

Nielsen, T. (2005b). Mental self-government: Relationships between personality dimensions, educational history and status, and learning styles. Paper 4 i Nielsen, T. (2005a). Learning styles of Danish university students – Do they differ according To subject of study at the start of the first academic year? – Is there a subject specific socialization effect of one year of higher education? Development of and Research by means of The Danish Learning Styles Inventory (D-LSI) based on Sternberg's theory of mental self-government. PhD thesis, the Department of Educational Psychology, the Danish University of Education.

## **Paper Four**

### **Mental Self-government: Relationships between Personality Dimensions, Educational History and Status, and Learning Styles**

**Tine Nielsen**

*Department of Educational Psychology, The Danish University of Education,  
Copenhagen, Denmark*

Paper presented at *the 9<sup>th</sup> European Congress of Psychology, Granada, Spain, July 3-8  
2005.*

Submitted for publication.



### **Abstract**

The study aimed at examining the relationship between gender, age, educational history and status, and big five personality dimensions (Costa & McCrae, 1992) and learning styles (Sternberg, 1988; 1997), as it pertains to course and lesson planning and design, the question of whether students' choice of subject of study is associated with differences in learning style being of particular interest. One-hundred and sixty-two Danish university students responded to the Revised Danish Learning Styles Inventory and the Danish NEO-PI-R, as well as a number of questions designed to elicit information on educational history and status. Item analysis by Rasch measurement models shows nine of the fourteen learning style scales to be functioning adequately as eight-item scales, and the remaining five scales to be functioning adequately as seven-item scales. With regard to the five personality dimensions, only the two scales of neuroticism and conscientiousness are considered to be of a quality to allow further analysis. Results of general linear model analyses for each learning style scale show group differences in learning style on such background variables as gender, age, being a university starter or not, and having previously interrupted a longer education or not, as well as group differences in learning style defined by the two personality dimensions neuroticism and conscientiousness. Finally a chain graph model describing all relations between background variables, personality dimensions and learning styles is proposed. No associations between students' choice of study subject and their learning styles were found.

### **Introduction**

In Denmark, as in many other countries, teaching in higher education is challenged by the diversity in the student body, not only diversity in abilities but also diversity in the students' preferences for mental processes when learning and thereby diversity in the degree to which these preferences are met by the teaching. In other words, the challenge can be formulated as student diversity in cognitive, thinking or learning style and how this diversity can be taken into account in course and lesson planning (Henson & Borthwick, 1984; Kolb, 1984; Sternberg, 1997).

Many researchers (Witkin, 1976; Kolb, 1984; Seidel & England, 1999; Verma, 2001; Zhang, 1999, and many other) have studied differences in cognitive, thinking and learning styles of university students according to different aspects of students' educational choices, within a range of different theories of style by means of cross-sectional samples. Within Witkin's theory of cognitive styles, students' choice of specialization was found to be associated with cognitive style, in that field-dependent students chose specializations favoring involvement with people, whereas field-independent students chose specializations favoring analysis (Witkin, 1976). Within Kolb's theory, differences in the learning styles of introductory accounting students according to their majors were found by Baldwin and Reckers (1984), in that students majoring in finance had the most marked assimilative learning styles, students majoring in accounting had a weak assimilative learning style, and students majoring in management, marketing and computer information systems had various degrees of divergent learning styles. Within Gregorc's (1982, 1988) theory of mind styles, differences in the learning styles of undergraduate students according to categories of major were found, in that 86% of students majoring in a science subject were classified in the concrete sequential or the dual sequential style categories, 85% of students majoring in a humanities subject were classified in the dual random style category, while students majoring in a social science subject were distributed evenly across style categories (Seidel & England, 1999). Last,

within Sternberg's theory of mental self-government (Sternberg, 1988, 1997), no research pertaining to choice of study subject, specializations or particular classes has been performed. However, Zhang and Sachs (1997) reports that students pursuing a degree in education with differing majors and at differing levels of education (B.Ed., P.C.Ed. and M.Ed.) who attended a class in research scored higher on the external thinking style than did students not attending this class, and that students who were pursuing a major in natural science and technology scored higher on the global thinking style than students pursuing a major in social science or humanities. On the other hand, Zhang (1999) found no differences in thinking styles for students pursuing a degree of education (B.Ed., P.C.Ed. and M.Ed.) or business (M.B.A.), and no differences in thinking styles for the same group of students, according to class levels.

Other researchers (Vermetten, Vermunt & Lodewijks, 1999; Schatteman, Carette, Couder & Eisendrath, 1997; Busato, Prins, Elshout, & Hamaker, 1998) have been concerned with changes in learning style, as defined in Vermunt's theory of learning styles (1992, 1998), during the course of study, and have thereby solidified the notion that learning styles are not a stable phenomenon which can be measured once during the time of study and then applied to the planning aspects of teaching. This research is typically longitudinal studies covering different periods of university study. Vermetten, Vermunt and Lodewijks (1999) report an increase in university students' use of strategies indicative of a meaning-directed learning style and no change in their use of strategies representing a reproduction-directed learning style from the first to the third semester, measured retrospectively at the end of semesters. Schatteman, Carette, Couder and Eisendrath (1997) report changes in learning styles from the start of the first academic year to the end of the first semester for both an experimental group which participated in a specifically designed process-oriented mechanics course, and a control group consisting of students of various majors which did not participate in this course. However, in the experimental group changes were more pronounced towards the learning styles sought enhanced with the process-oriented instruction; an increase in high scores on the meaning-directed and the application-directed learning styles, and a decrease in high scores on the reproduction-directed learning style. Busato, Prins, Elshout and Hamaker (1998) report from a cross-sectional study that there are no differences in the degree to which Dutch university students employ learning styles in the early and later years of university education, a finding supported by a longitudinal study involving university students in their first and second year of study where no changes in learning style scores are found. However, a second longitudinal sample with learning style measures from the first, second and third year of study show a significant increase in the use of the meaning-directed learning style from the second to the third year of study.

Questions left un-answered by previous research, cross-sectional as well as longitudinal, are questions on the nature of these differences in learning styles according to subject of study. The cross-sectional studies can document differences in learning styles according to subject of study, but are not able to explain these differences further in terms of the degree to which the differences can be attributed to differences which were present already at the start of the respective subjects of study – In other words, the question is: Do learning styles affect the choice of subject of study? The longitudinal studies can document socialization effects (that is changes) in the learning styles of students during various periods of study, but they are not able to disclose the degree to which the socialization effect depends on subject of study, the specific courses taken, and/or other variables on which the students are known to vary or could be expected to

vary with regard to learning styles, such as the learning styles at the start of study. Such a separation of the effect of learning style on students' choice of study subject and the effect of socialization of the study subject on the learning styles of the students has important implications for the application of findings on differences in learning styles to course and lesson planning. Knowledge on differences in students' learning styles, at the time they commence university, can be utilized in the planning of introductory and first courses. Knowledge on the development of learning styles through the time of study can be utilized in planning towards (knowledge) specific goals with regard to ways of thinking, methods of study, problem solving, etc. In addition, it is considered important with regard to utilization of the acquired knowledge on differences in the learning styles of university students in planning and design that background information which is directly observable and/or easily obtained by university teachers – such as age, gender, previous educational level, etc. – is incorporated into the design of such studies, in order to facilitate easy implementation of findings.

This paper, as the first of two<sup>1</sup> on the present study, addresses the first question regarding the effect of learning styles on the choice of subject of study, within the theory of mental self-government (Sternberg, 1988; 1997). The study also aims to investigate the associations between learning styles and other variables on which students are known to vary or could be expected to vary, variables which accordingly are possible confounders of learning style differences according to subject of study.

### ***The Theory of Mental Self-government and Learning Styles***

The learning style construct employed in the present study is derived from the thinking style construct proposed by Robert J. Sternberg in his Theory of mental self-government (Sternberg, 1988, 1997). Within this theoretical framework, thinking style is defined as a profile of *thinking* styles describing a person's preferred ways of thinking in specific contexts. The learning style construct used is therefore defined as: A profile of thinking styles describing the individual's *preferred* ways of thinking in the specific university learning context. These preferred ways of thinking represent different ways of perceiving and handling different types of problems in the learning context. For reasons of clarification, the term learning style is used as denoting the individual styles that make up the learning styles profile throughout the paper.

The theory of mental self-government (Sternberg, 1988, 1997) is based on the idea that the forms of government we see in the world represent alternative externalized ways of organizing our thinking. In this sense, individuals are regarded as systems, which must govern themselves in the same way as society must. The present study includes the thirteen styles contained in the theory of mental self-government, as well as the additional democratic form style proposed by Nielsen, Kreiner and Styles (2005). These fourteen learning styles organized in five categories signifying the functions, forms, levels, scopes and leanings of mental self-government make up the learning styles profile.

The functions of learning styles are defined according to the three major functions of government, the Legislative, the Executive, and the Judicial, and can briefly be described as a preference for problem definition, goal setting and strategy making (Leg-

---

<sup>1</sup> A second paper addressing the question of socialization of students learning styles during the course of study is forthcoming.

islative style), a preference for finding well-defined ways of doing this and execution of pre-defined activities and (Executive style), and a preference for evaluating and critiquing ideas, processes and results (Judicial style). The forms of learning styles are defined according to four classical forms of government, the Monarchic, the Hierarchic, the Oligarchic, and the Anarchic forms, and can be described respectively as a preference for fulfillment of a single, most important goal or need at a time (Monarchic style), a preference for fulfillment of a hierarchy of goals of differing importance in a balanced way and for being systematic (Hierarchic style), a preference for fulfillment of multiple competing goals of equal conceived importance with multiple, possibly competing, approaches and for being multi-systematic (Oligarchic style), a preference for fulfillment of multiple needs and goals of uncertain importance with a random approach and for being a-systematic (Anarchic style), and a preference for fulfillment of their own needs and goals as well as those of others – perceived as equally important – using a dialogical approach (Democratic style). The levels of learning styles are defined according to two basic levels of government, the Global and the Local, and can be described briefly as a preference for large and abstract issues in the world of ideas (Global style), and a preference for problems requiring detail work and an orientation toward the pragmatics of a situation (Local style). The scope of learning styles are defined from two basic foci of interest to governments, the External (foreign affairs), and the Internal (domestic affairs), and can be described as a preference for working with others and seeking problems that either involve working with other people or are about other people (External style), and working alone and applying their intelligence to things or ideas in isolation from other people (Internal style). The leaning aspects of learning styles are defined from what could be termed as two basic leanings of governments, the Conservative and the Liberal – in the classical meaning of the terms – and can be described as a preference for existing rules and procedures and seeking familiar/known problems and situations (Conservative style), and a preference for going beyond existing rules and procedures and seeking new/unknown problem or situations (Liberal style) – see Sternberg (1988, 1997) and Nielsen, Kreiner and Styles (2005) for in-depth descriptions.

It is important to emphasize that an individual having a certain learning style means that the individual prefers certain ways of thinking and that these ways of thinking represent different ways of perceiving and handling problems in the learning context. That is, an individual with a certain learning style will perceive problems that they encounter when learning as a certain type of problem and will as a consequence of their perception of the nature of the specific problem – real or perceived – choose to handle them in certain ways. In this way, each learning style can be said to entail a preference for solving certain types of problems – real or perceived – with thinking processes appropriate for the type of problem. The fourteen styles are *always* represented in each individual learning style profile, but to varying degrees. For example, the level of mental self-government is not a question of preference for either global ways of thinking or local ways of thinking, rather it is a question of degrees of preference for global *and* local ways of thinking. The preferences *for* certain ways of thinking can therefore (and usually will) be of differing strengths, but never entirely absent.

#### ***Variables which could Affect Learning Styles at the Start of Study***

Research into the possible effects of learning styles on students' choice of subject of study in higher education should include other variables that have been found to and could be expected to disclose differences in the learning styles of students in higher

education, in order to be able to explain differences in learning style more fully. For example, it is quite possible that an association between learning styles and choice of study subject could be explained by other variables such as age, gender, previous educational level, etc.

Some of the variables which have been shown to disclose differences in thinking styles within the theory of mental self-government (Sternberg, 1988, 1997) are background variables such as gender and age, personality variables, and educational status. It is therefore reasonable to assume that these variables would also disclose differences in the learning styles of Danish university students.

Previous research (Zhang, 2001; Zhang & Sternberg, 2001; Zhang & He, 2003; Verma, 2001; Zhang & Sternberg, 2002; Zhang & Sachs, 1997; Zhang, 2003b; Zhang, 1999) does not indicate general gender differences in thinking styles across studies, even if all the studies concerning gender has been on Asian samples, nor does research into age differences in thinking styles show general relationships (Zhang & Postiglione, 2001; Zhang & Sachs, 1997; Zhang, 2003a; Zhang, 1999; Zhang & He, 2003). Accordingly, it is difficult to make predictions on gender and age differences in learning styles among Danish university students, beyond the prediction that gender as well as age could prove to be associated with learning styles.

With regard to educational status and history, research within the theory of mental self-government is sparse. Zhang (2003b) reports a significantly higher score on the liberal thinking style for first year secondary school students, when compared to second year students. No research on the effect of educational history on thinking styles has been conducted to date. However, on the basis of the theoretical proposition that styles are partially socialized (Sternberg, 1994a, 1997) and research findings showing changes in learning styles during the course of higher education (Vermetten, Vermunt & Lodewijks, 1999; Schatteman, Carette, Couder & Eisendrath, 1997), it seems reasonable to assume that the educational history, as well as the educational status, of Danish university students could also disclose differences in their learning styles.

The personality measure often used in research into thinking styles as defined by the theory of mental self-government is the NEO-PI-R measuring personality dimensions as defined by the so-called big five construct (Costa & McCrae, 1992). This research (Zhang & Huang, 2001; Zhang, 2001; Zhang, 2002b; Fjell & Valhovd, 2004) has, however, not shown a general pattern of associations between personality dimensions and thinking styles. With regard to the two personality dimensions employed in the present study, previous studies report several findings that are consistent across at least three of the four studies: neuroticism correlates negatively with the Legislative and Liberal thinking styles and positively with the Executive and Conservative thinking styles, while conscientiousness correlates positively with the Legislative, Executive, Judicial, Monarchic, Hierarchic, Local, and External thinking styles – the positive correlation between conscientiousness and the Hierarchic thinking style being the only finding which is consistent across all five samples of the four studies. In addition, Zhang (2002a, 2002b) and Fjell and Walhovd (2004) report single correlations between the two personality measures and thinking styles, which are not replicated by any of the other studies. Zhang and Huang (2001) and Zhang (2002a) also both report, on the basis of multiple regression analyses, that the Executive, Local and conservative thinking styles are partially predicted by both neuroticism and conscientiousness. Both studies

report single findings on the predictive power of the two personality dimensions with regard to thinking styles, which are not consistent across the two studies. Furthermore, Zhang (2003a) report that neuroticism and conscientiousness are good predictors for different approaches to learning, as measured by Biggs' Study Process Questionnaire. On the basis of these findings and the theories behind the measurements, it is predicted that for Danish university students in the present study neuroticism will be positively associated with the Executive, Monarchic, and Conservative learning styles and negatively associated with the Legislative and Liberal learning styles, because emotionally insecure individuals (neuroticism) are expected to prefer to learn by doing what is expected of them (Executive style), going for *the* solution to the problem given (Monarchic style) and keeping to known methods and knowledge (Conservative style) in order to reduce the element of insecurity, while not preferring to learn by setting their own agenda (Legislative style) or seeking new methods (Liberal style), since this would increase insecurity (Costa & McCrae, 1992; Sternberg, 1997). And it is predicted that conscientiousness will be positively associated with the majority of learning styles, because being conscientious when learning can take many forms and as such involve setting your own agenda (Legislative style), being analytical and critical (Judicial style), prioritizing your work (Hierarchic style), and so on (Costa & McCrae, 1992; Sternberg, 1997; Nielsen, Kreiner & Styles, 2005).

## Methods

### *Participants*

One-hundred and sixty-two Danish university students (55 male and 107 female) participated in this study. All participants were attending classes in the second week of either the bachelor level education in sociology or the master (*kandidat*<sup>2</sup>) level education in educational psychology. The participants were 74 bachelor students of sociology, 66 master students of educational psychology, and 22 students of differing subjects at differing levels of study. Of the participants, 96 were first time university students (university starters) and the remaining 66 were not. 72 of the participants had earlier completed an education and 36 of the participants had earlier incomplete education. The ages of the participants ranged from 19 to 68 years, with a mean of 29.44 and a standard deviation of 9.97.

### *Measures*

Participants responded to the Revised Danish Learning Styles Inventory (Nielsen & Kreiner, 2004; Nielsen & Kreiner, 2005; Nielsen, Kreiner & Styles, 2005), a Danish edition of the NEO-PI-R (Costa & McCrae, 1992), and a questionnaire containing background questions on educational history and status.

The Revised Danish Learning Styles Inventory (LSI-R) is a Danish adaptation of the Thinking Styles Inventory (Sternberg, 1997) measuring specifically learning styles. The LSI-R is a self-report inventory consisting of 112 statements. Each eight statements fall into one of 14 scales, with 13 of these scales corresponding to the styles set forward by Sternberg (1988, 1997) in his theory of mental self-government, and the 14th scale corresponding to the proposed democratic style (Nielsen, Kreiner & Styles, 2005). The participants rated themselves according to how well the statements described them in

---

<sup>2</sup> The *kandidat* degree is a two-year subject specific study placed after the three years of bachelor level studies, and the Germanic equivalent of the Anglo-Saxon master degree.

learning situations within their field of study, using a polytomous answering scale with 1 corresponding to "not at all" and seven corresponding to "extremely well".

The Revised Danish Learning Styles Inventory has shown good reliability and validity. Item analysis by graphical loglinear Rasch models (Kreiner & Christensen, 2002; Kreiner & Bang Christensen, 2004) show nine of the fourteen learning style scales to be functioning adequately as eight-item scales<sup>3</sup> – the Legislative, Executive, Judicial, Monarchic, Anarchic, Democratic, Global, Local, and Liberal scales – and the remaining five scales to be functioning adequately as seven-item scales – the Hierarchic, Oligarchic, Internal, External, and Conservative scales (Nielsen and Kreiner, 2005). In the present study, reliability estimates (test-retest correlation) are .70, .86, .76, .71, .63, .55, .62, .70, .84, .59, .67, .74, .92, and .91 respectively for the Legislative, Executive, Judicial, Monarchic, Hierarchic, Oligarchic, Anarchic, Democratic, Global, Local, Internal, External, Liberal, and Conservative learning styles. This is comparable to the reliabilities reported in Zhang and Huang (2001) and Zhang (2002a, 2002b) for a Chinese short version of the TSI, and the reliabilities reported by Sternberg (1994a) for an earlier version of the TSI.

The NEO-PI-R is also a self-report inventory, translated and published by the Danish Psychological Publishers. The NEO-PI-R consists of 60 statements making up five 12-item scales measuring each of the five personality domains of neuroticism, extraversion, agreeableness, conscientiousness and openness to experience. Participants rated each statement on a 5-point scale, with 0 corresponding to "strongly disagree" and 4 corresponding to "strongly agree". The original version of the NEO-PI-R has good reliability and validity, as reported in the NEO-PI-R Professional Manual (Costa and McCrae, 1992). The present data collected with the Danish edition of the NEO-PI-R was also subjected to item analysis by graphical loglinear Rasch models (Kreiner & Christensen, 2002; Kreiner & Bang Christensen, 2004) in order to establish the reliability and validity of each of the five scales in this edition. The resulting usable scales were of differing lengths and with differing degrees of reliability (test-retest correlation): The neuroticism scale retained all 12 items with a reliability of .85, the extraversion scale retained 10 items with a reliability of .69, the openness scale retained 6 items with a reliability of .28, the agreeableness scale retained 11 items with a reliability of .67, and the conscientiousness scale retained 11 items with a reliability of .81. On the basis of these results, it was decided to exclude the openness to experience scale from further analyses. Further analyses of the contents of the remaining items in the scales revealed additional problems with two of the remaining four scales: The 10 items making up the extraversion scale seemed not to be measuring "extraversion", but rather "degree of optimism and energy". The 11 items making up the agreeableness scale seemed not to be measuring "degree of agreeableness", but rather "degree of consideration for others". Also, three items were problematic in that they asked about what the respondent thought other people thought about them, which is different from asking about the respondents' thoughts on themselves. In conclusion, only the two scales of

---

<sup>3</sup> The choice of modern test theory in the validation study was based on formulated aims concerning item bias - see Nielsen & Kreiner (2005). Exploratory as well as confirmatory factor analyses have also been conducted. However, the results and discussion of these analyses is extensive and beyond the boundaries of this paper.

neuroticism and conscientiousness are considered to be of a quality to allow further analyses<sup>4</sup>.

### ***Data Analysis***

Initial distributional measures, as well as correlations between the 14 learning style scales and between the two personality dimension scales, neuroticism and conscientiousness, and the 14 learning style scales, were calculated using Pearson's product-moment correlations. In order to examine the relationships between the two personality dimensions of neuroticism and conscientiousness, demographic variables such as age and gender, and educational history and status on one side and learning styles on the other, two statistical procedures were employed.

First, multiple analyses of variance<sup>5</sup> were conducted one by one for each learning style scale in order to explore the relationships between the independent variables of gender, age, the two personality dimensions neuroticism and conscientiousness, having previously completed a longer education or not, having previously interrupted a longer education or not, being a university starter or not, and subject of study, and the dependent learning style scores. The age variable and the two personality variables were entered into the analyses as dichotomized variables split at the median, so as to make the analyses more robust. Backwards model search from a model containing all variables and all two-way interactions, removing only one variable or interaction in each step, while adhering to the hierarchical principal for interactions in regression models (Kreiner, 1999), was used until an acceptable model was found. Significance of test statistics obtained during the analysis was evaluated at a 1% critical level in order to reduce the chance of type II errors due to multiple testing problems. In order to make sure that the model found was indeed the right model, two further steps of model search was employed: 1) Adding all possible interactions of the variables in the model determined and repeating a backwards model search, until a model at the 1% significance level was determined again. 2) Adding the three variables that were removed earliest in the model search procedure as a whole as well as the possible interactions of the variables in the model and repeating a backwards search, until a model at the 1% significance level was determined once again – both main effect and up to three-way interactions. Only with the External and the Liberal styles did changes occur in the resulting models due to point due in the extended model search: In the case of the External style, the model changed from an empty model to a model with the variable “having previously interrupted a longer education or not” as the independent variable. In the case of the Liberal style, the model changed from a model with subject of study and conscientiousness as the independent variables to a model with age and conscientiousness as the independent variables. In cases where the final model included interaction effects, the collective effect of the involved variables was calculated for each category combinations as the sum of the effect and interaction parameters (Nielsen & Kreiner, 2003). The multiple analyses of variance of the learning style scales gain strength from the fact that maxi-

---

<sup>4</sup> It should be noted that comparison of correlations between the NEO-dimension scores and the learning style scores with the findings of Zhang and Huang (2001), Zhang (2002a, 2002b), and Fjell and Walhovd (2004), supported this decision in that there were many unexplainable discrepancies between results for the extraversion, openness and agreeableness dimensions.

<sup>5</sup> The multiple analyses of variance were chosen instead of general linear analyses since preliminary analyses indicated that a linear regression model would be the resulting model in some cases, and that relationship between the continuous independent and the dependent variables were not linear in all cases.

mum information on learning styles in data is used during the analyses. They have, however, also weaknesses because the relationships between the dependent variables are not taken into account and because the relationships between independent variables are not analyzed. The analyses can therefore not say anything on the bigger picture including all the learning styles simultaneously.

Analysis by chain graph models was chosen as the second analysis, because this is a multivariate statistical analysis suited for analysis of complex relationships between categorical data (Edwards & Kreiner, 1983). In essence, the chain graph analysis allows you to analyze large multivariate tables of categorical data, thereby making it possible to conduct an analysis with several dependent variables as well as several independent variables. The analysis of relationships between pairs of variables can be controlled (elaborated) for influence of the respective sets of conditioning variables in the recursive model, making the analysis one of conditional association. The result of this analysis of conditional associations will then be a simultaneous description of associations between pairs of variables given the variables that are found to moderate the association in form of a so-called independence graph and a table of partial gamma coefficients (Kreiner, 1986). The chain graph analysis used categorized ordinal versions rather than the original raw scores, because expectations of purely linear relationships were considered unrealistic. A stepwise model search was conducted in the same manner as with the analyses of variance. In the analysis by chain graph models, the variables were entered into the analysis with the recursive structure shown in Figure 1. In the recursive structure, “earlier” variables can affect “later” variables, for which reason the structure was suitable for investigation of the questions put forward in this paper. The structure does, however, represent a common relation between the different groups of variables, which can be discussed. The background variables were entered with the following categories: gender (male, female), age (below 26 years, 26 years and above). The personality variables, neuroticism and conscientiousness were both entered as median splits (low, high). The educational variables were entered with the following categories: starter (no, yes), subject of study (educational psychology, sociology, other), previous incomplete education (no, yes), previous complete education (no, yes). The learning style variables were all entered as ordinal variables (no characteristics, few characteristics, some characteristics, many characteristics, all or almost all characteristics)<sup>6</sup>.

The weakness of the analysis by chain graph models is, of course, the opposite of those of analyses by multiple analyses of variance: The loss of information due to the categorization of the learning style scores into 14 ordinal variables with five categories each. It is, however, my contention that the schedule of analyses will give a fuller picture of the relationships at hand and that the two types of analyses taken together provide valuable insight in the relationships among variables that would have been inaccessible if the analysis had only relied on one type of statistical models.

---

<sup>6</sup> For details on the categorization method used see Nielsen and Kreiner (2005).

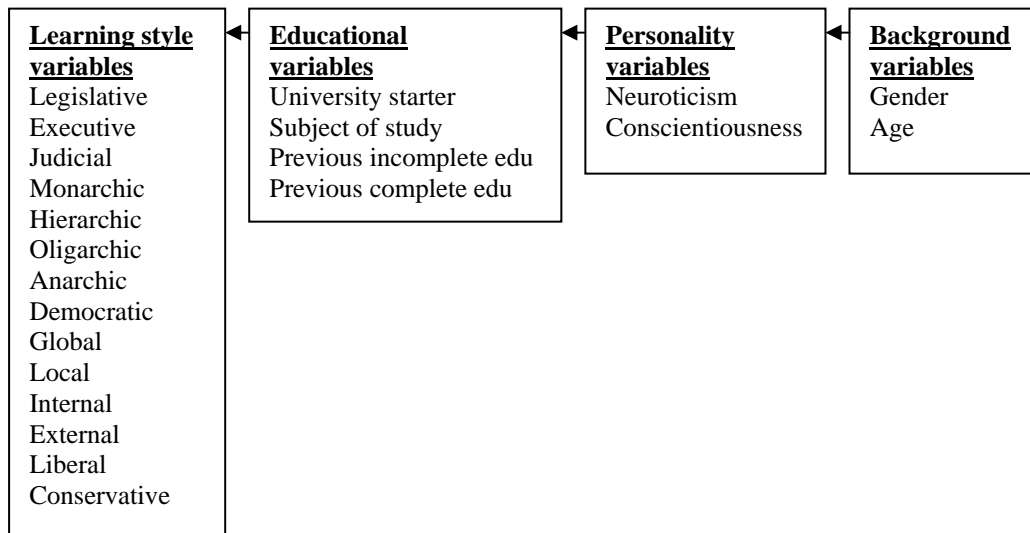


Figure 1. The recursive structure of the analysis by chain graph models.

## Results

### *Descriptives*

The means and standard deviations of the 14 learning style scales of the Revised Danish Learning Styles Inventory are reported in Table 1.

Table 1. *Means and Standard Deviations for the Revised Danish Learning Styles Inventory (N = 162)*

Scale	Mean	SD
1. Legislative	41.17	5.72
2. Executive	34.78	8.26
3. Judicial	39.19	6.92
4. Monarchic	28.65	6.89
5. Hierarchic	34.04	6.07
6. Oligarchic	21.86	5.61
7. Anarchic	33.51	6.36
8. Democratic	35.85	6.48
9. Global	35.50	8.51
10. Local	27.67	6.55
11. Internal	28.10	6.25
12. External	36.05	5.81
13. Liberal	41.58	8.19
14. Conservative	22.73	7.92

### *Scale Inter-correlations, Learning Styles*

Inter-correlations for the 14 scales are reported in Table 2. The absolute values of these correlations ranged from .00 to .59. Of the 93 correlations 35 were significant at the .01 level and 11 at the .05 level.

Within the five separate dimensions of style proposed in the theory of mental self-government (Sternberg, 1988, 1997) 6 significant correlations were in the directions to be expected from the theory: Monarchic versus Hierarchic ( $r = .16$ ), Oligarchic versus

Anarchic ( $r = .38$ ), Legislative versus Executive ( $r = -.27$ ), Global versus Local ( $r = -.30$ ), Internal versus External ( $r = -.38$ ), and Liberal versus Conservative ( $r = -.53$ ). The first correlation was significant at the .05 level, the remaining five at the .01 level. This is consistent with findings by Zhang (1999). The correlations to be expected between the Legislative and Judicial, the Executive and Judicial, the Monarchic and Oligarchic, and the Monarchic and Anarchic styles were not found. With regard to the Democratic style, two expected correlations significant at the .01 level with the Hierarchic ( $r = .22$ ) and Anarchic ( $r = .30$ ) form styles were found.

Between styles of the five separate style dimensions, several patterns of significant correlations as could be expected from the theory of mental self-government (Sternberg, 1988, 1997) were found. For example, the Legislative style correlates positively with the Anarchic ( $r = .20$ ), the Global ( $r = .17$ ), the Internal ( $r = .35$ ), and the Liberal ( $r = .43$ ) styles, and negatively with the Monarchic ( $r = -.20$ ) and the Conservative ( $r = -.42$ ) styles. And the Executive style correlates positively with the Monarchic ( $r = .34$ ), the Hierarchic ( $r = .41$ ), the Local ( $r = .30$ ), and the Conservative ( $r = .59$ ) styles, and negatively with the Oligarchic ( $r = -.18$ ) and the Liberal ( $r = -.29$ ) styles. With regard to the Democratic style, two expected positive correlations with styles of other dimensions were found; with the Judicial ( $r = .35$ ) and the External ( $r = .36$ ) styles – however, unexpected correlations were also found.

Table 2. *Interscale Pearson Correlation Matrix for 14 Scales of the Revised Danish Learning Styles Inventory (N = 162)*

Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
Functional styles													
1. Legislative													
2. Executive	-.27**												
3. Judicial	.06	.15											
Form styles													
4. Monarchic	-.20**	.34**	-.07										
5. Hierarchic	.15	.41**	.39**	.16*									
6. Oligarchic	.13	-.18*	.04	-.01	-.15								
7. Anarchic	.20*	.00	.27**	-.07	.10	.38**							
8. Democratic	-.07	.20*	.35**	.06	.22**	.12	.30**						
Level styles													
9. Global	.17*	-.15	-.03	.12	.18*	.05	-.12	-.00					
10. Local	-.10	.30**	.23**	.21**	.29**	-.02	.27**	.17*	-.30**				
Scope styles													
11. Internal	.35**	-.04	.11	.06	.15	.20*	.19*	-.21**	.16*	.00			
12. External	-.06	.01	.27**	-.07	.12	.11	.36**	.51**	.03	.20*	-.38**		
Leaning styles													
13. Liberal	.43**	-.29**	.37**	-.32**	.19*	.29**	.44**	.21**	.15	.08	.11	.37**	
14. Conservative	-.42**	.59**	-.05	.49**	.13	-.14	-.08	.11	-.06	.23**	.06	-.02	-.53**

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

### *Correlations Between Learning Styles and Personality Dimensions*

Of the 28 correlations between learning styles and the two personality dimensions, neuroticism and conscientiousness (Table 3), 9 were significant at the .01 level and 2 at the .05 level. The absolute values of these correlations ranged from .03 to .29.

As predicted, the neuroticism personality dimension correlated positively with the Monarchic learning style ( $r = .25$ ) and negatively with the Legislative learning style ( $r = -.25$ ) at the .01 level. The expected positive correlation with the Conservative learning style and negative correlation with the Liberal learning style were not found. An unexpected, but explainable, positive correlation with the Democratic learning style ( $r = .28$ ) was found – explainable in that emotionally insecure individuals (neuroticism) could be expected to prefer to learn by trying to find the *best* solution for all (Democratic style) in order to reduce the element of insecurity (Costa & McCrae, 1992; Nielsen, Kreiner & Styles, 2005). The significant negative correlation between neuroticism and the Legislative learning style is consistent with findings by Zhang (2002a) on an Asian sample of university students and Fjell and Walhovd (2004) on a Norwegian sample. Significant correlation between neuroticism and the Monarchic learning style has not been reported in previous studies (Zhang, 2002a, 2002b; Zhang & Huang, 2001; Fjell & Walhovd, 2004).

As predicted, the conscientiousness personality dimension correlated positively with the majority of learning styles; with the Legislative ( $r = .24$ ), the Judicial ( $r = .23$ ), the Hierarchic ( $r = .29$ ), the Anarchic ( $r = .28$ ), the Internal ( $r = .25$ ), and the Liberal ( $r = .29$ ) learning styles at the .01 level, and with the Local ( $r = .16$ ) and the External ( $r = .16$ ) learning styles at the .05 level. These significant correlations between the conscientiousness personality dimensions and learning styles are all, except the correlation with the Anarchic learning style, consistent with findings in at least two of the previous studies (Zhang, 2002a, 2002b; Zhang & Huang, 2001; Fjell & Walhovd, 2004), with the correlation with the Hierarchic learning style being consistent across all samples (Asian, American, and Norwegian) in the previous studies.

Table 3. *Correlations (Pearson's r) between Learning Style Scales (Revised Danish Learning Styles Inventory) and Personality Dimensions (NEO-PI-R) (N = 162)*

Learning styles	Personality dimensions	
	Neuroticism	Conscientiousness
1. Legislative	-.25**	.24**
2. Executive	.14	.11
3. Judicial	.06	.23**
4. Monarchic	.25**	-.06
5. Hierarchic	.04	.29**
6. Oligarchic	.07	-.04
7. Anarchic	.15	.28**
8. Democratic	.28**	.11
9. Global	-.09	-.03
10. Local	.15	.16*
11. Internal	-.05	.25**
12. External	.07	.16*
13. Liberal	-.06	.29**
14. Conservative	.15	-.04

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

### ***Multiple Analyses of Variance***

The results of the multiple analyses of variance show that the independent variables, subject of study, and previous complete longer education, had no significant effects on any of the fourteen learning styles. The same was found for gender, age, neuroticism, conscientiousness, previous incomplete longer education, and being a university starter or not, in connection with the Executive, Monarchic, Democratic, Internal and Conservative learning styles. With regard to the Legislative, Judicial, Hierarchic, Anarchic, Global, Local, External, and Liberal learning styles differing significant effects ( $p < .01$ ) of the independent variables, gender, age, neuroticism, conscientiousness, previous incomplete longer education, and being a university starter or not, were found.

The Legislative learning style is negatively affected by a high degree of neuroticism and positively affected by a high degree of conscientiousness ( $p < .01$ ): Students with a high score on neuroticism score 2.4 points lower on the Legislative learning style than do students with a low degree of neuroticism. And students with a high score on conscientiousness score 2.9 points higher on the Legislative learning style than students with a low degree of conscientiousness do (Table 4).

The Judicial learning style is negatively affected by age and positively affected by a high degree of conscientiousness ( $p < .01$ ): Students 26 years or older score 2.9 points lower on the Judicial learning style than do students younger than 26 years. And students with a high score on conscientiousness score 2.9 points higher on the Judicial learning style than students with a low score on conscientiousness do (Table 4).

The Hierarchic learning style is positively affected by a high degree of conscientiousness ( $p < .01$ ); students with a high score on conscientiousness score 4.3 points higher on the Hierarchic style compared to students with a low score on conscientiousness, and by the interaction between age and degree of neuroticism ( $p < .01$ ) (Table 4). The effect of the interaction between age and degree of neuroticism on the Hierarchic learning style is positive and approximately of the same magnitude for students younger than 26 years with a high score on neuroticism and students 26 years and older with a low score on neuroticism (score respective 3 and 2.7 points higher) than the group of students 26 years and older with a high score on neuroticism. The interaction effect for students below 26 years with a low score on neuroticism is negligible (Table 5).

The Oligarchic learning style is affected by the interaction between degree of neuroticism and degree of conscientiousness ( $p < .01$ ) (Table 4). The effect of this interaction is positive and of varying magnitude for the groups of students (Table 6): The effect is largest for the groups of students with a high score on neuroticism and a low score on conscientiousness (3.7 points) and somewhat lower for the group of students with a low score on neuroticism and a high score on conscientiousness (2.2 points) when compared to the group of students with high scores on both neuroticism and conscientiousness. The interaction effect for students with low scores on both neuroticism and conscientiousness is negligible.

The Anarchic learning style is positively affected by a high degree of conscientiousness ( $p < .01$ ): Students with a high score on conscientiousness score 3 points higher on the Anarchic learning style than students with a low degree of conscientiousness (Table 4).

The Global learning style is affected by the interaction between gender and previous incomplete longer education ( $p < .01$ ) (Table 4). The effect of this interaction is negative for two groups of students and positive for the third group (Table 7): Female students with no previous incomplete education has the largest negative effect on the global learning style (-4.3 points) and male students with previous incomplete education a slightly lower negative effect on the Global learning style (-3.6 points), when compared to female students with previous incomplete education. However, male students with no previous incomplete education have a positive effect on the Global learning style (2 points), when compared to female students with previous incomplete education.

The Local learning style is affected by the interaction between age and being a university starter or not and the interaction between age and previous incomplete longer education ( $p < .01$ ) (Table 4). The effect of the interaction between age and being a university starter is positive, but of different magnitudes for the groups of students (Table 8): Students below 26 years of age who are university starters have the largest effect on the Local learning style (10.4 points), when compared to students of 26 years or older who are also university starters. The two groups of students who are not university starters have a more modest positive effect on the Local learning style (3.2 and 2.1 points respectively) regardless of age, when compared to students of 26 years or older who are university starters. The effect of the interaction between age and previous incomplete education is positive, but of different magnitudes for the groups of students (Table 9): The group of students below 26 years of age with previous incomplete education has the largest effect on the Local learning style (10.4 points), when compared to students of 26 years or older who also have previous incomplete education. The group of students below 26 years of age without previous incomplete education has a positive effect on the Local learning style of about half the size of the former group (5.1 points), when compared to the reference group. And last, the group of students of 26 years or older without previous incomplete education has the smallest positive effect on the local learning style (3 points), when compared to the reference group.

The External learning style is negatively affected by previous incomplete education ( $p < .01$ ): Students with previous incomplete education score 3.1 points lower on the External learning style than students without previous incomplete education (Table 4).

The liberal learning style is positively affected by age and a high degree of conscientiousness ( $p < .01$ ): Students 26 years and older score 4.6 points higher on the liberal learning style than students below the age of 26. And students with a high score on conscientiousness score 4.5 points higher on the liberal learning style than students with a low degree of conscientiousness (Table 4).

Table 4. *Estimated Effect of Independent Variables on 9 Learning Styles*

Dependent learning style scale	Independent variables	$\beta$	Std. Error	T	Sig.
Legislative	Intercept	41.053	.756	54.319	.000
	Neuroticism				
	Low	2.381	.873	2.728	.007
	High	0(a)	.	.	.
	Conscientiousness				
	Low	-2.860	.876	-3.267	.001
	High	0(a)	.	.	.
Judicial	Intercept	39.270	.824	47.631	.000
	Age				
	Below 26 years	2.856	.979	2.917	.004
	26 years or more	0(a)	.	.	.
	Conscientiousness				
	Low	-2.880	.983	-2.931	.004
	High	0(a)	.	.	.
Hierarchic	Intercept	34.273	1.096	31.262	.000
	Conscientiousness				
	Low	-4.296	.909	-4.726	.000
	High	0(a)	.	.	.
	Age				
	Below 26 years	2.748	1.318	2.085	.039
	26 years or more	0(a)	.	.	.
	Neuroticism				
	Low	2.987	1.294	2.308	.022
	High	0(a)	.	.	.
	Age * Neuroticism				
	Below 26 years * Low	-5.239	1.830	-2.862	.005
	Below 26 years * High	0(a)	.	.	.
	26 years or more * Low	0(a)	.	.	.
26 years or more * High	0(a)	.	.	.	
Oligarchic	Intercept	20.179	.877	23.011	.000
	Neuroticism				
	Low	2.234	1.192	1.874	.063
	High	0(a)	.	.	.
	Conscientiousness				
	Low	3.682	1.266	2.909	.004
	High	0(a)	.	.	.
	Neuroticism * Conscientiousness				
	Low * Low	-5.295	1.764	-3.002	.003
	Low * High	0(a)	.	.	.
	High * Low	0(a)	.	.	.
High * High	0(a)	.	.	.	
Anarchic	Intercept	34.943	.665	52.545	.000
	Conscientiousness				
	Low	-2.998	.988	-3.034	.003
	High	0(a)	.	.	.

*Continues ...*

Dependent learning style scale	Independent variables	$\beta$	Std. Error	T	Sig.
Global	Intercept	37.913	1.696	22.356	.000
	Gender				
	Male	-3.595	2.425	-1.482	.140
	Female	0(a)	.	.	.
	Previous incomplete education				
	No	-4.345	1.942	-2.238	.027
	Yes	0(a)	.	.	.
	Gender * Previous incomp. edu.				
	Male * No	9.934	2.974	3.340	.001
	Male * Yes	0(a)	.	.	.
	Female * No	0(a)	.	.	.
	Female * No	0(a)	.	.	.
Local	Intercept	24.028	1.795	13.389	.000
	Age				
	Below 26 years	10.354	2.702	3.833	.000
	26 years or more	0(a)	.	.	.
	University starter				
	No	2.123	1.579	1.344	.181
	Yes	0(a)	.	.	.
	Previous incomplete education				
	No	3.024	1.708	1.770	.079
	Yes	0(a)	.	.	.
	Age * University starter				
	Below 26 years * No	-9.249	2.501	-3.698	.000
	Below 26 years * Yes	0(a)	.	.	.
	26 years or more * No	0(a)	.	.	.
	26 years or more * Yes	0(a)	.	.	.
	Age * Previous incomp. edu.				
	Below 26 years * No	-8.290	2.640	-3.140	.002
	Below 26 years * Yes	0(a)	.	.	.
	26 years or more * No	0(a)	.	.	.
	26 years or more * Yes	0(a)	.	.	.
External	Intercept	34.000	.832	40.864	.000
	Previous incomplete education				
	No	3.057	.993	3.078	.002
	Yes	0(a)	.	.	.
Liberal	Intercept	45.915	1.010	45.440	.000
	Age				
	Below 26 years	-4.644	1.200	-3.870	.000
	26 years or more	0(a)	.	.	.
	Conscientiousness				
	Low	-4.519	1.205	-3.751	.000
High	0(a)	.	.	.	

*Note.* Independent variables not included in individual sub-tables had no significant effect on the dependent variable in question.

*Note.* (a) This parameter is set to zero because it is redundant.

Table 5. *Interaction Effect of Age and Neuroticism on the Hierarchic Learning Style.*

<u>Age</u>	<u>Neuroticism</u>	
	Low	High
<26	0.496	2.748
=>26	2.987	0.00

Table 6. *Interaction Effect of Neuroticism and Conscientiousness on the Oligarchic Learning Style.*

<u>Conscientiousness</u>	<u>Neuroticism</u>	
	Low	High
Low	0.621	3.682
High	2.234	0.00

Table 7. *Interaction Effect of Gender and Previous Incomplete Education on the Global Learning Style.*

<u>Gender</u>	<u>Previous incomplete education</u>	
	No	Yes
Men	1.994	-3.595
Women	-4.345	0.00

Table 8. *Interaction Effect of Age and University Starter on the Local Learning Style.*

<u>Age</u>	<u>University starter</u>	
	No	Yes
<26	3.228	10.354
=>26	2.123	0.00

Table 9. *Interaction Effect of Age and Previous Incomplete Education on the Local Learning Style.*

<u>Age</u>	<u>Previous incomplete education</u>	
	No	Yes
<26	5.088	10.354
=>26	3.024	0.00

### **Chain Graph Modeling**

The result of analysis by chain graph models is illustrated in the so-called dependence graph in Figure 2 showing the model of associations between background, personality, educational and learning style variables. The partial gamma coefficients giving the strength of the associations between variables in the dependence graph are shown in Table 10. The associations in the dependence graph can be described with two different foci: One focusing on the direct or indirect associations between the three levels of independent variables – that is the background, personality and educational variables making up the first three recursive levels in the model – and the dependent learning style variables making up the fourth recursive level. And one focusing on the conditional associations between learning style variables, given the distribution of the conditioning variables (background, personality and educational). Due to the aim of this study, the first approach is chosen for the initial description, followed by the second

approach for a supplementary description. However, only the most important results in relation to the posed question are accounted for in the following sections.

The absolute size of the conditional associations in the independence graph in Figure 2 ranged from .26 to .95 (Table 10) indicating very strong associations in most cases (Kreiner, 1999).

***Effect of background, personality and educational variables on learning styles; first, second and third recursive levels***

The first recursive level of the independence graph (Figure 2, Table 10) is made up of the background variables age and gender, which are independent. Age is directly associated with the Liberal learning style ( $\gamma = .41, p < .01$ ), and with the remaining learning styles via the Liberal learning style. Gender is directly associated with the Global learning style ( $\gamma = -.30, p < .05$ ), and via this association with the remaining learning styles.

The second recursive level of the dependence graph (Figure 2, Table 10) is made up of the personality variables neuroticism and conscientiousness, which are conditionally independent given gender and age. neuroticism is directly associated with the Democratic learning style ( $\gamma = .35, p < .01$ ), and via this association with the remaining learning styles. conscientiousness is directly associated with the Liberal learning style ( $\gamma = .45, p < .01$ ), and with the remaining learning styles via this association.

The third recursive level of the dependence graph (Figure 2, Table 10) is made up of the educational variables subject of study, university starter, previous complete education, and previous incomplete education. The three educational variables, university starter, previous complete education and previous incomplete education, are all directly associated with subject of study, and associated with the learning styles only via the previous incomplete education variable. Only having previous incomplete education is directly associated with learning styles; namely the External style ( $\gamma = -.58, p < .001$ ) and the Oligarchic style ( $\gamma = .57, p < .001$ ). The remaining learning styles are associated with previous incomplete education via the External learning style.

In summation, only five learning styles (External, Oligarchic, Democratic, Liberal, and Conservative) are directly affected by the background, personality and educational variables. The effects of the exogenous variables on the remaining learning styles are all mediated by the aforementioned five learning styles.

***Conditional associations between learning styles; fourth recursive level***

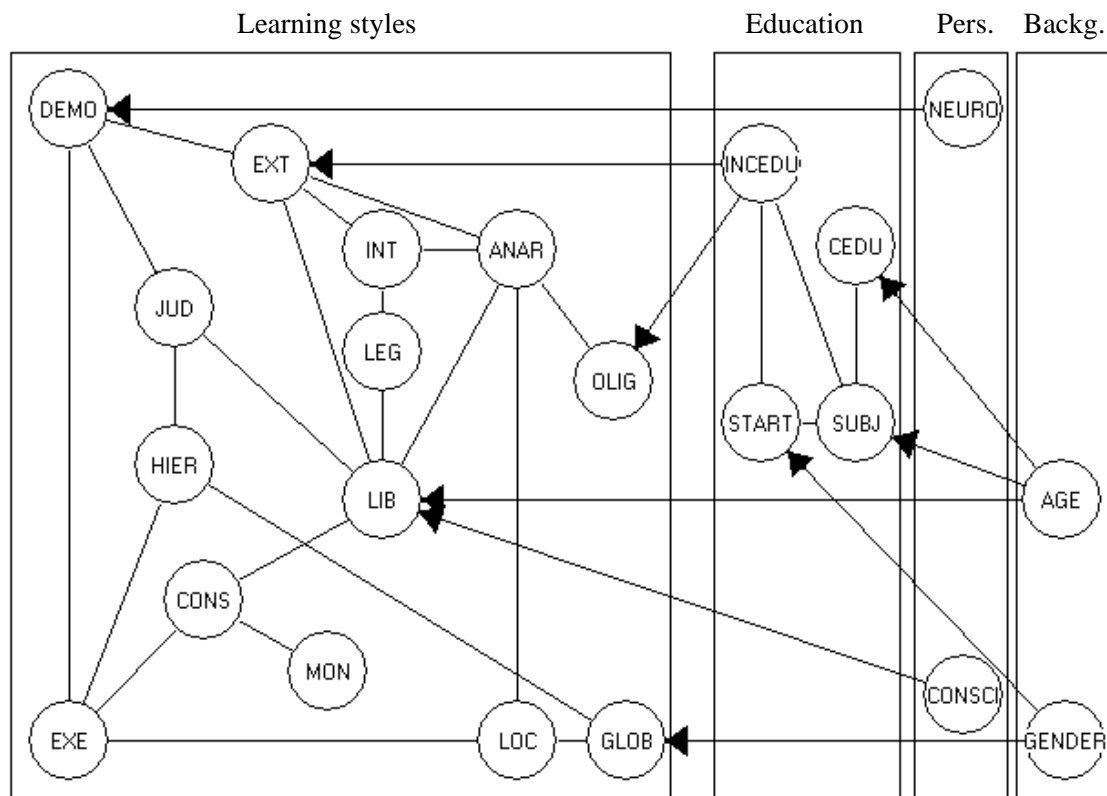
The absolute size of the conditional associations between learning styles ranged from .26 to .58, and they were primarily positive (Table 10). Only associations between three pairs of learning styles were negative, as would be expected: the Global and the Local styles ( $\gamma = -.34, p < .001$ ), the Internal and the External styles ( $\gamma = -.58, p < .001$ ), and the Liberal and the Conservative styles ( $\gamma = -.58, p < .001$ ).

Few associations between learning styles were directly conditioned by educational, personality or background variables, as described above, they are primarily conditioned by these variables via conditioning by other learning style variables – for example, the

Executive and the Local styles are associated given the Global style and gender ( $\gamma = .41, p < .001$ ).

The only two learning styles directly associated exclusively to one other learning style were the Oligarchic and the Monarchic styles: The Oligarchic style was positively associated to the Anarchic style ( $\gamma = .49, p < .001$ ). The Monarchic style was positively associated to the Conservative style ( $\gamma = .55, p < .001$ ). The remaining learning styles were directly associated with a number of other learning styles.

Several groupings of associations between learning styles were found (Figure 2, Table 10), depending on the point of departure when reading the model. One such grouping was the ring of positive associations between the Democratic, Judicial, Hierarchic, and Executive learning styles. Other positive ring-groupings were found between the Democratic, Judicial, Liberal, and External styles, and between the Internal, Legislative, Liberal, and Anarchic learning styles.



Note: Pers = Personality, Backg. = Background, Leg = Legislative, Exe = Executive, Jud = Judicial, Mon = Monarchic, Hier = Hierarchic, Olig = Oligarchic, Anar = Anarchic, Glob = Global, Loc = Local, Int = Internal, Ext = External, Lib = Liberal, Cons = Conservative, Incedu = Previous incomplete education, Cedu = Previous complete education, Start = University starter, Subj = Subject of study, Neuro = Neuroticism, Consci = Conscientiousness.

Figure 2. Dependence graph of conditional associations between background, personality, educational, and learning style variables.

Table 10. *Partial Gamma Correlation Coefficients for Conditional Associations in the Dependence Graph in Figure 2 (N = 102)*

Scale	1	2	3	4	5	6	7	8	9	10
1. Legislative										
2. Executive	-.26									
3. Judicial	-.06	.12								
4. Monarchic	-.01	.11	-.05							
5. Hierarchic	.11	.50***	.47***	.06						
6. Oligarchic	.03	-.15	-.16	.08	-.17					
7. Anarchic	.12	-.07	.31	.00	.03	.49***				
8. Democratic	.06	.26**	.35**	.15	-.03	.09	-.02			
9. Global	.10	-.22	-.10	.07	.30**	.05	.02	-.04		
10. Local	-.17	.41***	.31	.18	.23	-.21	.40**	.14	-.34***	
11. Internal	.31**	.00	.11	.01	.26	.09	.35***	-.03	.14	.01
12. External	.09	-.15	.12	-.10	-.27	.15	.48***	.44***	.11	.06
13. Liberal	.50***	.18	.36**	-.08	.35	.08	.43**	.07	.11	.33
14. Conservative	-.30	.58***	.17	.55***	-.01	-.04	.12	.09	-.02	.24
15. University starter	-.16	.00	.11	-.04	.33	-.30	.14	.22	.05	.13
16. Prev. complete education	.27	-.07	-.43	-.15	-.17	.23	-.01	-.15	.14	-.16
17. Prev. Incomplete education	-.08	.50	-.08	.10	-.30	.57***	-.33	-.13	.02	-.10
18. Neuroticism	-.33	.23	-.25	.26	.10	-.04	.03	.35**	.03	-.07
19. Conscientiousness	.20	.50	.18	.01	.43	-.36	.16	-.02	-.10	.27
20. Gender	-.30	.03	-.16	-.34	.20	-.04	.07	-.19	-.30*	-.17
21. Age	.21	-.08	-.60	-.06	.21	.29	-.05	-.07	.04	-.13

*Continues ...*

Scale	11	12	13	14	15	16	17	18	19	20
1. Legislative										
2. Executive										
3. Judicial										
4. Monarchic										
5. Hierarchic										
6. Oligarchic										
7. Anarchic										
8. Democratic										
9. Global										
10. Local										
11. Internal										
12. External	-.58***									
13. Liberal	.28	.43**								
14. Conservative	.31	.09	-.58***							
15. University starter	.11	-.08	.02	-.33						
16. Prev. complete education	-.39	.23	-.04	-.05	-.76					
17. Prev. Incomplete education	.17	-.58**	.23	.07	-.95***	.15				
18. Neuroticism	-.16	-.11	-.33	.03	-.15	.01	.16			
19. Conscientiousness	.05	.07	.45**	-.11	.33	-.08	-.26	-.10		
20. Gender	.23	.10	-.16	-.07	.37**	.02	-.18	.15	.23	
21. Age	-.14	.18	.41**	-.04	-.48	.79**	.44	-.32	-.03	.18

*Note.* The subject of study variables is excluded from the table due to its nominal nature. The significant associations between this variable and the remaining variables are shown in Figure 2.

\*  $p < .05$ ; \*\*  $p < .01$ , \*\*\*  $p < .001$

## Discussion

The aim of this study was twofold: First to examine whether learning styles were associated with the choice of subject of study, second to examine the relationships between background, personality, educational variables and learning styles, with a particular focus on application to course and lesson planning and design in the Danish university setting.

In order to accomplish these aims as fully as possible, two complementary regimes of analyses were performed; multiple analyses of variance and analyses by chain graph modeling. The first regime of analyses gaining strength from the use of maximum information with regard to the learning style scales, but also being limited by the fact that relationships between the learning style scales are not possible to analyze. The second regime gaining strength from the possibility of analyzing relationships between the learning style scales, but being limited by the loss of information due to categorization of the learning style scores into ordinal variables with five categories each. This double regime of analyses has provided insights into the relationships between background, personality and educational variables and the 14 learning style scales, as well as the relationships between learning styles, which could not have been obtained with any one of the analyses regimes exclusively.

### *Background Variables and Learning Styles*

With regard to the effect of the background variables, gender and age on learning styles, one significant direct effect was found across the two regimes of analyses, namely a direct positive effect of age on the Liberal learning style: Students of 26 years and older score higher on the Liberal learning styles than students below the age of 26 do. This positive effect of age on the Liberal style for Danish students of 26 years and older is supported by Zhang's (1999) finding of a similar effect for Hong Kong students between 27 and 50 years when compared to students below 27 years of age.

In addition, Analyses of variance disclosed a direct negative effect of age on the Judicial learning style: Students 26 of years and older score significantly lower on the Judicial learning style than do students below the age of 26. In the analysis by chain graph models, which included all the learning styles, this effect of age on the Judicial learning style was discovered to be mediated by the Liberal learning style. The negative association between age and the Judicial style was also detected, but not included in the chain graph model, (see Table 9), and a closer look at this association for the different levels of the Liberal style showed that the negative association between age and the Judicial style was only present for students with some and many characteristics of the Liberal style, while for students with few or almost all characteristics of the Liberal style there was no significant association between age and the Judicial style. Thus, the result is an indirect positive effect of age on the Judicial style mediated by the Liberal style. The negative effect of age on the Judicial learning style of Danish students proposed by the analyses of variance is also in opposition to Zhang's (1999) finding of a positive effect of age on the Judicial thinking style for Hong Kong students by one way analysis of variance. Of course, such a difference in the direction of the effect of age on the Judicial style could in fact be a cultural difference. It is, however, my contention that the chain graph model with its inclusion of all the styles points to a more plausible answer; there is no direct effect of age – positive or negative – on the Judicial style, but instead a positive effect mediated by the Liberal style.

The analyses of variance also disclosed interaction effects of age and university starter and of age and previous incomplete education on the Local learning style and interaction effect of age and neuroticism on the Hierarchic learning style of the Danish students (Table 4, 8, 9 and 5). None of these interaction effects were found in the analysis by chain graph models when all the styles were included (Figure 2). Instead, indirect effects of age on the Local and Hierarchic learning styles mediated by a number of other variables – educational as well as other style variables – were found, adding to the complexity of the effects of age. No other studies have reported any effects of age on the Local or Hierarchic thinking styles.

Additional findings on relationships between age and thinking styles are Zhang's (1999) findings that show 19-26 years old Hong Kong University students to score significantly higher on the conservative thinking style than students 27-32 years old, and students 39-50 years old to score higher on the External thinking style than students 19-26 years old. This study did not disclose any direct effects of age on the Conservative or External learning styles with any of the two regimes of analyses employed. However, the chain graph model did reveal an indirect effect of age on the conservative style, that is an effect mediated by the Liberal style, which corresponds to Zhang's negative effect of age on the Conservative style. In the chain graph model, the Conservative and Liberal styles are negatively associated, and age had a direct positive effect on the Liberal style. Furthermore, a closer look at the details of the chain graph model, revealed a positive association between age and the External learning style, which is explained – in the sense that it disappears – when including the two mediating educational variables, previous incomplete education and subject of study. To be mentioned is also Zhang and Sachs' (1997) and Zhang's (2003b) findings of *no* age differences in the thinking styles of college and high school students respectively according to age.

With regard to gender effects on learning styles, the analyses by chain graph modeling disclosed a negative direct effect of gender on the Global learning style: Male students score significantly *higher* on the Global learning style than do female students. The analysis of variance, on the other hand, showed a rather puzzling interaction effect between gender and previous incomplete education, puzzling in the sense that having previous incomplete education had a negative effect and *not* having previous incomplete education had a positive effect on the global learning style of male students, while *not* having previous incomplete education had a negative effect on the global learning style of female students, when compared to the reference group of female students with previous incomplete education. I can find no explanation for this finding, and it is not supported by the chain graph analysis or previous research. The direct negative effect of gender on the Global learning style from the analysis by chain graph models, is, however, consistent with Zhang & Sachs' (1997) finding that male Hong Kong university students score higher on the global thinking style than female students, and Zhang's (2003b) finding that Chinese high school boys score higher on the global thinking style than girls. Other studies have, however, reported gender differences on other styles, such as males being more Executive (Zhang & Sternberg, 2002), males being more Monarchic and less Legislative and Executive (Verma, 2001), males being more Internal (Zhang & He, 2003), and males being more Judicial (Zhang & Sternberg, 2001). Of equal importance is the finding of *no* gender differences in thinking styles among university students by Zhang (1999).

### ***Personality Variables and Learning Styles***

With regard to the effect of the two personality variables, conscientiousness and neuroticism, on learning styles, one significant direct effect was found across the two regimes of analyses, namely a direct positive effect of conscientiousness on the Liberal learning style; students with a high score on conscientiousness scored significantly higher on the Liberal learning style than did students with a low score on conscientiousness. This finding is not supported by the findings of Zhang & Huang (2001) and Zhang (2002a), where multiple regression analyses in both studies report that conscientiousness does not contribute to the prediction of the Liberal thinking style. From a theoretical standpoint there is, however, nothing to contradict that students with a higher degree of conscientiousness also have a higher degree of preference for going beyond existing rules and procedures and seeking new/unknown problems or situations when learning (Costa & McCrae, 1992; Sternberg, 1997). The discrepancy in findings between the current study on Danish students and the studies of Zhang and Huang (2001) and Zhang (2002a) on Chinese students could reflect a cultural difference between Danish and Chinese university students. However, this discrepancy – as well as the other discrepancies discussed below – could also stem from other factors such as differences in the measures used (the Chinese studies employed short versions of the Sternberg-Wagner Thinking Styles Inventory, where the current study employed a long version in the form of the Revised Danish Learning Styles Inventory), differences in the validation methods employed resulting in the exclusion of different subscales in the studies (the Chinese studies did not include the Anarchic and Oligarchic styles, while the current study included these styles as well as the Democratic style. The Chinese studies accordingly included all five Personality dimensions of the big-five construct, while the Danish study only included two; neuroticism and conscientiousness), as well as differences in regimes of analyses (the present study employed analysis which included all the styles as dependent variables simultaneously, while the Chinese studies employed analyses which included single styles as dependent variables).

The analyses of variance disclosed direct positive effects of conscientiousness on the Legislative, Judicial, and Anarchic learning styles. This finding is supported by Zhang and Huang's (2001) finding that conscientiousness contributes to the prediction of both the Legislative and the Judicial thinking styles, but not by Zhang (2002a), who reports that conscientiousness does *not* contribute to the prediction of these styles – the Anarchic style was not included in these studies. In the analysis by chain graph models, which included all the learning styles, the effect of conscientiousness was mediated by the Liberal learning style in all three cases, thus indicating indirect positive effects of conscientiousness on the Legislative, Judicial, and Anarchic learning styles, mediated by the Liberal learning style, rather than direct effects.

The analyses of variance also disclosed a direct positive effect of conscientiousness on the Hierarchic learning style. Similarly, Zhang (2002a) reports that conscientiousness is the only of the five personality dimensions to predict the Hierarchic thinking style, and Zhang & Huang (2001) report that conscientiousness contributes to the prediction of the Hierarchic thinking style. However, this direct effect was not replicated in the analysis by chain graph models in the current study, where instead a much more complex relationship between conscientiousness and the Hierarchic learning style was revealed; here the association between conscientiousness is mediated by several other learning styles. The lack of a direct effect of conscientiousness on the Hierarchic learning style is interesting, since the expectation would be that conscientiousness and a

preference for prioritized goal pursuit were to be directly related (Costa & McCrae, 1992; Sternberg, 1997).

With regard to the effect of neuroticism on learning styles, no common results were found across the two regimes of analyses. Instead, several direct and indirect effects were found in one of the two analyses regimes.

In the analysis by chain graph models, a direct positive effect of neuroticism on the Democratic learning style was found, in the sense that emotionally insecure students are also the students who prefer to learn by trying to find the *best* solution for all. An effect which could reflect a way of reducing insecurity on the part of the students with a high neuroticism score (Costa & McCrae, 1992; Nielsen, Kreiner & Styles, 2005). Since the Democratic learning style is a new construct, no other studies include this style as yet!

The analyses of variance disclosed a direct negative effect of neuroticism on the Legislative learning style of the Danish students. Zhang (2002a) reports that neuroticism contributes negatively to the prediction of the Legislative thinking style, while Zhang and Huang (2001) do not find neuroticism to contribute to the prediction of the legislative style. The chain graph analysis of the current study reveals a much more complex picture of the relationship between neuroticism and the Legislative learning style, one mediated by several other learning styles (Figure 2). Even though the theories behind the measures (Costa & McCrae, 1992; Sternberg, 1988, 1997) could lead to an expectation of a direct negative effect of neuroticism on the Legislative learning style, due to the increase in insecurity which could result from a preference for setting one's own agenda when learning, the current study does not support such a simple, causal relationship.

The analyses of variance also disclosed two interaction effects involving neuroticism: An interaction effect of age and neuroticism on the Hierarchic learning style and an interaction effect of neuroticism and conscientiousness on the Oligarchic learning style. Such effects are not supported by other studies or the chain graph analysis in the current study.

In summation, when all learning styles are considered simultaneously in analysis, both neuroticism and conscientiousness have direct effects on less learning styles than expected, due to the complex interrelations of the learning styles mediating the effects of the two personality dimensions (Figure 2).

### ***Educational Variables and Learning Styles***

With regard to the possible effect of learning styles on Danish university students' choice of subject of study, no such effect was found in any of the analyses performed. The multiple analyses of variance showed no differences in any of the fourteen learning styles for students of sociology, educational psychology and the rest-group of students studying other subjects. Nor did the chain graph analysis disclose any direct associations between subject of study and any learning styles. However, the chain graph analysis did show indirect associations between learning styles and subject of study via the previous incomplete education variable. No previous research has been performed to support or discount this finding.

Across the two regimes of analyses, only previous incomplete education was found to have a direct negative effect on a learning style, namely the External style: Students with previous incomplete education scored significantly *lower* on the External learning style than did students without previous incomplete education. In addition, the analyses by chain graph modeling disclosed a positive direct effect of previous incomplete education on the Oligarchic learning style: students with previous incomplete education scored significantly *higher* on the Oligarchic learning style than did students without previous incomplete education. No previous research has been performed relating to these findings.

The remaining two educational variables (previous complete education and university starter) are, according to the analysis by chain graph modeling, only indirectly associated with learning styles via the previous incomplete education variable.

The interaction effects of previous incomplete education with age and being a university starter with age on the Local learning style, as well as the interaction effect of previous incomplete education with gender on the Global learning style found in the analyses of variance, have already been discussed in the section on the effects of background variables.

### **Theoretical Implications and Practical Applications**

The results of this study have demonstrated effects of age, gender, educational variables, and personality variables. What are then the implications of these results? And how can the results be applied to higher education? General guidelines for course and lesson planning based on learning style differences on directly observable variables, such as age and gender, and easily accessible variables, such as educational history and status, would naturally ease the application of research result in higher education, whereas learning style differences on non-observable variables, such as personality dimensions, are not directly applicable to university teaching. Such guidelines require both results, theoretical interpretation of these results, and discussion of a number of factors effecting the specific application of the interpreted results.

#### ***Theoretical Interpretation***

The current study has given a number of results on learning style differences with regard to the observable and easily obtained information on students, which can be interpreted theoretically for application within university teaching. With regard to age, the current study has shown that older university students – students above the “normal” university age range – are more Liberal in their learning styles, that is to say that they have a tendency to seeking new ways and methods when they learn than their younger counterparts. Furthermore, the students that are the most Liberal in their learning styles (the older students) are also the most Legislative, Anarchic, and Judicial, and the least Conservative in their learning styles. This means that the older students who tend to seek new ways and methods when they learn, also tend to prefer to define the problems to be solved and how to solve them, tend to pursue goals in an a-systematic way and avoid systems, to prefer analytical, evaluative and critical assignments, and not to prefer known ways or methods when they learn. In this way, knowledge of the age distribution of a student group can be utilized in the planning of lessons, classes, assignments, etc. Of course, all the learning styles are connected, and so this stream of reasoning can be brought further using the information in Figure 2 and Table 10.

With regard to gender, male students are found to be more Global in their learning styles than female students, a finding which is supported by Zhang and Sachs (1997) and Zhang (2003b) for university respectively high school students. Students who are most Global in their learning styles (male students) are also the least Local in their learning styles. This means that the male students tend to prefer abstract ideas and the bigger picture and to not prefer detail work when they learn, while the opposite is the case for the female students. And as was the case with the age differences described above, it is possible to make further connections to the remaining learning styles in Figure 2. The gender distribution of a student group can accordingly be utilized in planning.

With regard to educational status, no differences in learning styles are found between the groups of students studying sociology, educational psychology, and a mix of other subjects, or between students who are university starters and student who are not university starters. However, this does not necessarily mean that these factors do not affect the learning styles of the Danish university students, in that the factors are a part of a complex system of factors affecting the learning styles, thereby playing an indirect role (see Figure 2). Both factors are related to previous incomplete education, which directly affects two learning styles and indirectly the remaining learning styles.

Furthermore, being a university starter depends on gender in the sense that the majority of the female students in the sample are university starters, while equal amounts of male students are university starters and not. In the same way, the age differences for students with different subjects of study are sample specific, due to the different levels of education for sociology and educational psychology students. Accordingly, it seems timely *not* to make any recommendations on the basis of these findings.

With regard to educational history, the age and subject specific differences found for students with and without previous complete education are also sample specific, due to the different levels of education for sociology and educational psychology students. Having previous complete education or not has only indirect effect on the learning styles, via the other three educational variables, for which reason recommendations based on these findings are not made.

With regard to having previous incomplete education, students with previous incomplete education are less External and more Oligarchic in their learning styles than students without previous incomplete education. As tempting as it is to hypothesize that students who have earlier started, but not completed an education have been socialized by this experience resulting in lower scores on the External style and higher scores on the Oligarchic style than students who have not undergone this experience, such reasoning could be erroneous due to the lack of direct effects of having previously completed an education. Instead, a more cautious approach as to the reasons to these differences is taken. One such explanation could be that it is a question of these students having been different to begin with, that is that it is their thinking which has caused them to end their previous education prematurely. Such an explanation is more credible according to the theory of mental self-government (Sternberg, 1988, 1997), since students with lower scores on the External and higher scores on the Oligarchic learning style are students who tend *not* to prefer to work with others or with subjects that include other people in any way, and students who tend to try to do many things simultaneously with possibly competing approaches. Both these descriptions could lend them-

selves to explain why these groups of students have started, but not completed one or more previous educations. The less External students could have had problems fitting in, due to the current trend towards project oriented group work in Danish university education, while the Oligarchic students might have had too many things on their plate to stick with the education they had chosen. Accordingly, no recommendations as to the application are made based on these findings. Of course, there are many other – and maybe better – explanations for interrupting an education, such as discovery of lack of ability in that field, loss of interest in a subject, and personal issues.

Though the current study has provided insights into the relationships between the personality dimensions of neuroticism and conscientiousness and learning styles, these insights mainly have theoretical and research value, since such variables require some kind of medium to be discovered and applied pedagogically.

### ***Application***

Having interpreted the results theoretically into applicable knowledge, the question remains how exactly to apply this knowledge? The answer to this question is, however, not straightforward in itself, and when combined with the question of simultaneously allowing for the general variety in learning styles that is present in the current – and probably any student group – it only becomes more complicated. Sternberg (1994a, 1997) and Zhang (1999) both argued that allowing for the general variety of learning styles in students should mean that the teacher should diversify instruction as well as assessment in order to allow students to capitalize on their strengths as well as compensate for their weaknesses. The questions then become: How does one diversify instruction and assessment to allow this? What are the criteria for strengths and weaknesses with regard to learning styles? And who or what sets these criteria?

The question of how university teachers can diversify instruction, assignments, assessment, etc. to allow students to individually capitalize on their strengths and compensate for their weaknesses, while at the same time diversifying according to age, gender, and educational history on a more general group oriented level, is not a simple question of variation in methods, but rather a question of teaching styles. Diversification via teaching methods will *not*, as suggested by Sternberg (1994b, 1997), give students opportunity to capitalize on their learning style strengths, since a given method of teaching in itself does not favor particular learning styles. Rather, it is the preferences for thinking that in the planning, organization and execution of the methods will favor particular learning styles, as pointed out by Kolb (1984) and Sternberg and Grigorenko (1993, 1995) – that is the teaching styles<sup>7</sup>. This point extends naturally to cover all the elements of teaching, such as instruction, assignments, assessments, etc. The requirement for diversification by teaching styles is then development of flexibility in the teaching styles of university teachers. A development which could be described as starting with a teaching style which replicates the teacher's learning style – we start out by teaching copies of our own thinking – and ending with a flexible teaching style which can “bend” to demand (Nielsen, 2001). That such a development towards being more flexible in teaching styles is feasible is supported by Valentine's (1997) qualitative findings of how teachers' perception of students as learning beings and their application of teaching and assessment methods developed towards flexibility through and

---

<sup>7</sup> For detailed discussion see Nielsen (2001).

after a course where the teachers gained knowledge on learning style and insights into their own learning styles.

The more specific question of diversification of assessment in higher education further adds what Zhang (1999) calls the “backwash” effect of assessment, meaning that what students learn is to some degree driven by the chosen form of assessment, thereby overriding their learning styles – this might be more true in higher education than any other part of the educational system, due to the competition factor on the job market. Also, diversification of assessment in higher education is not always something the individual teacher can decide on – for example in Denmark, this is decided by local study boards across universities. So in a Danish university, learning style specific diversification of assessment in higher education would require a change in thought in the entire faculty of that university.

The questions of criteria for strengths and weaknesses with regard to learning styles and who or what sets these criteria are complicated questions to answer. Sternberg (1997) argues that the criteria for successful thinking and thereby learning in a university setting are dependent on the specific subject. It is not hard to imagine that for students of journalism a typical learning style strength could be preferring to evaluate, analyze and critique (the Judicial style), while for students of law a typical learning style strength could be preferring to follow set rules and regulations (the Executive style). Further complications of these questions are the fact that within a single department there are many teachers who have their individual styles of thinking (learning and teaching) to be put in play in the setting of these criteria, so there might be “general” criteria as well as teacher group specific and teacher specific criteria for strengths and weaknesses in the learning styles of students. Also, the level of the subject being taught could be in play, in the sense that the more compliant styles (the Executive, Monarchic, and Conservative styles) might be considered strengths in the introductory courses where the road is paved with knowledge, but weaknesses in the more advanced courses where application of the acquired knowledge is the primary aim. And the other way around, while the more creative styles (The Legislative, Anarchic, and Liberal styles) might be considered weaknesses in introductory courses, they are likely to be considered strengths in the more advanced courses.

### **Conclusions and Future Directions**

The current study has shown that the Revised Danish Learning Styles Inventory is a reliable and valid instrument for the measurement of learning styles of Danish University students. No evidence of relationships between learning styles and the choice of subject of study for Danish university students were found in this study, thereby indicating that preferences for different ways of thinking is not a factor effecting the choice of study subject. Age and gender differences in learning styles of the Danish university students, which could have practical impact on course and lesson planning, were found. What remains crucial to investigate further with regard to course and lesson planning is the possible subject dependent socialization of the learning styles during the first year of study, with the current as well as other groups of university students. Future research into the actual application of results like the current, in the form of studies investigation the application of results in pedagogical practice in higher education, is also crucial for the development of this area of research and education.

### References

- Baldwin, B. A. & Reckers, P. M. J. (1984). Exploring the role of learning style research in accounting education policy. *Journal of Accounting Education*, 2(2), 63-76.
- Busato, V. V.; Prins, F. J.; Elshout, J. J. & Hamaker, C. (1998). Learning styles: A cross-sectional and longitudinal study in higher education. I *British Journal of Educational Psychology*, 68, 427-441.
- Costa, P. T. Jr. & McCrae, R. R. (1992). The revised NEO Personality Inventory (NEO-PI-R) and NEO five-factor-inventory (NEO-FFI). Professional manual. Psychological Assessment Resources. Odessa, FL.
- Edwards, D. & Kreiner, S. (1983). The analysis of contingency tables by graphical models. *Biometrika*, 70(3), 553-565.
- Fjell, A. M. & Walhovd, K. B. (2004). Thinking styles in relation to personality traits: An investigation of the Thinking Styles Inventory and NEO-PI-R. *Scandinavian Journal of Psychology*, 45, 293-300.
- Gregorc, A. F. (1982): *An Adult's Guide to Style*. USA, Gregorc Associates Inc.
- Gregorc, A. F. (1988). *The mind styles model*. USA, Gregorc Associates Inc
- Henson, K. T. & Borthwick, P. (1984): Matching styles: A historical look. I *Theory into Practice*. 23(1), 3-9.
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. New Jersey, Prentice Hall.
- Kreiner S. (1986). An informal introduction to graphical modelling. In Knudsen, H. C. & Thornicroft, G. (Eds.): *Mental Health Service Evaluation* (pp. 156-175). Cambridge University Press, 1996.
- Kreiner, S. (1999). *Statistisk problemløsning. Præmisser, teknik og analyse*. [Statistical problem solving. Requirements, techniques and analyses]. Copenhagen, Denmark, Jurist- og Økonomforbundets Forlag.
- Kreiner, S. & Christensen, K. B. (2002). Graphical Rasch models. In Mesbah, M., Cole, B. F. & Lee, M. T. (eds.) (2002): *Statistical Methods for Quality of Life Studies* (pp. 187-203). Dordrecht, Kluwer Academic Publishers.
- Kreiner, S. & Bang Christensen, K. (2004). Analysis of local dependence and multidimensionality in graphical loglinear Rasch models. In *Communication in Statistics. Theory and methods*, 33(6), 1239 – 1276.
- Nielsen, T. (2001). *Problemløsning – Et spørgsmål om stil! Problemløsnings-stil, et teoretisk krydsfelt mellem kognitiv, personligheds- og pædagogisk psykologi, med særligt henblik på anvendelse i den pædagogiske sammenhæng, der udgør den danske læreruddannelse*. [Problem solving – A question of style! Problem solving, a theoretical meeting ground between cognitive, personality, and educational psychology, with particular emphasis on application in the pedagogical context of the Danish teacher education]. Psychology thesis submitted to the Department of Psychology, The University of Copenhagen.
- Nielsen, T. & Kreiner, S. (2003). *SPSS. Introduktion til databehandling & statistisk analyse*, second edition. [SPSS. Introduction to data treatment & statistical analysis]. Copenhagen, Denmark, Jurist- og Økonomforbundets Forlag.

- Nielsen, T. & Kreiner, S. (2004). Modifying or replacing items: A suggestion for a strategy. *Paper presented at the 2nd International Conference on Measurement in Health, Education, Psychology and Marketing: Developments in Rasch and Unfolding Models. Murdoch University, WA. 20-22<sup>nd</sup>, Jan 04.* (Paper one in thesis)
- Nielsen, T. & Kreiner, S. (2005). Mental self-government: Development and validation of a Danish self-assessment inventory for measuring learning style using Rasch measurement models. (Paper three in thesis)
- Nielsen, T., Kreiner, S. & Styles, I. (2005). Mental Self-Government: Development of the Additional Democratic Learning Style using Rasch Measurement Models. *Paper presented at the 22<sup>nd</sup> Nordic Congress on Psychology. Copenhagen, Denmark, 18-20th August 2004.* (Paper two in thesis)
- Schatteman, A.; Carette, E.; Couder, J. & Eisendrath, H. (1997). Understanding the effects of a proces-oriented instruction in the first year of university by investigating learning style characteristics. I *Educational Psychology*, 17(1 & 2), 111-125.
- Seidel, L. E. & England, E. M. (1999):. Gregorc's cognitive styles: College students' preferences for teaching methods and testing techniques. *Perceptual and Motor Skills*, 88, 859-875.
- Sternberg, R. J. (1988). Mental self-government: A Theory of intellectual styles and their development. *Human Development*, 31, 197-224.
- Sternberg, R. J. (1994a). Thinking styles: Theory and assessment at the interface between intelligence and personality. In R. J. Sternberg & P. Ruzgis (Eds.) *Intelligence and personality*. New York, Cambridge University Press.
- Sternberg, R. J. (1994b): Allowing for thinking styles. *Educational Leadership*, 52(3), 36-40.
- Sternberg, R. J. (1997). *Thinking styles*. New York, Cambridge University Press.
- Sternberg, R. J. & Grigorenko, E. L. (1993): Thinking styles and the gifted. *Roepers Review*, 16(2), 122-130.
- Sternberg, R. J. & Grigorenko, E. L. (1995): Styles of thinking in the school. *European Journal for High Ability*, 6, 201-219.
- Valentine, K. M. (1998). *An investigation of teacher knowledge of learning styles and their possible facilitative effects on the learning process*. Dissertation, University of South Florida, USA.
- Verma, S. (2001). A study of thinking styles of tertairy students. *Psycho-lingua*, 31(1), 15-19.
- Vermetten, Y. J.; Vermunt, J. D. & Lodewijks, H. G. (1999). A longitudinal perspective on learning strategies in higher education: Different viewpoints towards development. *British Journal of Educational Psychology*, 69, 221-242.
- Vermunt, J. D. (1992). *Leerstijlen en sturen van leerprocessen in het hoger onderwijs – Naar procesgerichte instructie in zelfstandig denken*. [Learning styles and regulation of learning in higher education – toward process-oriented instruction in autonomous thinking]. Amsterdam/Lisse, Swets & Zeitlinger.
- Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology*, 68, 149-171.

- Witkin, H. (1976). Cognitive styles in academic performance and teacher-student relations. In S. Messick (Ed.) *Individuality in Learning*. San Francisco: Jossey-Bass.
- Zhang, L.-F. (1999). Further cross-cultural validation of the theory of mental self-government. *The Journal of Psychology*, 133(2), 165-181.
- Zhang, L.-F. (2001). Thinking styles, self-esteem, and extracurricular experiences. *International Journal of Psychology*, 36(2), 100-107.
- Zhang, L.-F. (2002a). Measuring thinking styles in addition to measuring personality traits. *Personality and Individual Differences*, 33, 445-458.
- Zhang, L.-F. (2002b). Thinking styles and the big five personality traits. *Educational Psychology*, 22(1), 17-31.
- Zhang, L.-F. (2003a). Does the big five predict learning approaches? *Personality and Individual Differences*, 34, 1431-1446.
- Zhang, L.-F. (2003b). Are parents' and children's thinking styles related. *Psychological reports*, 93. 617-630.
- Zhang, L.-F. & He, Y. (2003). Do thinking styles matter in the use of and attitudes toward computing and information technology among Hong Kong university students. *Journal of educational Computing Research*, 29(4), 471-493.
- Zhang, L.-F., & Huang, J. (2001): Thinking styles and the five-factor model of personality. *European Journal of Personality*, 15, 465-476.
- Zhang, L.-F. & Postiglione, G. A. (2001): Thinking styles, self-esteem, and socio-economic status. *Personality and Individual differences*, 31. 1333-1346.
- Zhang, L.-F., & Sachs, J. (1997). Assessing thinking styles in the theory of mental self-government: A Hong Kong validity study. *Psychological Reports*, 81, 915-928.
- Zhang, L.-F. & Sternberg, R. J. (2001). Thinking styles across cultures: Their relationships with students learning. In R. J. Sternberg & P. Ruzgis (Eds.) *Intelligence and personality*. New York, Cambridge University Press.
- Zhang, L.-F., & Sternberg, R., J. (2002). Thinking styles and teacher's characteristics. *International Journal of Psychology*, 37(1), 3-12.