rlp

Adaptive Teaching and Field Dependence-Independence: Instructional Implications

Enseñanza adaptativa y dependencia-independencia de campo: implicaciones instruccionales

Recibido: Septiembre de 2010
Aceptado: Septiembre de 2011

Carolina Tinajero
Alba Castelo
Adelina Guisande
Fernanda Páramo
Universidad de Santiago de Compostela, España

La correspondencia relacionada con este artículo, debe ser enviada a Carolina Tinajero, Facultad de Psicología, Departamento de Psicología Evolutiva y de la Educación, Campus universitario, 15782 Santiago de Compostela, España, o e-mail (carolina.tinajero@usc.es).

Abstract

Cognitive styles are among the dimensions of individual differences considered particularly relevant in adaptive teaching. Field dependence-independence is one of the most heuristic cognitive style constructs and has been shown consistently to determine academic results of students, regardless of their educational level or cultural origin and the area of knowledge considered. This fact has prompted attempts to train field independence and a thriving line of investigation focused on the adaptation of instructional methods to cognitive style, which has been offering data which should be considered in educational practice. Studies made to date both on training and instructional adaptation have been gathered and synthesized in the present revision, and some general lines of action when adapting teaching to cognitive style have been extracted.

Key words: cognitive style, field dependence-independence, adaptive teaching

Resumen

Los estilos cognitivos se encuentran entre las dimensiones de diferencias individuales consideradas relevantes en la enseñanza adaptativa. De especial valor heurístico se ha mostrado la dependencia-independencia de campo, dimensión que influye, de manera consistente en los resultados académicos de los estudiantes, al margen de su nivel educativo y su origen cultural y del área de conocimiento evaluada. Esta constatación ha inspirado intentos de entrenar a los estudiantes en las habilidades de los independientes de campo, así como una línea de investigación centrada en la adaptación de los métodos instruccionales al estilo cognitivo, que ha venido proporcionando datos que deberían ser considerados en la práctica educativa. En el presente trabajo, se sintetizan los estudios realizados hasta el momento sobre entrenamiento y adaptación instruccional y se proponen algunas líneas generales de actuación en la adaptación de la enseñanza al estilo cognitivo.

Palabras clave: estilo cognitivo, dependencia-independencia de campo, enseñanza adaptativa

Introduction

The suitability of teaching to the characteristics of the student is one of the main concerns of educational investigation. Recent theories about this issue defend that teaching must be adapted to individuals while promoting, at the same time, the student's adapting to the teaching demands (Corno, 2008). Cognitive styles are among the dimensions of individual differences considered particularly relevant in adaptive teaching (Sternberg, Grigorenko, & Zahn, 2008). They have been defined as forms of processing information, manifested in intellectual activities and also in the affective and social spheres of the individual (Grigorenko & Sternberg, 1995); these patterns seem to modulate individuals' learning behavior (Price, 2004; Richardson, 2005).

In particular, field dependence-independence (FDI) is considered one of the most heuristic cognitive styles constructs (Zahn & Sternberg, 2006). It is conceived as referred to preference for internal versus external cues for conduct organization (Witkin & Goodenough, 1981). Field-dependent subjects, who are especially sensitive to external clues, and tend to take information exactly as it is presented to them, normally pay attention to its global aspects in what seems to be an effort to capture the structure of this information (Clark & Roof, 1988; Marendaz, 1985). This tendency is an obstruction in intellectual tasks which demand concentration upon isolated elements within a perceptive and/or symbolic whole, or in those which involve restructuring. That is the case of the Embededded Figures (EFT) (Witkin, Oltman, Raskin, & Karp, 1971), the most widely used index for assessing field dependence-independence. Moreover, global approximation leads to a passive, expectative attitude towards learning tasks, which are faced through data accumulation and/or trial and error (Tinajero & Páramo, 1998a). Nevertheless, field-dependent subjects are particularly receptive to social information and/or information whose origin is social (Wapner & Demick, 1991; Witkin & Goodenough, 1981).

In turn, field-independent subjects, who are characterized by their confidence in internal references, tend to assume an analytical approach towards the information, which allows them to break it down into its component parts and restructure it according to their needs (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). This fact appears to enable them to spontaneously undertake multiple operations with the information, such as classifying it, or generating inferences and hypotheses related to it and to approach learning in general with a high degree of involvement (Kang, Scharman, Noh, & Koh, 2005; Tinajero & Páramo, 1998a).

Field-independent students have been shown consistently to obtain better academic results than field-dependent ones, regardless of their educational level or cultural origin and the area of knowledge considered (Tinajero & Páramo, 1997, 1998b). This fact has prompted attempts to train field independence and a thriving line of investigation focused on the adaptation of instructional methods to cognitive style, which has been offering data which should be considered in educational practice. With the purpose of extracting some general lines of action when adapting teaching to cognitive style**,** studies made to date both on training and instructional adaptation have been gathered in the present revision; they have been organized according to the three fields of instructional preferences proposed by Sadler-Smith and Riding (1999): instructional media preference, assessment method preference and instructional method preference.

FDI and instructional media preferences

The most direct consequences we may expect for field dependence-independence in academic situations are related to didactic material. In particular, it has been suggested that those illustrations, texts, presentations and general learning tools which do not offer a clear structure will present a greater difficulty to extremely field-dependent subjects. In one of the first studies on this issue, Coward and Lange (1979) proposed two storage conditions to children at elementary school level for a group of objects presented on pictures. In the first condition, the objects belonged to four categories which were very familiar to the children (animals, food, jobs, and vehicles). In the second one, the relationships between the objects were not so obvious; the children had to use their own criteria to classify them prior to the recall stage. While in the first condition cognitive style did not lead to significant differences in recall, in the second the field-independent children remembered a larger number of items, and did so in a more orderly fashion (according to the established classification). The authors concluded that the limited restructuring ability of field-dependent subjects would hamper the process of remembering disorganized material.

However, in a study by Frank and Keene (1993) in which a word-memorising task in conditions of high and low inherent list organisation was posed to university students, no differences in relation to cognitive style were obtained for the number of items remembered in either condition. Further investigation with lists of items should be conducted to ascertain whether the age is mediating in the relation between cognitive style and list memorizing or the linguistic format could benefit field dependent learners in order to create personal organizational criteria to support memorizing.

The latest interpretation is at least in accordance with the results on text recall obtained by Annis (1979). The author presented organized and disorganized texts (in which the sentence order had been changed) to university students; after reading the texts with or without taking notes, they made a free-recall exercise and another consisting of completing high and low-rated structural importance sentences. The disorganized texts did not affect differentially the performance of field dependent subjects, since their notes compared with those of field independent students were equally precise and organized, and their results on the tests after taking notes were very similar. Thus, some kind of verbal cues presented in the sentences could have given sufficient support to field dependent students for the extraction of the structure. Nevertheless, the worst performance on the part of these subjects in the no-notes condition, leads the authors to conclude that they do not tend spontaneously to abstract the most important information during reading.

Some studies have examined the effect of reinforcing the structure of texts to be remembered through resources such as adjunct questions, embedded headings or illustrations (see, for example, Baker & Dwyer, 2005; Balluerka, & González-Tablas, 1996; Brooks, Dansereau, Spurlin, & Holley, 1983; Hsu, 2001; Kiewra & Frank, 1986). The results of these studies indicate that field-dependent subjects experience with these resources a recall improvement similar to that of field-independent ones, although it does not compensate their disadvantage when it is present.

However, the reinforcing resources of the structure have shown differential effects in problems resolution. In a pioneering study, Bien (1974) showed that when field-dependent subjects in elementary education were supplied with a structure in mathematics problems by circling the relevant information, their performance improved and matched to that of field independent subjects. In a more recent study, Threadgill-Sowder, Moyer, & Moyer (1985) demonstrated that presenting mathematical problems in drawing format selectively favored field-dependent subjects' achievement, although field independent students still obtained better scores in that condition.

Occasionally, the apparent structure of a material may be an obstacle to learning objectives. In concept-identification tasks, for example, subjects must distinguish between items that do and do not belong to a certain type of stimulus, based on their different attributes, which may be more or less noticeable or prominent. Normally, after the presentation of each item, the subject is required to try and guess the possible relevant attributes. In these circumstances, field-independent subjects tend to use all the attributes in order to construct their initial hypothesis, and gradually eliminate those which change from one item to another. However, field-dependent subjects tend to consider only the most outstanding features (see, for example, Davis & Frank, 1979; Goodenough, 1976). Since the outstanding features do not normally coincide with the relevant features, field-dependent subjects are at a disadvantage in this type of task. The same phenomenon have been found in classification tasks (Ohlmann, 1982; Ohlmann & Carbonnel, 1983) and also in Piagetian tasks, where perceptive configuration has an important role and is often disorientating, placing field-dependent subjects at a disadvantage (Tinajero & Páramo, 1996). For example, Corral (1982) carefully examined the procedure used by 10 field-dependent and 10 field-independent subjects when carrying out two controlling variable tasks, presented in graphic and manipulative formats. He asked the subjects to anticipate the factors which they considered relevant for the phenomenon involved in each task, and observed the steps they took when carrying it out. Cognitive style did not determine differences with regard to the spontaneous ideas expressed by the subjects in the presentation of the tasks. Two types of difficulties arose from the way in which these tasks were carried out, which became more frequent when the tasks were presented graphically: a resistance to abandoning ideas which prove to be erroneous when checked empirically, and a difficulty in disassociating and isolating different elements. These difficulties mainly affected the field-dependent subjects, although the author observed that the performance of field-dependent and field-independent subjects was the

same when a) the factors were highly differentiated, b) their perceptions did not clash with the results of the tests and c) the problem was presented in a manipulative format. The field-dependent subjects suffered from the disadvantage of being less able to overcome the barrier formed by the perceptive configuration of the situation; this disadvantage disappeared when the perceptive data were not disorientating.

Consequently, taking into account the cognitive style of the students should imply selecting and designing learning materials with a clear structure, whose content should be easily accessible and compatible with the demands of the learning tasks. Another approach to instructional design could be to provide practice in structuring abilities. Efforts made in this direction have been productive, and have confirmed the possibility of devising effective programs to teach field dependent subjects to dissembed (Collings, 1985; Ludwig & Lachnit, 2004), restructure (Cathcart, 1990; Collings, 1994; Pennings, 1991; Rush & Moore, 1991) or perform operational tasks at the same level as field independent ones (Globerson, Weinstein, & Sharabany, 1985) and that these abilities are transferred to similar tasks. Also, recent studies on information seeking on the web have indicated that differences found between field dependent and field independent learners disappear when they acquire experience. Concretely, experienced field dependent students spend the same time in retrieving tasks and abanone a linear navigation strategy, typical of novice students, once familiarised with the structure of the course through the use of hypermedia tools such as embedded links and home page (Kim, 2001).

FDI and instructional method preferences

As Corno (2008) indicated, it is possible to differentiate among types of instructional methods according to the degree in which they give guidance and support to the student by organizing the class dynamics, administrating motivational incentives, and give feedback about their progress and setbacks. It has been suggested that the most directive and supportive methods are the most suitable for field-dependent students, because of their tendency to trust in external references and their passive attitude towards learning. On the other hand, field-independent students, who trust in internal referents and show a greater engagement in learning, would probably work more comfortably with teaching methods that give them autonomy (Jonassen & Grabowski, 1993; Summerville, 1999). In line with these suppositions, Thompson and Knox (1987) found that students enrolled in distance education programs for different university degree courses tended to field-independence in comparison with normative groups, although the authors did not register an association between cognitive style and persistence or level of satisfaction in courses. Brenner (1997) neither have observed any achievement differences between field- dependent and field-independent university students following telecourses.

In classroom context, Sánchez-Gámez and González-Girón (1993) found that the achievement of field independent undergraduate Psychology students was improved by self-instructional materials in comparison with a traditional lecture, while field dependents subjects obtained similar results in both situations, and Summerville (1999) informed of greater demands of instructional support (for example definitions and consultant advice) on the part of undergraduate field dependent students interviewed after an hypercard course.

Guidance vs. autonomy in teaching methods

Some authors have explored the adaptability of discovery vs. expository methods to different cognitive styles, assuming that the first type represents a minimum degree of guidance and the second a maximum level of autonomy. Actually, the discovery method is characterized by learning tasks and presentation forms for the information based on the student's activity, typically representative problems to solve, while in the expository method information is delivered to the learner in final form (Mayer, 2003). McLeod and Adams (1979) taught a course about addition and subtraction to elementary-level students following the instructional models of discovery and exposition. As expected, the field-dependent subjects obtained better results with the expository method, while the field-independent subjects did so with the discovery method. The discovery method also produced significant differences in performance which favoured field-independent subjects. However, in later investigations, the expected interaction between these opposed methods and the cognitive style was not confirmed (Canino & Cicchelli, 1988; Chou, 2001; MacNeil, 1980).

These contradictory results may be due to the confusion between the discovery-expository dichotomy and the degree of guidance. In fact, different forms of discovery

and expository methods, which have been described, and which may be situated in a continuum ranging from guidance to autonomy, and its relation to cognitive style, have been explored. We may take for example, the study by Shymansky and Yore (1980) who examined how the use of three modalities of the discovery method affected the performance of field-dependent and field-independent university students enrolled in a general science program. In the first, *semideductive* modality, the field-independent students's performance was superior to that of the field-dependent students; whereas with the other two, *inductive* and *hypothetical-deductive*, both groups of subjects obtained similar results. The first modality required the students to extract critical observations and measurements from the natural environment of the physical sciences, developing inferences, trends and generalizations without the teacher's help and almost without peer interactions. In the other two modalities, the teacher introduced the materials following an organized structure, selecting and filtering data and sequencing its presentation and promoted group investigations by group planning and discussions. Besides, in the *hypothetical-deductive* approach, students were required to use deductive reasoning to generate and test hypotheses. Strawtiz (1984) obtained similar results with two different modalities of discovery method used to teach the separation of variables scheme to children between 10 and 12 years of age with different cognitive styles.

On the other hand, Frank (1984) compared the recall capabilities of field-dependent and field-independent university students of a lesson exposed under different conditions. The first condition was listening, the second listening and taking notes, and in the third and fourth an outline was handed out which detailed the main ideas of the lesson, and students were asked to take notes about these ideas or the total content, respectively. Field-dependent remembered the information from the lesson and also took advantage of the outlines just as field-independent students, but in the second condition (listening and taking notes without outline) the latter showed a better recall. Notes taken by field-dependent subjects in this condition seemed less efficient in supporting the learning process; although they gathered a similar quantity of information units they used significantly more words. In the opinion of the author of the study, this would suggest that the task was dealt with in a different way. Perhaps field-dependent subjects try to note down as much information as possible while it is being presented, whereas field-independent learners actively extract what is strictly essential in relation to their prior knowledge. In fact, more recent studies show that they are more prone to use, transfer, and modify their own prior concepts (Kang, Scharmann, Noh, & Koh, 2005). Just like the outlines, contextual organizers may be used to compensate field-dependent subjects' tendency favouring their achievement in expository learning situations (Meng & Patty, 1991).

As an alternative means of instructional mediation particularly directed at field-dependent students, some authors have tried to stimulate their involvement in the learning process by using experimental instructional methods, in which exemplary experiences of the contents to be learned are proposed (Burkhalter & Schaer, 1984-85; Ritchey & LaShier, 1981; Rollock, 1992). These efforts have not been successful, except in the case of Rollock (1992) who devised an instructional condition where personal involvement and social sensibility would have a favouring effect. The author proposed to undergraduates in an introductory psychology course a "hot-cold" guessing game to illustrate the basic principle of shaping and reinforcement. One of the students tried to guess a target behaviour basing on the other participants' feedback who labelled actions in the correct direction with "hot" and incorrect ones with "cold". In these circumstances field-dependent subjects did better than field-independent ones.

We would expect a similar effect from teaching methods that encourage interaction between students, such as cooperative group instruction. In fact, field dependent students openly express their preference for these types of methods (Sadler-Smith, 1999). Moreover, they manifest preference for teachers who share their style, and who are in favour of interactive methods (Saracho, 1991, 1997). Nevertheless, we lack data to confirm the expected mediation of cognitive style on the effectiveness of an interactive class dynamic.

Support strategies in teaching

Some authors have focused on managing feedback and motivational incentives in instructional mediation. Generally, they have started out from the supposition that depending on the degree that subjects trust external references, they will demand and be influenced by targets, reinforcements and indications defined by the exterior. In fact, social reward and punishment seem to specially favour field dependent

learners' performance. This was first observed, for example, in the study by Konstadt and Forman (1965) who proposed a way of analyzing the effect of changes in the "human environment" on the performance of a simple task. They selected field dependent and field independent children from the fourth year of elementary school, and gave them a letter cancellation task in two experimental conditions, one of approval and another of disapproval. In each of them, the experimenter offered a series of comments during the session, positively or negatively evaluating the speed and precision of the group in carrying out the task. Disapproval affected the performance of field-dependent subjects significantly.

More recently, Ennis (1991) collected data through field note observations on second-grade pupils of physical education classes and found that when field dependent children in particular were rewarded socially by being selected for class demonstrations, they became more involved.

These motivational tendencies may underlie the repercussions which competitive classroom situations have for subjects with different cognitive styles, and this is illustrated in a study by Bolocofsky (1980). Ten-year-old children were given a comprehension exercise in competitive and non-competitive conditions. In the competitive situation, the experimenter informed the subjects that their exercises would be marked in comparison to their classmates. In the non-competitive condition they were told that their exercises would be marked according to the total number of correct answers, without considering the other children's achievement. Competitiveness produced a better performance in all the subjects, especially notable in field-dependent subjects.

The provision of feedback is both a motivating and guiding strategy for the way in which subjects perform. This dual influence may underlie the differential effects found for feedback in field-dependent and -independent subjects; concretely, the first group pays greater attention and gets more benefit from the feedback when it is present. This was observed in the pioneering study of Ruble and Nakamura (1972), in which they noticed the selective attention of field-dependent subjects with social information. The authors presented a task in which a puzzle had to be completed, and another of acquiring concepts, to children of different cognitive styles, aged between 7 and 10. In the first task, two conditions were established: a) the child put together the puzzle on its own and b) the child assembled a puzzle while the experimenter was working on a different one in front of him. In the second task three conditions were established: a) the experimenter gave redundant information about the correct answer, subtly indicating it, b) the relevant information was exclusively that of the experimenter who presented the items randomly, and c) the experimenter did not reveal any type of information. In both tasks, the field-dependent subjects were more attentive towards social cues, as they looked to the experimenter more often. Also, these children used the information they received from the experimenter more efficiently than field-independent children, obtaining better results in conditions when this was relevant.

In the same line, there are results of Fernández-Ballesteros, Macia, Ruiz, Fernández-Lagunilla, Del Villar, and Díaz-Veiga (1980), who compared the performance of field independent and field dependent university students in a stimulus detection task with and without indication of reaction time in each trial. The field-dependent subjects made more use than the field-independent subjects of the information given during the trials, as they obtained significantly lower reaction times when they were given information, unlike the field-independent subjects.

The introduction of feedback may cause the decrease (Baker & Dwyer, 2005) or disappearance (Sarmany, 1993) of the differences in performance related to cognitive style, or it may even selectively favour field dependent students' achievement (Adegoke, 2011).

A final aspect which should be pointed out with regard to the effect of feedback on subjects according to their cognitive style refers to the persistence of its power. The ability to avoid the influx of feedback which has been previously *presented* as erroneous is smaller in field-dependent subjects (Brown, 1984), and their resistance to abandoning the ideas created from a feedback they have received is greater, even when they discover later on that it was false (Davies, 1985). This adherence of field-dependent subjects to externally defined information about their performance has clearly intellectual and affective implications. Intellectually, it is a call for attention to the particular importance which the indications of teachers must have in the construction of knowledge by field-dependent subjects. Affectively, it supports the idea that these same subjects would be more

receptive to the evaluations of their achievement made by the teacher, which would influence their attributions, self-concept, etc., eventually affecting their motivation towards academic tasks. A study by Davies (1985) explored this issue. The author was interested in the resistance of the subjects' beliefs about personal ability to complete a task, based on false feedback. The task consisted of intuitive distinction between false and true reports of supposed suicides. After giving an answer, the subjects were told if they were right or wrong, considering two conditions. In the first, of *apparent success*, correct answers were given in most of the items (13 out of 15); in the second condition, of *apparent failure*, the subject apparently identified 3 out of 15 items correctly. The subjects were then told that the feedback had been *bogus*, and they were asked to estimate the number of correct answers they had, the average number of correct answers among their colleagues and their level of ability in the task. The difference between estimations which corresponded to the two experimental conditions was significantly higher in the field-dependent subjects, with a greater resistance appearing concerning feelings of self-efficiency in the subjects faced with evident discredit of the source they had used.

Computer assisted teaching has emerged as a privileged method to gather the teaching adaptations mentioned in this section, helping to cover the organizational needs of field-dependent students and lending a degree of autonomy to field-independent ones. In fact, both groups of students improve their achievement with computer presentations. This effect is particularly relevant for field-dependent learners; unlike studies about academic achievement with conventional methods, those centered on the relation of cognitive style with computer assisted learning do not reveal a general disadvantage on the part of these students, suggesting a compensating action over the influence of other educational variables. More concretely, studies on computer assisted lessons designed in a linear, sequential manner, inform consistently of similar achievement scores by field dependent and field independent students (Chuang, 1999; Lu, Yu, & Liu, 2003; Price, 2004; Shih, Ingerbritsen, Pleasants, Flickinger, & Brown, 1998), while some studies with hypermedia instruction still have register better results for field independent subjects (Cardozo, 2004; Chen & Macredie, 2002; Handal & Herrington, 2004). Efforts are being made to determine the relation between cognitive style with learning patterns in hypermedia environments and the dimensions to be considered when designing matching instructional strategies (Chen & Liu, 2008; Stash & De Bra, 2004; Triantafillou, Pomprotsis, Demetriadis, & Georgiadou, 2004).

Nevertheless, adapting students' learning strategies to the diversity of instructional methods, and in particular computer presentations, must be also considered. To date, little attention has been given to this issue, although data derived from research focused on cognitive processing and academic achievement suggest that field independent students are more prone to spontaneous use of different strategies while field dependent students must be stimulated to do so (see for example Emmett, Clifford, & Gwyer, 2003). In this line, it has been suggested that field-dependent learners might lack conditional knowledge, i.e., knowledge referred to *when* and *where* to use the strategies (Rickards, Fajen, Sullivan, & Gillespie, 1997). Until we have more data, specific training in meta-cognitive strategies should be considered as a 'preliminary' step in attending learning diversity due to cognitive style in academic contexts (see, for example, Pintrich, 2002).

FDI and assessment method preferences

In monitoring the progress and setbacks of students, teachers use a wide range of instruments for evaluation which may be more or less suited to the individual characteristics of the students. Some authors interested in cognitive styles have drawn attention to the bias that certain tests requiring restructuring may introduce in favour of field independent students (Aubret, 1986; Davey, 1990). On the other hand, tests with a clear structure are supposed to assist field dependent students (Davey, 1990; López-Rupérez, Palacios, & Sánchez, 1991). Multiple choice tests are a clear example of the last type; they consist of questions that refer directly to the relevant aspects of the learning content and offer a series of options from which the subject may find the correct answer. Benefits of these characteristics for the performance of field dependent subjects have been noted even in situations where they are consistently at a disadvantage, such as in Piagetian tasks used to evaluate formal reasoning. As an example, we may take the study by López-Rupérez et al. (1991) who applied Longeot's test to a group of secondary school students to measure their intellectual development. This test comprises open answer and closed answer (multiple-choice type) items. Field independent students outperformed field-dependent ones in relation to the global score of the test, but comparing

the results for the open and closed answer questions, the authors found that the effect size of cognitive style increased in the second modality (eta squared = 0.1) in relation with the first one (eta squared=0.04).

The application of multiple-choice tests may lead to the disappearance of the differences in performance which are present in other evaluation methods; this phenomenon has been observed in different educational levels and for different subjects (Danili & Reid, 2006; Davey, 1990; Dwyer & Moore, 1991; Lu & Suen, 1995; Mitchell & Lawson, 1988). In fact, the confidence shown by field-dependent subjects in this type of assessment is similar to that of the field-independent subjects, judging by the number of changes they make to their answers, an issue explored by Friedman and Cook (1995). The authors also observed that the repercussions of those changes on the global score of the test were not related to the subjects' cognitive style.

It is very likely that all the objective tests which share the characteristics of multiple-choice tests have the same favouring effect on field-dependent subjects. This is at least the case of "matching items" used by Mitchell and Lawson (1988) to assess performance in a biology university course; in this evaluation format, premises and responses within a set must be related. Also "structural communication grids" seem a good option to adapt to field dependence, as shown by Danily and Reid (2006) with Grade-10 pupils (age 15-16) of chemistry lessons. This format consists of a database of elements that should be combined to answer a number of questions. Both multiple-choice items and this type of evaluation made differences due to cognitive style disappear in three of the five tests applied in the study.

However, a kind of objective test widely used in the area of language, the cloze test, appears to have the opposite effect, placing field-dependent subjects in a disadvantaged position compared to field-independent subjects (Stanfield & Hansen, 1983). In this test the subjects must fill in blanks in either isolated or textually incorporated sentences, based on their meaning or syntactical structure. Aubret (1986) defends the view that this type of task requires either a degree of flexibility to accept or reject alternative representations of the sentence content (in case the subject has to rely on the meaning), or a syntactical structure analysis (in the event of having to rely upon this); both requisites may be considered as types of restructuring. Given that in his study differences were not detected in the texts proposed according to the academic year of the subjects (5th or 6th grade of basic education), and that differences were obtained for cognitive style, the author concluded that this kinds of tests are not a good index of knowledge or understanding of text content, but instead, they reflect inter-individual differences in processing style.

Open answer tests also seem to be more suited to the characteristics of most field-independent subjects, giving rise to or increasing their superior performance with regard to field-dependent subjects (Lu & Suen, 1995; López-Rupérez et al., 1991). Carrying out this type of test means that the accessible and/or acquired information has to be revised, seeking data relevant to the question which has been proposed, and presenting it in a way which suits the question's format. They therefore present the need for disembedding and restructuring which is an obstacle for field-dependent subjects.

The same demands are also normally present in problem solving. In this type of task, frequently used to evaluate academic performance in subjects such as Mathematics or Natural Sciences, field-independent subjects usually perform better than field-dependent subjects (Garret, 1989; Ronning, McCurdy, & Vallinger, 1984). Ronning et al.'s study (1984) made it possible to confirm the fundamental problem of the difficulties which field-dependent subjects have in problem solving. The authors presented five Natural Sciences problems to 150 secondary school students and evaluated their cognitive style. The students had to say out loud the ideas they had as they were performing the task. By applying a regression analysis it was observed that field dependence-independence significantly contributed to the variability of executions, even after controlling intelligence. By examining the solving protocols recorded during the problem solving process, the authors noticed that field-independent subjects were better at distinguishing between relevant and irrelevant information, and relied more on previous experiences to organize the data necessary to carry out the task.

Finally, communication measures of achievement have been found to favour field dependent students to the detriment of field independent ones with regard to second language achievement. Johnson, Prior, and Artuso (2000) registered communicative production transcripts and teachers' ratings of oral proficiency of ESL students from a university in Toronto, obtaining negative correlations of

these measures with subjects' scores in field dependence-independence. Recently, Salmani-Nodoushan (2006) has also observed a better performance of field dependent students compared to field independent ones in communicative English language tests. The relation of this sort of measures with cognitive style should be explored for other content areas.

Therefore, some particular types of objective tests, open answer tests and problems seem to bias evaluation against field-dependent students, while oral exams, at least in second language learning, prejudice field-independent students. Besides the repercussion of these tools on academic marks, they may also influence learning itself when used as teaching resources (proposed as exercises or strategies of comprehension or memorizing, etc.). This is another issue that should be investigated.

Conclusions

Field dependence-independence has been shown consistently to affect academic achievement (Tinajero & Páramo, 1997, 1998b). The objective of the present revision was to compile and synthesize findings in the literature about the relation between instructional dimensions and cognitive style, in order to extract some general adapting teaching strategies to compensate its effect. Studies made to date on this issue lead to conclude that the influence of cognitive style covers all the three facets of instructional preferences distinguished by Sadler-Smith and Riding (1999): instructional media, instructional method and assessment method.

With regard to instructional media, structuring is a process to be taken into account when selecting or designing didactic materials and also in relation to the learning skills to be trained in field dependent students. Since they are at a disadvantage when faced with structuring demands, they should receive clearly organized presentations, illustrations, texts…where relevant information is noticeable or indicated by markers, headings, organizers and so on. At the same time, they should be stimulated to summarize, elaborate and structure class materials by themselves and they should be given orientation and practice in these strategies when applied to materials in which relevant and irrelevant data are mixed (see for example, in relation with learning strategies training, Sternberg, Grigorenko & Zahn, 2008).

Regarding the instructional methods, we should presume that combining support and guidance strategies with opportunities to work autonomously would be the most suitable way for dealing simultaneously with the characteristics of field-dependent and field-independent students. In this line, computer assisted instruction seems a promising alternative that is being investigated and the potentials of cooperative group instruction should be explored.

Special attention should be given to motivational incentives and feedback. Since field-dependent students are at a disadvantage when they lack these resources and their use does not seem to interfere with field-independent students' learning, they would be contemplated as suitable measures in adapting teaching to cognitive style.

Nevertheless, students should be made aware of their learning tendencies; field dependent students in particular may be instructed to adopt *meta-motivational* strategies (see, for example, Trawick & Corno, 1995 and Wolters, 2003) and for their field independent counterparts, communication skills should be promoted. Data obtained by Rittschof and Chambers (2005) suggest that these groups of students are not conscious of their differences in learning, although a previous study by Summerville (1999) indicates they can be easily made aware by simply letting them know about cognitive style's implications and that this information leads them to adopt a critical perspective on teaching and learning.

Finally, although more research is needed in relation with assessment methods, at the moment it is important to consider the bias which some types of exams produce against students with a particular cognitive style, distorting the realistic appreciation of their acquisitions and perhaps interfering with their learning. Teachers should assess learning by different methods to elude the effect of cognitive style and also try to make their students aware of their weakness in evaluation situations and train them in exam preparation strategies (Vanderheiden, Donavan, & Duluth, 2007).

Measures suggested may be easily applied in educational practice, are in accordance with general guidelines of adaptive teaching (Corno, 2008). Moreover, they offer a plausible alternative which may specially help extremely field-

dependent students to overcome the academic disadvantage they experience. Teachers should not remain impassive when facing a situation which affects a large sector of the academic population.

References

Adegoke, B.A. (2011). Effect of indirect teacher influence on dependent-prone students' learning outcomes in secondary school mathematics. *Electronic Journal of Research in Educational Psychology, 9, 283-308*.

Annis, L.F. (1979). Effect of cognitive style and learning passage organization on study technique effectiveness. *Journal of Educational Psychology, 71,* 620-626.

Aubret, J. (1986) Traitements syntaxique et sémantique de textes et différences individuelles. Observations sur un test de phrases lacunaires. *Revue de Psychologie Appliquée, 36,* 447-468.

Baker, R.M., & Dwyer, F. (2005). Effect of instructional strategies and individual differences: a meta-analytic assessment. *International Journal of Instructional Media, 32,* 69-84.

Balluerka, N., & González-Tablas, M.M. (1996). Influencia de las instrucciones y de los esquemas en el aprendizaje de textos científicos en función de la dependencia de campo. *Psicológica, 17,* 143-160.

Bien, E.C. (1974). The relationship of cognitive style and structured arithmetic materials to performance in fourth grade arithmetic. *Dissertation Abstracts International, 35,* 2040-2041.

Bolocofsky, D.N. (1980). Motivational effects of classroom competition as a function of field dependence. *The Journal of Educational Research, 73,* 213-217.

Brenner, J. (1997). An analysis of students' cognitive styles in asynchronous distance education courses. *Inquiry, 1*, 37-44

Brooks, L.W., Dansereau, D.F., Spurlin, J.E., & Holley, C.D. (1983). Effects of headings on text processing. *Journal of Educational Psychology, 75,* 292-302.

Brown, M.S. (1984). Do confusing information and egocentric instructions influence perception? *Perceptual and Motor Skills, 59,* 15-20.

Burkhalter, B.B., & Schaer, B.B. (1984-85). The effect of cognitive style and cognitive learning in a nontraditional educational setting. *Educational Research Quarterly, 9,* 12-18.

Canino, C., & Cichelli, T. (1988). Cognitive styles, computerized treatments on mathematic achievement and reaction to treatments. *Journal of Educational Computing Research, 4,* 253-264.

Carbonnel, S. (1982). Influence de la signification des objets dans les activités des classifications. *Enfance, 3,* 193-210.

Cardozo, A. (2004). *Influencia de la dimensión dependencia-independencia de campo sobre el aprendizaje en contextos instruccionales asistidos por el computador.* Paper presented at the Congreso Internacional Virtual de Educación. Islas Baleares, España.

Cathcart, W.G. (1990). Effects of logo instruction on cognitive style. *Journal of Educational Computing Research, 6,* 231-247.

Chen, S.Y., & Liu, X. (2008). An integrated approach for modelling learning patterns of students in web-based instruction: A cognitive style perspective. *ACM Transactions of Computer-Human Interaction (TOCHI), 15* (1).

Chen, S.Y., & Macredie, R.D. (2002). Cognitive styles and hypermedia navigation: Development of a learning model. *Journal of the American Society for Information Science and Technology, 53* (1), 3-15.

Chou, H. (2001). Influences of cognitive and training method on training effectiveness. *Computers & Education, 37,* 11-25.

Chuang, Y. (1999). Teaching in a multimedia computer environment: A study of the effects of learning style, gender, and math achievement. *Interactive Multimedia Electronic Journal of Computer Enhanced Learning 1*(1).

Clark, H.T., & Roof, K.D. (1988). Field dependence and strategy use. *Perceptual and Motor Skills, 66,* 303-307.

Collings, J.N. (1985). Scientific thinking through the development of formal operations: Training in the cognitive restructuring aspects of field independence. *Research in Science and Technological Education, 3,* 145-152.

Collings, J.N. (1994). Some fundamental questions about scientific thinking. Research in Science and Technological Education, 12 (2), 161-173.

Corno, L. (2008). On teaching adaptively. *Educational Psychologist, 43,* 161-173.

Corral, A. (1982). La influencia del estilo cognitivo dependencia-independencia de campo en la resolución de dos problemas de física. *Infancia y Aprendizaje, 18,* 107-123.

Coventry, L. (1989). Some effects of cognitive style on learning UNIX. *International Journal of Man-Machine Studies, 31,* 349-365.

Coward, R.T., & Lange, G. (1979). Recall and recall-organization behaviours of field dependent and field-independent children. *Psychological Reports, 44,* 191-197.

Danili, E., & Reid, N. (2006). Cognitive factors that can potentially affect pupils' test performance. *Chemistry Education Research and Practice, 7*, 64-83.

Davey, B. (1990). Field dependence-independence and reading comprehension questions: Task and reader interactions. *Contemporary Educational Psychology, 15,* 241-250.

Davies, M.F. (1985). Cognitive style differences in belief persistence after evidential discrediting. *Personal and Individual Differences, 6,* 341-346.

Davis, J.K., & Frank, B.M. (1979). Learning and memory of field-dependent individuals. *Journal of Research in Personality, 13,* 469-479.

Dwyer, F.M., & Moore, D.M. (1991). Effect of colour coding on visually oriented tests with students on different cognitive style. *The Journal of Psychology, 125,* 677-680.

Emmett, D., Clifford, B.R. & Gwyer, P. (2003). An investigation of the interaction between cognitive style and context reinstatement on the memory performance of eyewitnesses. *Personality and Individual Differences, 34,* 1495-1508.

Ennis, C.D. (1991). Instructional strategies to facilitate the learning of field-dependent children. *Early Child Development and Care, 67,* 95-109.

Fernández-Ballesteros, R., Macia, A., Ruiz, J.M., Fernández-Lagunilla, E., Del Villar, M.V., & Díaz-Veiga, P. (1980). Influencia de la dependencia-independencia de campo sobre el efecto del "feedback" en una tarea de tiempos de reacción. *Revista de Psicología General y Aplicada, 35,* 589-595.

Frank, B.M. (1984). Effect of field independence-dependence and study technique on learning from a lecture. *American Educational Research Journal, 21,* 669-678.

Frank, B.M., & Keene, D. (1993). The effect of learner's field independence, cognitive strategy instruction, and inherent word-list organization on free-recall memory and strategy use. *Journal of Experimental Education, 62,* 14-25.

Friedman, S.J., & Cook, G.L. (1995). Is an examinee's cognitive style related to the impact of changing on multiple-choice test? *Journal of Experimental Education, 63,* 199-213.

Garret, R.M. (1989). Problem-solving and cognitive style. *Research in Science and Technological Education, 71,* 27-44.

Globerson, T., Weinstein, E., & Sharabany, R. (1985). Teasing out cognitive development from cognitive style: A training study. *Developmental Psychology, 21,* 682-691.

Goodenough, D.R. (1976). The role of individual differences in field dependence as a factor in learning and memory. *Psychological Bulletin, 83,* 675-694.

Grigorenko, E.L., & Sternberg, R.J. (1995). Thinking styles. In D.M. Saklofske, & M. Zeidner (Eds.), *International Handbook of Personality and Intelligence* (pp. 205-229). New York: Plenum Press.

Handal, B., & Herrington, A. (2004). On being dependent or independent in computer based learning environments. *Journal of Instructional Science and Technology, 7* (2), 1-10.

Hsu, P. (2001). *The effects of varied levels of adjunct questions on the performance of field-independent and field-dependent learners.* Paper presented at the annual meeting of the Association for Education Communications and Technology, Atlanta, Georgia.

Johnson, J., Prior, S., & Artuso, M. (2000). Field dependence as a factor in second language communicate production. *Language Learning, 50,* 529-567.

Jonassen, D.H.,& Grabowski, B.L. (1993). *Handbook of individual differences, learning, and instruction*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kang, S., Scharmann, L. C., Noh, T., & Koh, H. (2005). The influence of students' cognitive style and motivational variables in respect of cognitive conflict and conceptual change. *International Journal of Science Education, 27* (9), 1037-1058.

Kiewra, K.A., & Frank, B. (1986). Cognitive style: Effects of structure at acquisition and testing. *Contemporary Educational Psychology, 11,* 253-263.

Kim, K.S. (2000). *Effects of cognitive style on web search and navigation.* Proceedings of World Conference

on Educational Multimedia, Hypermedia and Telecommunications, Chesapeke, VA: AACE.

Kim, K.S. (2001). Information seeking on the web. Effects of user and task variables. *Library & Information Science Research, 23* (3), 233-255.

Konstadt, N., & Forman, E. (1965). Field dependence and external directedness. *Journal of Personality and Social Psychology, 1,* 490-493.

López-Rupérez, F., Palacios, C., & Sánchez, J. (1991). Relation of field independence and test-item format to student performance on written piagetian tests. *Journal of Research in Science Teaching, 28,* 389-400.

Lu, C.H., & Suen, H.K. (1995). Assessment approaches and cognitive styles. *Journal of Educational Measurement, 32,* 1-17.

Lu, J., Yu, C., & Liu, C. (2003). Learning style, learning patterns, and learning performance in a WebCT-based MIS course. *Information and Management, 40,* 497-507.

Ludwig, I., & Lachnit, H. (2004). Effects of practice and transfer in the detection of embedded figures. *Psychological Research, 68,* 277-288.

McLeod, D.B., & Adams, V.M. (1979). The interaction of field independence with discovery learning in mathematics. *Journal of Experimental Education, 48,* 32-35.

MacNeil, R.D. (1980). The relationship of cognitive style and instructional style to the learning performance of undergraduate students. *Journal of Educational Research, 73,* 354-359.

Marendaz, C. (1985). Global precedence and field dependence: Visual routines? *Cahiers de Psychologie Cognitive, 5,* 727-745.

Mayer, R.E. (2003). *Learning and Instruction.* Upper Saddle River, NJ: Prentice-Hall.

Meng, K., & Patty, D. (1991). Field dependence and contextual organizers. *Journal of Educational Research, 84* (3), 183-189.

Mitchell, A., & Lawson, A.E. (1988). Predicting genetics achievement in non majors college biology. *Journal of Research in Science Teaching, 25,* 23-37.

O'Connor, K.P., & Blowers, G.H. (1980). Cognitive style, set and sorting strategy. *Journal of Psychology, 71,* 17-22.

Ohlmann, T. (1982). Plasticité des activités classificatoires. *Bulletin de la Société Francaise por L'Etude du Comportement Animal, 2,* 371-380.

Ohlmann, T., & Carbonnel, S. (1983). Dépendance-indépendance a l'égard du champ et activities classificatoires su objects signfictatifs. In T. Ohlmann (Ed.), *La pensée naturelle.* Rouen: P.U.F.

Pennings, A.H. (1991). Altering the strategies in embedded-figure and water-level tasks via instruction: A neo-piagetian learning study. *Perceptual and Motor Skills, 72,* 639-660.

Pintrich, P.R. (2002). The role of metacognitive knowledge in learning, teaching and assessing. Theory into practice, 41(4): 219–25.

Price, L. (2004). Individual differences in learning: cognitive control, cognitive style, and learning style. *Educational Psychology, 24,* 681-698.

Rickards, J.P., Fajen, B.R., Sullivan, J.F., & Gillespie, G. (1997). Signaling, notetaking, and field independence-dependence in text comprehension and recall. *Journal of Educational Psychology, 89,* 508-517.

Richardson, J.T.E. (2005). Students' approaches to learning and teachers' approaches to teaching in higher education. *Educational Psychology, 25*, 673-680.

Ritchey, P.A., & LaShier, W.S. (1981). The relationship between cognitive style, intelligence and instructional mode to achievement of college science students. *Journal of Reserach in Science Teaching, 18,* 41-45.

Rittschof, K.A. & Chambers, W.L. (2005). *Instructional favoritism? Field dependence-independence does not consistently predict self perceptions or teaching preferences.* Paper presented at the Annual Conference of the American Psychological Society, Los Angeles, California.

Rollock, D. (1992). Field dependence-independence and learning condition: An exploratory study of style vs. ability. *Perceptual and Motor Skills, 74,* 807-818.

Ronning, R.R., McCurdy, D., & Vallinger, R. (1984). Individual differences: A third component in problem-solving instruction. *Journal of Research in Science Teaching, 21,* 71-82.

Ruble, D.N., & Nakamura, C.Y. (1972). Task orientation versus social orientation in young children and their attention to relevant social cues. *Child Development, 43,* 471-480.

Rusch, G.M., & Moore, D.M. (1991). Effects of restructuring training and cognitive style. *Educational Psyhcology, 11,* 309-321.

Sadler-Smith, E. (1999). Intuition-analysis style and approaches to studying. *Educational Studies, 25,* 159-173.

Sadler-Smith, E., & Riding, R. (1999). Cognitive style and instructional preferences. *Instructional Science, 27,* 355-371.

Salmani-Nodoushan, M.A. (2006). Does cognitive style affect communicative language tests. *Language, Society and Culture, 19*.

Sánchez-Gámez, J.L., & González-Girón, G. (1993). Interacción del estilo cognoscitivo con el método instruccional en el aprendizaje de las matemáticas. *Revista intercontinental de Psicología y Educación, 6* (1-2), 257-269.

Saracho, O.N. (1991). Student's preference for field dependence-independence teacher characteristics. *Educational Psychology, 11,* 323-332.

Saracho, O.N. (1997). *Teachers' and students' cognitive styles in early childhood education.* London: Bergin & Garvey.

Sarmany, I. (1993). Aspects of cognitive style in anticipatory time-space task. *Studya Psychologica, 35,* 151-158.

Shih, C, Ingerbritsen, T., Pleasants, J, Flickinger, K., & Brown, G. (1998). *Learning strategies and other factors influencing achievement via web courses.* Proceedings of the Annual Conference on Distance Teaching & Learning, Madison, WI.

Shymansky, J.A., & Yore, L.D. (1980). A study of teaching strategies, student cognitive development, and cognitive style as they relate to student achievement in science. *Journal of Research in Science Teaching, 17,* 369-382.

Stanfield, C., & Hansen, J. (1983). Field dependence-independence as a variable in second language cloze test performance. *TESOL Quarterly, 17* (1), 29-38.

Stash, N., & De Bra, P. (2004). *Incorporating cognitive styles in AHA! (the adaptive hypermedia architecture).* Proceedings of the IASTED International Conference web-based education. February 16-18, Insbruck, Austria.

Sternberg, R.J., Grigorenko, & Zahn, L.F. (2008). Styles of learning and thinking matter in instruction and assessment. *Perspective on Psychology Science, 3,* 486-506.

Strawitz, B.M. (1984b). Cognitive style and the effects of two instructional treatments on the acquisition and transfer of the ability to control variables: A longitudinal study. *Journal of Research in Science Teaching, 21,* 833-841.

Summerville, J. (1999). Role of awareness of cognitive style in hypermedia. International *Journal of Educational Technology, 1*.

Thompson, G. & Knox, A.B. (1987). Designing for diversity: Are field-dependent learners less suited to distance education programs of instruction?. *Contemporary Educational Psychology, 12*, 17-29.

Threadgill-Sowder, J., Sowder, L., Moyer, J.C., & Moyer, M.B. (1985). Cognitive variables and performance on mathematical story problems. *Journal of Experimental Education, 54,* 56-62.

Tinajero, C., & Páramo, M.F. (1996). Dependencia-independencia de campo: ¿Nivel de desarrollo o estilo cognitivo? *Infancia y Aprendizaje, 75,* 97-106.

Tinajero, C., & Páramo, M.F. (1997). Field dependence-independence and academic achievement: A reexamination of their relationship. *British Journal of Educational Psychology, 67,* 199-212.

Tinajero, C., & Páramo, M.F. (1998a). Field dependence-independence and strategic learning. *International Journal of Educational Research, 29*, 251-262.

Tinajero, C., & Páramo, M.F. (1998b). Field dependence-independence and academic achievement: A review of research and theory. *European Journal of Psychology of Education, 13,* 227-251.

Trawick, L., & Corno, L. (1995). Expanding the volitional resources of urban community college students. *New Directions for Teaching, 63,* 57-70.

Triantafillou, E., Pombortsis, A., Demetriadis, S., & Georgiadou, E. (2004). The value of adaptivity based on cognitive style: an empirical study. *British Journal of Educational Technology, 35* (1), 95-106.

Vanderheiden, S., & Donavan, J. (2007). *Connecting student outcomes to exam preparation strategies: Promoting self-reflective learning.* Paper presented at annual meeting of the Midwest Political Science Association, Chicago, Illinois.

Wapner, S., & Demick, J. (1991). *Field dependence-independence. Cognitive style across the life span.* New Jersey: Lawrence Erlbaum.

Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R., & Karp, S.A. (1962). *Psychological differentiation.* New York: Wiley.

Witkin, H.A., & Goodenough, D.R. (1981). *Cognitive styles: Essence and origin.* New York: International Universities Press.

Witkin, H.A., Oltman, P.K., Raskin, E., & Karp, S.A. (1971). *A manual for the embedded figures tests.* Palo Alto, CA: Consulting Psychology Press.

Wolters, C.A. (2003). Regulation of motivation: Evaluating an underemphasized aspect of self-regulated learning. *Educational Psychologist, 38,* 189-205.

Zhang, L.F. & Sternberg, R.J. (2006). *The nature of intellectual styles.* Mahwah, New Jersey, NJ: Lawrence Erlbaum Associates.