dissatisfaction, anxiety, poor mental health, and social difficulties (Mofield & Parker Peters, 2018a; Zeidner & Shani-Zinovich, 2011).

Many studies have indicated that gifted students are academic perfectionists, who set high personal standards for themselves, especially in the classroom (Fletcher & Neumeister, 2012; Fong & Yuen, 2014; Margot & Rinn, 2016; Neumeister, Williams, & Cross, 2007; Wang, Fu, & Rice, 2012). There are many reasons behind perfectionist behaviors among gifted students, which might be family or environmental factors (Neumeister, Williams, & Cross, 2009). However, these behaviors in academia could be appeared in the form of overcompensating behaviors, such as excessive checking and rechecking (Mofield & Parker Peters, 2018a), concern over mistakes, doubts about actions, and discrepancy (Fletcher & Neumeister, 2012).

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Perfectionism and self-handicapping are similar in many ways, such as reaching a specific standard, concern about others' perception in case of failure, and self-image that rely on achievements and recognition; therefore, this similarity justifies the number of studies that found a relationship between perfectionism and self-handicapping (Akça, Uçak-Azboy, & Tadık, 2017; Kearns, Forbes, Gardiner, & Marshall, 2008; Kearns, Forbes, & Gardiner, 2007). However, other studies argue that perfectionism and self-handicapping are two different constructs, but perfectionist characteristic may lead to outcomes in the form of self-handicapping strategies, such as procrastination, overcommitting, or not putting in the effort (Akça, Uçak-Azboy, & Tadık, 2017; Kearns, Forbes, Gardiner, & Marshall, 2008). However, the relationship between perfectionism, especially maladaptive type and self-handicapping among gifted students, has not been addressed in the researchers, and it still needs further investigation (Akça et al., 2017).

Relationship between Self-Handicapped and Perfectionism

Previous studies did not identify the relationship between perfectionism and academic self-handicapping among gifted students (Akça et al., 2017). Specifically, most of the studies examined the relationship between perfectionism and academic self-handicapping among students at the university level. For example, Kearns, Forbes, Gardiner, and Marshall (2008) proposed a model that explains this relationship among perfectionist college students, but they did not specify this model to explain the relationship among gifted students. Additionally, Stewart and De George-Walker (2014) studied self-handicapping as a performance-debilitating characteristic that linked underachievement, perfectionism, locus of control, and self-efficacy among university students. Karner-Huțuleac (2014) also examined the relationship between perfectionism and self-handicapping among university students with high standards while Hobden and Pliner (1995) linked self-handicapping among university students to perfectionism dimensions, which were self-Presentation and self-Protection. On the other hand, Shih (2011) conducted a study on perfectionist Taiwanese high school students, not identified as gifted, and the researcher found that adaptive perfectionism behaviors were

associated with positive emotions and self-regulation while maladaptive perfectionism behaviors were associated with negative emotions and self-handicapping.

As for the studies that investigated self-handicapping among gifted students, these studies did not directly link self-handicapping to perfectionism, yet they studied the relationship between self-handicapping and other variables, such as achievement motivation, personal self-esteem, and self-orientation (Akça et al., 2017). For example, Neumeister (2004) studied the relationship between perfectionism and achievement motivation among gifted university students. However, gifted students may use maladaptive academic behaviors to protect the giftedness image (Snyder et al., 2014), while these maladaptive behaviors could be a defensive mechanism to justify the low achievement of these students (Snyder & Linnenbrink-Garcia, 2013). On the other hand, Mofield and Parker Peters (2018b) argued the differences between gifted, advanced, and typical students in the level of mindset, perfectionism, and achievement attitudes where the study findings showed that there was a positive association between perfectionism and achievement attitudes among gifted students.

Purpose of the Study

This study has two main objectives. The first objective was to identify the relationship between academic self-handicapping and perfectionism among gifted students in Jordan. Based on the lack of studies that investigate the relationship between academic self-handicapping and perfectionism among gifted students in general, this study mainly focused on a sample of gifted students in high school. This study attempted to find the correlative relationship between perfectionism (adaptive and maladaptive) with self-handicapping by using reliable scales. The second objective was to determine the fundamental reasons for using self-handicapping strategies among perfectionist gifted students by using the focus group discussion method. Overall, this study used a mixed-method approach to examine the relationship between academic self-handicapping and perfectionism among gifted students and any other factors associated with the use of these strategies.

Method

Participants

Participants of this study included 242 gifted students (105 females, 137 males) from the Jubilee High School for Giftedness in Amman, Jordan, during the second semester of the 2018/2019 academic year. For the first phase of the study (quantitative phase), the participants were randomly selected from grades 9-12 (9th= 63, 10th= 64, 11th= 64, and 12ve= 51) and their ages ranged from 15-18 years old with a mean of 16.04 (Std. = 5.66). For the second phase of the study (qualitative phase), the participants were purposely selected based on the quantitative phase's results, where students who had a higher correlation between perfectionism and self-handicapping were invited to four different focus group discussions. These discussions included six students from 9th grade (4 females, 2 males), six students from 10th grade (4 females, 2 males), six students from 11th grade (3 females, 3 males), and five students from 12ve grade (2 females, 3 males).

Data Collocation and Analysis

To identify the level of perfectionism and academic self-handicapping among the participants, the Revised Almost Perfect Scale (APS-R) (Slaney, Rice, Mobley, Trippi, & Ashby, 2001) and the Academic Self-Handicapping Strategies Scale (Midgley, Maehr, Hruda, Anderman, Anderman, Freeman, & Urdan, 2000) were used. Both of the scales have been shown strong psychometric properties across different cultures (Dever & Kim, 2016; Mobley, Slaney, & Rice, 2005; Ulu, Tezer, & Slaney, 2012). However, the researchers conducted a set of procedures to verify the psychometric properties of the scales by using back-translation and content validity methods. For the back-translation procedures, the scales were translated from English into Arabic by the researchers and then back-translated from Arabic to English by an expert in both languages to ensure the stability of the scales' items. The Arabic translated scales were compared with the original scales to

verify the accuracy of language. In general, the back-translated scales were matched with the original scales except for slight differences in some vocabularies. Moreover, the researchers gave the translated scales to a group of experts in educational measurement and giftedness to determine the appropriateness of using these scales with the Jordanian culture. The results showed that the scales are valid to use in the Jordanian environment.

APS-R scale consisted of a 23-item, which were scored using a 5-point Likert scale. The 23 items of APS-R used to measure three dimensions of perfectionism: discrepancy, high standards, and order. Slaney et al. (2001) reported acceptable reliability of the APS-R subscales (Cronbach's $\alpha = 0.85$ for high stander, 0.86 for order, and 0.92 for the discrepancy). The Academic self-handicapping strategies scale consist of 6 items that were scored using a 5-point Likert scale, as well. This scale was used to measure students' self-handicapping tendencies. Midgley et al. (2000) reported acceptable reliability of the scale (Cronbach's $\alpha = 0.84$). Written consents were obtained from all students to complete a paper-pencil scale, which took between 25-30 minutes.

The researchers developed four focus group discussions based on the quantitative phase results to probe for factors that may lead the gifted students to use self-handicapping strategies. The focus group sessions aimed to discuss the following questions: How do you feel if you have not achieved the expected accomplishment in the school, such as exams or assignments? What are the possible strategies that you would use to justify any expected failure? What are the reasons for using these strategies? Can you describe any strategies that you had used to justify any failure of not meeting your expectations? What are the possible strategies that you would use to justify any expected failure outside the academic life? The focus group sessions were conducted by the researchers, who lead these open discussions by encouraging participants to express their thoughts. The focus group discussions took place in the library at Jubilee High School. Each focus group discussion was audio-recorded and verbatim transcribed manually. The researchers coded each focus group discussion independently; thereafter, the researchers discussed themes emerging from the codes. Written consents were obtained from students to participate and audio-recording the focus group discussions, which took between 110-140 minutes.

This study complied with the ethics code of scientific research at the university where the numerical system was used in the quantitative stage, and the names used in the qualitative stage are pseudonyms.

Results

Quantitative Phase

The results of the quantitative phase of the study showed a higher correlation between maladaptive perfectionism and academic self-handicapping. The results showed that there was a correlation between the maladaptive perfectionism and academic self-handicapping among 172 students of the study sample ($r = .71$), while the correlation with adaptive perfectionism was among 70 students of the sample ($r = .29$). A simple logistic regression was performed to ascertain the effect of self-handicapping on the likelihood that students have maladaptive perfectionism, as shown in Table (1).

Table 1.

Logistic Regression Analysis of Self-handicapping Effect on Maladaptive Perfectionism

Included	B (SE)	95% CI for Odds Ratio		
		Lower	Odds Ratio	Upper
Constant	-0.225 (0.434)			
Self-handicapping	0.074 (0.027) *	1.021	1.077	1.136

Note: $R^2 = .03$ (Hosmer & Lemeshow), $.03$ (Cox & Snell), $.046$ (Nagelkerke). Model $\chi^2(1)$

$= 7.827, p < .01$. *, $p < .01$.

As it could be seen from Table (1), the simple logistic regression model was statistically significant, $\chi^2(1) = 7.827, p < .01$. The model explained 4.6% (Nagelkerke R^2) of the variance in maladaptive perfectionism among students and correctly classified 71.5% of cases. Self-handicapped students were 4.58

times more likely to be maladaptive perfectionists than non-self-handicapped students.

Quantitative Phase

The researchers grouped the codes, and the analysis of the focus data showed four emerged themes, which were: feelings, factors and reasons, relation with perfectionism, and strategies. The researchers discussed data in each group of coding in order to discover all factors associated with using self-handicapping strategies by gifted students and possible reasons behind using such strategies. Table 2 shows the main themes and codes emerged from analyzing the focus groups discussion.

Table 2.
Themes and Categories of Focus Group Discussions

Themes	Codes
Feelings	Emotion, Expectation, Jealous, Justification, Sadness, Understanding.
Environmental Factors	Competition with class, School environment, School effect, School requirements, Parental style.
Personal and Cultural Factors	Gifted characteristics, Self-concept, Self-esteem, Self-image, Social-image, Gifted classification.
Self-handicapping Patterns	Motivations, Strategies.

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Feelings. Students in the discussion groups showed a mixed set of feelings and emotions regarding their high expectations and their inability to meet these expectations. During the discussions, gifted students expressed their feelings of sadness and frustration as a result of their inability to achieve their goals. Table 3 shows a range of emotions that students have mentioned in the discussions.

Table 3.
Codes and Supporting Quotes for the Feeling Theme

Feelings	Supporting quotes
Emotion	[Sarah, 11 th grade] "maybe I will cry if I did not get this mark."
Expectation	[Ahmad, 9 th grade] "I studied hard and got unexpected marks."
Jealous	[Ahlam, 9 th grade] "if someone gets a higher mark than mine, I will be sad and upset"
Justification	[Muna, 9 th grade] "it is not a big deal that I did not get a full mark."
Sadness	[Alaa, 12 th grade] "sometimes I became very sad and blamed myself"
Understanding	[Maha, 10 th grade] "I deserve this mark."

Environmental factors. During the discussion, students presented a range of reasons and environmental factors that contributed to their use of the academic self-

handicapping strategies. The students showed several critical environmental factors that lead them to justify low academic performance. Among these factors, students mentioned school, parents, and a highly competitive environment. Table 4 shows the main environmental factors that were discussed in the focus groups.

Table 4.
Codes and Supporting Quotes for the Environmental Factors Theme

Environmental Factors	Supporting quotes
Competition with class	[Roaa, 10 th grade] "I do not want my friends to feel that I am less than them."
School environment	[Hanan, 12 th grade] "there are a lot of excellent students here, and you start to compare yourself with them."
School effect	[Khaled, 10 th grade] "we have to keep our average because of our scholarships."
School requirements	[Sana, 9 th grade] "I am really careful to get high marks to reach the wanted average here in this school more."
Parental style	[Rana, 9 th grade] "every time I got a bad mark, I think about what I want to say to my parents."

Personal and cultural factors. In addition to environmental factors, students in the discussion groups added a range of personal and cultural factors that contribute to their use of academic self-handicapping strategies. These factors are no less important than environmental factors, but often during the debate, they have emerged as more

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important factors for students. The most important personal and cultural factor that emerged in the debate was the social image of students as "talented" in front of others. Table 5 shows the most important personal and cultural factors that have emerged in the discussion groups.

Table 5.
Codes and Supporting Quotes for the Personal and Cultural Factors Theme

Personal and Cultural Factors	Supporting quotes
Gifted characteristics	[Raad, 9 th grade] "every one of us wants to be perfect."
Self-concept	[Ahmad, 9 th grade] "I will make it for myself because I think other students will say I am lazy."
Self-esteem	[Farah, 12 th grade] "I know myself."
Self-image	[Zainb, 12 th grade] "Instead of hearing everybody blaming me."
Social image	[Ali, 11 th grade] "everybody expects a full mark from you."
Gifted classification	[Tasnim, 12 th grade] "I am between lions, all of them are excellent."

Self-handicapping patterns. On the other hand, the students discussed a set of strategies they use when providing excuses for low academic performance, which

varied from not studying well, blaming teachers, preoccupation with other work, and other strategies. The students also discussed the motivations behind the use of such strategies, most notably self-satisfaction. Table 6 shows some of the strategies and motivations cited by the students.

Table 6.
Codes and Supporting Quotes for the Self-handicapping Patterns Theme

Self-handicapping Patterns	Supporting quotes
Motivations	<p>[Mayson, 11th grade] "I would make any excuses up to feel satisfied."</p> <p>[Alaa, 12th grade] "I will not ever let my parents down. I will do anything to make sure that will not happen"</p> <p>[Roaa, 10th grade] "There is a big challenge in this school; I mean, competitive classmates."</p>
Strategies	<p>[Noor, 10th grade] "When I have an exam, I go out with my friends."</p> <p>[Ahmad, 9th grade] "I don't know; I might pretend that I am sick."</p> <p>[Sarah, 11th grade] "In this school, we always have something to do. We have many outside activities, initiatives, and competitions."</p>

Explanatory Model

The quantitative results of the study showed that there was a correlation between maladaptive perfectionism and academic self-handicapping among gifted students. On the other hand, the qualitative results of this study explained the nature of this correlation and the factors that contributed to developing such strategies by gifted students. This model suggests that there are two sets of factors that determine the use of academic self-handicapping strategies by gifted students. These factors are environmental and cultural factors, which are strictly related to the development of perfectionism tendency among gifted students. In other words, the academic self-handicapping strategies used by gifted students, such as preoccupation, illness, or blaming others, occur because of a range of environmental and cultural factors, but the ultimate goal of using these strategies is to achieve the perfectionist image.

This model, as shown in Figure 1, links the existence of a competitive environment in the school and the parental style pattern to the social image of the gifted student, who must be undefeatable. This situation leads the gifted student to develop academic self-handicapping strategies to reach this perfectionist personality, while factors that cause the use of these strategies considered as assistance indications rather than the main objectives.

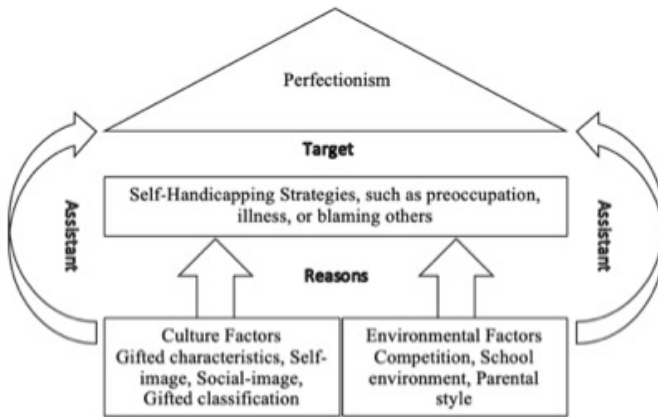


Figure 1. An Explanatory Model of the Relationship between Perfectionism and Self-Handicapping among Gifted Students

Discussion

This study examined the relationship between perfectionism and academic self-handicapping among a Jordanian gifted students' sample, which could be considered as one of the first studies that investigated this topic among gifted students, especially in high school. This study used a mixed approach method to discover the correlation between adaptive and maladaptive perfectionism and self-handicapping strategies, as well as the related reasons that may contribute to using such strategies by gifted students. The quantitative results of this study showed a higher correlation between maladaptive perfectionism and academic self-handicapping. This finding is aligned with previous literature that referred to the relationship between maladaptive behavior and self-handicapping strategies among perfectionists' students, such as gifted students, to the high personal standards for themselves, especially in school (Fletcher & Neumeister, 2012; Fong & Yuen, 2014; Margot & Rinn, 2016; Neumeister, Williams, & Cross, 2007; Wang, Fu, & Rice, 2012).

The qualitative phase of this study aimed to identify the underlying reasons behind the use of academic self-handicapping strategies by gifted students. The discussion groups' results indicated a range of environmental factors contributing to the use of such strategies as parental style and school competition. This finding is consistent with the study of Neumeister, Williams, and Cross (2009), in which the authors pointed out some environmental and parental factors. On the other hand, the results showed a range of personal and cultural factors that contribute to the students' use of the strategies of academic self-handicapping strategies, such as social image and self-concept, and this finding is consistent with Kearns, Forbes, and Gardiner (2007). Hence, it is necessary to mention the singularity of Jordanian society in the form of strict parental care on the academic side, especially for outstanding students. On the other hand, the Jubilee School for gifted students is one of the most prestigious schools that has a high reputation in Jordan, where the students have a respectful social image. The above factors contribute to the use of gifted students to strategies of academic self-handicapping, but this study differed from other studies in the interpretation of the relationship between perfectionism and academic self-handicapping and other factors. The authors proposed a model to illustrate the contribution of the environmental, personal, and social factors and the use of academic self-handicapping strategies in achieving the perfectionist personality among gifted students. This model shows the contribution of the enviro-social factors in the achievement of the personal perfectionism of gifted students using academic self-handicapping strategies.

The results of this study are essential for teachers, parents, schools, and students themselves. The results of this study could help teachers, parents, and schools to fully understand the personalities of gifted students, who are profoundly affected by the high standers and goals that they set for themselves. Thus, they may transform the factors that cause maladaptive behaviors, such as family care and competition to a motivation to use adaptive behaviors away from academic self-handicapping strategies. This transforming in the school and family environments from competition to the realistic standards could help the gifted students to get rid of the psychological maladjustment that is associated with maladaptive behaviors (Ozbilir, Day, &

Catano, 2015; Suddarth & Slaney, 2001), which may lead students to stop the using of academic self-handicapping strategies and replace them with motivations towards the achievement.

As for the cultural factors contributing to using the academic self-handicapping strategies by gifted students in Jordan, this is mainly due to the social image of gifted schools' students in Jordan, especially the Jubilee School. Hence, educational decision-makers in Jordan must pay attention to the effect of such a type of school in Jordan and replace it with other educational alternatives such as the inclusive education settings. On the other hand, labeling gifted students have adverse effects, such as boredom, isolation, nonconformity, and resentment, just like its positive effects on gifted students (Hickey & Toth, 1990). In Jordan, using such labels in addition to the educational settings of gifted students contributed to the development of maladaptive behaviors and, thus, the use of self-handicapping strategies. Hence, this study describes the cultural and personal factors that prompt gifted students in Jordan to use these strategies. The results of this study could help teachers, schools, and society to change their attitudes and methods of dealing with these students to reach a positive adjustment.

The proposed model in this study may help teachers and schools in educational planning for gifted students. On the one hand, teachers can use this model to fully understand the relationship between perfectionism and academic self-handicapping among gifted students in Jordan and to identify the factors that contribute to strengthening this relationship. On the other hand, teachers and schools can adjust all relevant variables such as competitiveness and challenging instruction to be cooperative and motivational strategies. This understanding may lead to control of these factors that were contributing to the emergence of maladaptive behaviors, which may reduce students' use of self-handicapping strategies.

Limitations

Limitations of this study include that this study was conducted with gifted students in one school in Jordan, which may affect the results' generalizability. Moreover, the results of this study are affected by the Jordanian cultural context and the extent of representation of the study sample. Therefore, these

factors must be taken into consideration when generalizing the results of this study.

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