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RELEVANCE OF THE ONION MODEL: MYTH OR REALITY IN THE FIELD OF INDIVIDUAL DIFFERENCES PSYCHOLOGY?

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ABSTRACT

To bring order in the multitude of concepts in the field of individual learning differences Curry (1983) designed the three-layered onion model. As this model provides an interesting way to distinguish related concepts – such as cognitive styles, learning styles, and approaches to studying - theoretically on the basis of their stability versus malleability in learning situations, ample studies build further on this model. However, only few studies have been conducted to empirically test the assumptions of the onion model. We conducted two empirical studies to address this research gap. In the first, cross-sectional study (*N* = 113), results of path analysis do not show a clear causal path from three concepts belonging to different layers in relation to students' learning outcomes. In the second, longitudinal study (*N* = 162), which focused on the stability of two concepts belonging to different layers, no support is found for differences in stability. To conclude, both studies do not provide solid empirical evidence for the conceptual onion model, which warns to be cautious with applying theoretical models in educational practice without empirical support.

Keywords: Individual learning differences; test of onion model; stability versus malleability

INTRODUCTION

Scholars in the education field as well as educational practitioners are increasingly convinced that a 'one-size-fits-all' paradigm is no longer an effective model for today's students, as learners approach learning in different ways (Evans, Cools, & Charlesworth, 2010). This implies that educators nowadays have to use diverse learning methods, didactics, and educational interventions to create a constructive learning climate for all learners. To reach this objective it is necessary to develop a good understanding of the impact of individual differences on learning outcomes. In this, ample research already has been conducted on the roles of cognitive and learning styles and approaches to studying in the context of education (e.g., Armstrong, 2000; Backhaus & Liff, 2007; Riding & Rayner, 1998; Sadler-Smith, 1999a; 1999b; Sadler-Smith, Allinson, & Hayes, 2000). However, we still have no definite answer as to how and when cognitive styles and approaches to studying predict learning outcomes beyond other individual characteristics (Cools et al., submitted; Gully & Chen, 2010). One of the reasons for this lack of understanding might be related to the fact that literature in the field of individual style differences is diffuse (Zhang & Sternberg, 2009). Different authors use concepts such as cognitive styles, learning styles, and learning preferences randomly and interchangeably, and there seems to be no consensus on how these concepts are interrelated (Sadler-Smith, 1999a, 2001a, 2001b).

In an attempt to bring order in the multitude of concepts, Curry (1983, 2000) designed the onion model, which situates existing style theories in an integrated model that distinguishes three levels, organised as the layers of an onion: an inner 'cognitive personality style' layer, a middle 'information-processing style' layer, and an outer 'instructional preference' layer. The onion model assumes that the more a concept is situated on the outside layers, the more it is influenced by external stimuli and hence the least stable. The outermost layer is most observable and is labelled 'instructional preferences' (i.e., the individual's choice of how to learn). Because this layer interacts most with the external features of the learning environment (e.g., learner expectations, teacher expectations, learning environment), Curry (1983) expected that this is the least stable and most influenced layer. The Learning Preference Inventory (Rezler & Rezmovic, 1981) is an instrument that measures a concept belonging to this layer of the onion (Cassidy, 2004). The second layer is labelled 'information-processing style' and refers to the individual's approach – in the classical information-processing perspective – to assimilate information (i.e., orientation, sensory loading, short-term memory, enhanced association, coding system, long-term storage). According to Curry (1983), information processing is not directly involved in the environment. It is therefore expected that this layer is more stable than the outer layer, but still subject to the influence of learning strategies.

Instruments measuring concepts belonging to this layer of the onion are Kolb's Learning Style Inventory (Kolb, 1976), Cognitive Preference Inventory (Tamir & Cohen, 1980) and Inventory of Learning Processes (Schmeck, Ribich & Ramaniah, 1977) (Cassidy, 2004). The innermost layer of the onion is labelled 'cognitive personality style' and refers to the individual's approach of assimilating and adapting information. The adaptation of information does not directly interact with the environment, but is a function of the deep, more permanent personality. Associated instruments for the measurement of concepts belonging to this layer are the Embedded Figures Test (Witkin, 1962), Myers Briggs Type Indicator (Meyers, 1962) and Matching Familiar Figures Test (Kagan, 1965) (Cassidy, 2004). In summary, according to Curry (1983, p. 117), "learning behaviour is fundamentally controlled by the central personality dimensions, translated through middle stratum information-processing dimensions, and given a final twist by interaction with environmental factors in the outer strata".

The onion model is one of the most widely cited integrated models within the style field (Coffield, Moseley, Hall, & Ecclestone, 2004) and ample studies build further on the model's assumptions (e.g., Hsieh, Jang, Hwang, & Chen, 2011; Richardson, 2011), as it provides an interesting way to distinguish related concepts theoretically. Nevertheless, only few studies have been conducted to empirically test the assumptions of the model (Cools, 2008, 2009). Moreover, these studies show contradictory results (e.g., Sadler-Smith, 1999a; Sadler-Smith et al., 2000). To address this research gap, we conducted two empirical studies: the first one being a cross-sectional study focusing on the relation between diverse individual learner differences and learning outcomes, and the second one looking at the stability versus malleability of these concepts in a longitudinal design. Before we move on to the methodology and results of these studies, we describe in more detail the different concepts and hypotheses that have been investigated. We subsequently define cognitive styles (inner layer), approaches to studying (middle layer), and didactical preferences (outer layer).

Cognitive styles

Messick (1996) conceptualised cognitive styles as stable attitudes, preferences, or habitual approaches determining a person's typical mode of perceiving, remembering, thinking, and problem solving. Cognitive styles have more recently been defined as "individual differences in processing that are integrally linked to a person's cognitive system… they are a person's preferred way of processing… they are partly fixed, relatively stable and possibly innate preferences" (Peterson, Rayner, & Armstrong, 2009a, p. 11). Studies investigating the cognitive style concept conclude that students' cognitive styles are likely to be stable characteristics (Ausburn & Ausburn, 1978; Peterson

et al., 2009b; Riding & Pearson, 1994; Riding & Sadler-Smith, 1997), which implicates that it can be generalised across different contexts and that it is not likely to change based on a specific learning context. Therefore, we consider cognitive style as a concept belonging to the inner 'cognitive personality style' layer of the onion model.

Despite the wide diversity of available cognitive style models (Kozhevnikov, 2007), many researchers have focused on the distinction between analytic and intuitive thinking (Hodgkinson & Sadler-Smith, 2003), assuming that cognitive styles can be positioned on an axis (Allinson & Hayes, 1996; Nickerson, Perkins, & Smith, 1985), distinguishing an analytic, structured, detail-oriented cognitive style on one side of the axis, and an intuitive, divergent, global cognitive style on the other side. Following recent evolutions in the style field, however, we preferred a multidimensional rather than a unidimensional perspective in this research (Kozhevnikov, 2007; Sadler-Smith, 2009). Cools and Van den Broeck (2007; 2008a; 2008b) recently developed and validated a multidimensional cognitive style model based on three cognitive styles: knowing, planning, and creating. Consistent with a non-unitary conceptualisation of style (Hodgkinson & Sadler-Smith, 2003), people can score high or low on the three styles, thereby offering a flexible approach to style assessment (Miron, Erez, & Naveh, 2004). Individuals with a *knowing style* have strong analytical skills; prefer a logical, rational, and impersonal way of information processing; make informed decisions on the basis of a thorough analysis of facts and figures and rational arguments. Individuals who score high on *planning* are attracted by structure; search for certainty; prefer well-organised environments; make decisions in a structured way and are concerned with efficiency in decision making. Individuals with a *creating style* search for renewal; have a strong imagination; like to work in a flexible way; prefer creative and unconventional ways of decision making, and make decisions based on intuition ('gut-feel'). As previous research in diverse Western and non-Western samples (e.g., students, managers, employees, entrepreneurs) found strong support for the construct validity and predictive validity of this new three-dimensional model (Cools, De Pauw, & Vanderheyden, in press; Cools and Van den Broeck, 2007, 2008a; 2008b; Cools, Van den Broeck, & Bouckenooghe, 2009), we chose to use this framework in the current studies.

Approaches to studying

An approach to studying is generally defined as "the manner in which studying is grasped" (Ashworth & Greasley, 2009, p. 561), pointing to students' mental orientation to studying. Entwistle and Peterson (2004a, p. 537) defined an approach to studying as "a context- and content-specific way of carrying out academic tasks". Ashworth and Greasley (2009) assume that students prefer to

use a certain approach to studying across different learning contexts . This does not imply that an approach to studying can be considered to be a stable psychological trait, as students have the flexibility to change their approach to studying according to their perception of the specific context (Entwistle, 1991; Entwistle & Peterson, 2004b; Segers, Nijhuis, & Gijselaers, 2006; Struyven, Dochy, Janssens, & Gielen, 2006; Vanthournout, Donche, Gijbels, & Van Petegem, 2009, 2011). Consequently, students' approaches to studying are defined by features of the learning and teaching environment as well as students' characteristics and experiences, and as such depend on both the 'context' and 'the learner'. Therefore, approaches to studying are considered to be a concept belonging to the middle layer of the onion model.

Most authors investigating students' approaches to studying built further on the work of Marton and Saljö (1997), distinguishing between a deep and a surface approach (Furnham, Christopher, Garwood, & Martin, 2008). A *deep approach* to studying entails looking for meaning in the matter being studied and relating it to other experiences and ideas with a critical approach. Students adopting a deep approach aim to understand the subject and are intrinsically interested in, and derive enjoyment from, studying. Deep learners attempt to build a global picture of all the knowledge gathered. A *surface approach* is adopted when learners view the task as a demand to be met to reach a goal. Surface learners perceive the task of learning as an external imposition and they are externally motivated, thereby depending largely on rote learning and memorisation. They typically treat parts of the subject as separate entities and fail to integrate topics into a coherent whole. Some researchers (e.g., Entwistle & Ramsden, 1983; Marton & Saljö, 1997) mentioned the need to add a third approach, namely a *strategic approach*. Learners who adopt this approach are characterised by the intention to achieve the highest grade possible through effective time management and organised study methods and an alertness of the assessment process. A strategic approach entails well-organised and conscientious study methods linked to achievement motivation, and the determination to do really well in the courses taken. We used this three-dimensional conceptualisation within our research, in line with this more recent theorising on approaches to studying.

Didactical preferences

Didactical preferences are defined as "individual's propensity to choose or express a liking for a particular instructional technique or combination of techniques" (Sadler-Smith, 1997, p.52). Following this definition, students' didactical preferences depend heavily on the context in which learning takes place, as they will judge the appropriateness of a particular method in relation to the

specific subject and context. It is, for instance, possible that a learner wants to learn through individual methods when studying theories of psychology, while the same learner prefers to learn through interaction or group work when learning about social skills. Therefore, this concept is seen as belonging to the outermost layer of the onion model.

Inspired by the earlier work of Sadler-Smith (1999a; Sadler-Smith et al., 2000) and Chuang (2004), we distinguish between four didactical preferences. On the one hand, a distinction is made between a preference for either active or passive didactics. *Active learning* is an umbrella term that refers to several models of instruction that put the responsibility of learning with the learners. Didactics that fit this learning preference are, for instance, class discussions, doing exercises, case studies, and attending workshops. To the contrary, *passive learning* refers to a preference to absorb new knowledge by listening to an authority. The most commonly used didactics of passive learning are taking notes, listening to a lecture, and watching supporting videos in class. On the other hand, a preference for either individual or group didactics has been distinguished. Students who score high on *group learning* generally like and learn more by learning in groups, while a preference for *individual learning* techniques entails that a person likes to learn by him- or herself. Didactics of group learning are, for instance, participating in group works, group assignments, business games, and group discussions. Didactics of individual learning are self-study, doing individual work assignments, and writing individual papers. As there is not much previous work on learning or didactical preferences, we chose to use this four-dimensional model within our research.

Research objectives and hypotheses

As mentioned in the introduction, few empirical studies have been conducted to test the assumptions underlying the onion model. Moreover, these studies left us with divergent and sometimes even contradictory results (Price, 2004; Sadler-Smith, 1999a, 1999b, 2001a; Sadler-Smith et al., 2000). Sadler-Smith et al. (2000) and Sadler-Smith (1999a), for instance, framed their research as a test of the onion model, investigating the link between cognitive styles and learning preferences. Sadler-Smith et al. (2000) concluded that their results do not provide sufficient support for any existing link and that the relationship between cognitive style and learning preferences is likely to be mediated by other individual characteristics, such as gender. In contrary, Sadler-Smith (1999a) stated that there is a link between cognitive styles and learning preferences, which according to him provides some support for the onion model. A further examination of the relationship between learning style and cognitive style led Sadler-Smith (2001a) to conclude that cognitive style and learning style are different constructs, which is according to Sadler-Smith (2001b) evidence for the

appropriateness of the onion model. The link between cognitive styles, learning styles, and learning preferences was also investigated by Price (2004), but her results did not provide consistent information for predicting students' academic performance on the basis of these individual learner differences.

Looking at these empirical tests of the onion model, three observations are notable. First, it is remarkable that abovementioned studies make use of correlations and analysis of variance to investigate the relationship between different concepts. These data analyses techniques do not assume a causal relationship between concepts, which implies that conclusions about the conceptual assumptions of the onion model cannot be drawn. A high correlation between cognitive styles and learning preferences suggests that these concepts are interrelated (Sadler-Smith, 2001a), but does this also imply that cognitive style is more robust than learning preferences, as the onion model of Curry (1983) suggests? Second, most studies that aim to test the onion model have only taken concepts of two layers into account in their design instead of concepts belonging to all three layers of the model. Finally, Curry (1983) originally designed the onion model to organise the cognitive and learning styles field in a more accurate way as a means to get a better understanding of the learning process and eventually improve the learning outcomes of all learners. This implies that studying the effect of concepts belonging to the three layers of the onion model on learning outcomes is as important as investigating the interrelatedness between the concepts themselves. However, most authors do not take learning outcomes into account when testing the usefulness of the onion model for educational practice (e.g., Sadler-Smith, 1999a, 2001a, 2001b; Sadler-Smith et al., 2000).

Given these observations, we aim to further empirically test the assumptions underlying the onion model by investigating the relationship between concepts belonging to the three layers of the model on the one hand and their link with learning outcomes on the other hand. In this way, we hope to derive valid and relevant conclusions for educational practice that can stimulate effective learning for all. In study 1, the causal link between cognitive styles, approaches to studying, and didactical preferences is tested in relation to students' learning outcomes, using path analysis. More specifically, under the assumption that the onion model is a correct representation, we hypothese (1) that the causal relation runs from concepts of the inner layers over concepts of the outer layers to learning outcomes (Hypothesis 1). In study 2, which uses a longitudinal design, we test the hypothesis that the more a concept is situated at the outer layers, the more malleable it will be. More specifically, we expect that cognitive styles will be more stable over time than approaches to studying (Hypothesis 2).

METHOD

Data were collected by means of self-reporting questionnaires. In the first study, the three concepts (cognitive styles, approaches to studying, and didactical preferences), each belonging to a different layer of the onion model, were measured cross-sectionally in the spring term of 2010. In the second study, cognitive styles and approaches to studying were measured at the beginning and near the end of the academic year 2010-2011, which allowed us to study the stability of these concepts. We clearly informed the students that the surveys were for research purposes only and that participation was voluntary. In return, participants received an individualised feedback report with the general results of the study and their personal scores.

Samples

Samples for both studies consisted of postgraduate and MBA students from a European business school. The sample for study 1 (Sample 1) contained 113 students (mean age = 26, *SD* = 4.99, ranging from 21 to 48 years; 65% men and 35% women; 61% national and 39% international students; 65% postgraduates with a major in management and 35% in general business). The sample for study 2 (Sample 2) contained 162 students (mean age = 26, *SD* = 3.9, ranging from 21 to 42 years; 69% men and 31% women; 62% national and 38% international students; 28% with a major in accounting and finance, 33% in management, 17% in marketing, and 23% in general business).

Measures

Cognitive styles. The 18-item Cognitive Style Indicator (CoSI; Cools & Van den Broeck, 2007) was used to measure cognitive styles in both studies, distinguishing between a knowing style (4 items; $\alpha_{\text{Sample 1}}$=.73; $\alpha_{\text{Sample 2 (T1)}}$ =.65; $\alpha_{\text{Sample 2 (T2)}}$ = .74; e.g., 'I like to analyse problems'), a planning style (7 items; $\alpha_{\text{Sample 1}}$=.86; $\alpha_{\text{Sample 2 (T1)}}$ =.80; $\alpha_{\text{Sample 2 (T2)}}$ = .88; e.g., 'I prefer clear structures to do my job'), and a creating style (7 item; $\alpha_{\text{Sample 1}}$=.84; $\alpha_{\text{Sample 2 (T1)}}$ =.75; $\alpha_{\text{Sample 2 (T2)}}$ = .80; e.g., 'I like to extend the boundaries'). The response format was a five-point Likert scale, ranging from 1 (totally disagree) to 5 (totally agree).

Approaches to studying. We used the Revised Approaches to Studying Inventory (RASI; Duff, 2004; Entwistle & Tait, 1994) to measure approaches to studying in study 1. This 45-item instrument

uses a five-point Likert scale response format, ranging from 1 (totally disagree) to 5 (totally agree) and consists of six subscales (deep approach, strategic approach, surface approach, lach of direction, academic self-confidence and metacognitive awareness of studying), of which we used the three scales linked to different approaches of learning: a surface approach to learning (10 items; $\alpha_{sample\ 1}$ =.77 ; e.g., 'Often I find myself reading things without really understanding them'), a deep approach to learning (10 items; $\alpha_{sample\ 1}$ = .69; e.g., 'I usually set out to understand for myself the meaning of what we have to learn'), and a strategic approach to learning (10 items; $\alpha_{Sample\ 1}$ =.74; e.g., 'I organise my study time carefully to make the best use of it'). In study 2, we used the Approaches and Study Skills Inventory for Students (ASSIST; Tait, Entwistle, & McCune, 1998) to measure approaches to studying. This 66-item instrument uses a five-point Likert scale response format, ranging from 1 (totally disagree) to 5 (totally agree) and consists of seven subscales, of which we used the three scales linked to approaches to studying: a surface approach to studying (16 items; $\alpha_{Sample\ 2\ (T1)}$ = .78; $\alpha_{Sample\ 2\ (T2)}$ =.67; e.g., 'I find I have to concentrate on just memorising a good deal of what I have to learn'), a deep approach to studying (16 items; $\alpha_{Sample\ 2\ (T1)}$ = .78; $\alpha_{Sample\ 2\ (T2)}$ = .77; e.g., 'I usually set out to understand for myself the meaning of what we have to learn') and a strategic approach to studying (20 items; $\alpha_{Sample\ 2\ (T1)}$ =.77; $\alpha_{Sample\ 2\ (T2)}$ = .68; e.g., 'I look carefully at tutors' comments on course work to see how to get higher marks next time').

Didactical preferences. To measure students' didactical preferences, we searched for an existing validated scale that would be appropriate for use within the business school. As no adequate measure seemed to exist, we started from the items of Sadler-Smith (1997, 1999a) and Chuang (2004) to compile our own didactical preferences questionnaire. Based on additional feedback from five professors of the business school, some further adaptations were made to the instrument. Preliminary analyses (item analysis, exploratory factor analysis) reduced the initial 33-item questionnaire to 21 items. This final instrument was used to assess students' didactical preferences, distinguishing between four subscales: active (5 items; $\alpha_{Sample\ 1}$ = .68; e.g., Participating in field trips), passive (7 items; $\alpha_{Sample\ 1}$ = .70; e.g., Listening to lectures that present theories), individual (4 items; $\alpha_{Sample\ 1}$ = .64; e.g., Writing individual papers), and group (5 items; $\alpha_{Sample\ 1}$ = .70; e.g., Participating in group work). The response format was a five-point Likert scale, ranging from 1 (I did not like this didactic at all) to 5 (I like this didactic very much). As mentioned in the literature overview, didactical preferences are heavily influenced by the specific context in which learning takes place. For this reason, students answered these questions with a specific course in mind.

Learning outcomes. Following the reasoning that students' approaches to studying and their didactical preferences can differ according to the specific learning context, academic achievement was conceptualised as the final score of the students on the Management and Organisation course in

which they participated during this study. Students were given a score on 20. The scores were normally distributed, with a mean of 14.26 (*SD* = 1.51; min = 10 ; max = 18).

RESULTS

To test Hypothesis 1, we conducted path analysis to examine the causal relationship between the different concepts. We tested the causal model that runs from cognitive style over approaches to studying and didactical preferences to academic achievement (see Figure 1), which yielded mixed results. The chi-square/degrees of freedom ratio ($\chi 2/df$) of the tested model was 3, which is well below the standard criterion of 5 (Schumacker & Lomax, 2004), thereby suggesting that the model shows an adequate fit to the data. However, when looking at other fit indices, the model did not show adequate fit: the Comparative Fit Index (CFI) as well as the Normed Fit Index (NFI) were much lower than .90 (CFI = .19, NFI = .31), and the Root Mean Square Error of Approximation (RMSEA) was above .08 (RMSEA = .13). Taking into account the modification indices, as suggested by Byrne (2001), the model could not be improved to the extent that it could unanimously be accepted. Nevertheless, the hypothesised model demonstrated much better fit to the data than alternative models that we tested, with relative chi-squares ranging from 3.83 to 5.23. Interestingly, our hypothesised model also shows several significant causal paths. As can be seen in Table 1, a significant positive path runs from the creating ($p < .05$) and the knowing ($p < .001$) cognitive style to a deep approach to studying and a negative one from the creating style to a surface approach to studying ($p < .01$). Additionally, following significant paths were found from approaches to studying to didactical preferences: positive paths from a deep approach to studying to a preference for active ($p < .001$) and individual ($p < .01$) didactics, and from a strategic approach to studying to a preference for active ($p < .001$) and group ($p < .001$) didactics, and a negative path from a surface approach to studying to group didactics ($p < .05$). We found no significant path coefficient from didactical preferences to academic achievement. To conclude, Hypothesis 1 was not supported: the model running from cognitive styles over approaches to studying to didactical preferences showed the most adequate fit, although based on the different fit measures we can not accept the model.

Insert Figure 1 and Table 1 About Here

Examining the stability versus malleability of concepts of different layers in Study 2, we hypothesised that cognitive style, as a concept belonging to the innermost layer, would be more stable than students' approaches to studying, which is a concept of the middle layer (Hypothesis 2). Table 2 shows the results of the paired sample t-tests that compared the means of approaches to studying and cognitive style over data collected in phase 1 and in phase 2. As can be noticed, both approaches to studying and cognitive styles show significant mean differences over time, yielding no support for Hypothesis 2. Looking at Cohen's d, we see that the effect size is slightly higher for cognitive styles (ranging from .20 to .32) than for approaches to studying (ranging from .24 to .44), suggesting that cognitive styles changed more over time than approaches to studying.

Insert Table 2 About Here

DISCUSSION

Curry (2000) tried to overcome the unclarity of the relation between concepts in the cognitive and learning style field by clustering different concepts in the so-called onion model, distinguishing between three different layers. As it is important for evidence-based practice (Rousseau, 2007; Rousseau, Manning, & Denyer, 2008) to start from a clear body of evidence supporting the assumptions of a particular theoretical model, this study aimed to empirically test the hypothesised onion model, given the lack of such empirical tests and the unequivocal findings in the few studies that have been conducted. Looking at our mixed results, we can not conclude that we found solid proof to accept the onion model and its assumptions.

In study 1, path analysis yielded no support for the hypothesis that the causal relation would run from concepts of the inner layers over concepts of the outer layers to learning outcomes (Hypothesis 1). More specifically, path analysis led to unsatisfactory results, with the best fit to the data for the hypothesised model (onion model) in comparison with alternative models, but overall no good fit. Nevertheless, some interesting relations were found between cognitive styles and approaches to studying, and between approaches to studying and didactical preferences, which contributes to the fragmented findings of previous research thus far (e.g., Biggs, 2001; Price, 2004; Sadler-Smith, 1999a, 1999b, 2001a; Sadler-Smith et al., 2000). In contrary to Sadler-Smith (1999b), we found that not only students with a knowing style preferred a deep approach to studying, but

also students with a creating style This finding confirms the utility and relevance of taking a multidimensional perspective on styles rather than a unidimensional perspective in which people receive one style score situated on an analytical-intuitive dimension (Kozhevnikov, 2007; Sadler-Smith, 2009).This can lead to more fine-grained results for educational practice. Furthermore, in parallel with Biggs (2001), we found that students with a deep approach to studying are more active (showing a preference for active and individual didactics), while students with a surface approach to studying are more passive (showing a disliking for group didactics).

In the second, longitudinal study, Hypothesis 2 could not be supported, as both cognitive styles and approaches to studying showed significant differences over time. Interestingly, previous longitudinal research mainly found an increase in deep and strategic approaches to studying over time in higher education, and a decrease in the surface approach (Vanthournout et al., 2011). This was not the case in our research, as we found an increase in both the deep and surface approach and a decrease in the strategic approach. In addition, in contrary to the assumed stability of cognitive styles (Peterson et al., 2009a, 2009b), we saw a decrease for all cognitive styles over time. This suggests that students become more flexible in their cognitive profile during the academic year, for instance through the use of diverse cognitive strategies, which are specific behaviours that people use to cope with particular situations and tasks outside their natural preferences (Cools, 2008). More research will be needed to shed further light on these shifts in approaches to studying and cognitive style.

Overall, the empirical evidence for the onion model from this research is not reached. It can be concluded, based on this preliminary study, that the onion model might not be the best representation to cluster different concepts and to investigate their interrelations with learning outcomes. Nevertheless, this study sheds some further light on the relationship between different individual difference concepts and learning outcomes, irrespective of the overall relationships assumed in the onion model. Quite some research has been conducted on the relation between particular individual learner differences and learning outcomes in an attempt to predict students' academic achievement based on their individual learner characteristics, but these studies often did not yield unequivocal results.

First of all, ample studies investigated the relationship between cognitive style and learning outcome. Diseth and Martinsen (2003) did not find a correlation between cognitive style and academic performance. Although Armstrong (2000), Au (1997), and Backhaus and Liff (2007) found higher academic grades for analytic students in their research, they attributed this to the assessment methods used to score the students, as it is generally assumed that cognitive styles and overall ability

are independent (Cools, 2009; Riding & Rayner, 1998). The present study showed no direct effect of cognitive styles on learning outcomes, as such supporting the independence of style and ability.

Secondly, the relation between approaches to studying and learning outcomes has been often studied. Although some authors do not find a relationship between approaches to studying and academic performance (e.g., Backhaus & Liff, 2007), there seems to be widely held consensus that the approaches to studying students take are related to their academic performance (e.g., Chamorro-Premuzic & Furnham, 2008; Diseth, 2003; Diseth & Martinsen, 2003; Richardson, 2003; Sadler-Smith, 1996). Research found that a deep approach to studying is positively related to academic performance, as students with a deep approach obtain higher scores on examinations (Chamorro-Premuzic & Furnham, 2008; Diseth, 2003; Diseth & Martinsen, 2003; Drew & Watkins, 1997; Duff, 2003). A positive relationship has also been found in earlier research between a strategic approach to studying and students' academic performance (Diseth & Martinsen, 2003; Duff, 2003). On the contrary, a negative correlation has been reported between the surface approach and academic performance (Diseth, 2003; Diseth & Martinsen, 2003; Duff, 2003). In this study, the influence of approaches to studying to student learning outcomes is in line with previous research, as we found a positive effect of a strategic approach to studying to learning outcomes and a negative effect from a surface approach. The positive effect of a deep approach to studying on learning outcomes, however, was not found in this study.

Thirdly, few studies have been conducted to investigate the direct link between didactical preferences and learning outcomes. Hence, it is less clear how they are related, and in this sense our research could shed some further light on this relationship. Dobson (2009), for instance, found a significant positive relation between preferred sensory modality and course scores. Naimie, Siraj, Abuzaid, and Shagholi (2010) also found evidence for the hypothesis that learning outcomes improve when instructional material is matched to students' didactical preference. However, it is still unclear from research in this area in general whether didactical preferences of students should be matched or mismatched with the didactics used to obtain the best academic performance (e.g., Evans & Cools, 2011; Evans & Waring, 2011; Ford & Chen, 2001; Hayes & Allinson, 1993, 1996; Pashler, McDaniel, Rowher, & Bjork, 2009). As the present study showed no significant effect of didactical preferences on learning outcomes, it is difficult to argue based on these results whether a match or a mismatch would be the best. Again, a call for further research can be made to continue studying the so-called 'matching hypothesis' (Hayes & Allinson, 1993, 1996). Overall, when looking at the relationship between these aforementioned concepts, it is clear that the different concepts one way or another are related to student learning outcomes and as a consequence important to include when studying students' learning processes. However, the representation suggested through the onion model –

with the accompanying assumptions of causality and stability - might not be the best representation of concepts in the field of cognitive style and learning differences.

CONCLUSION

Although many studies use Curry's (1983, 2000) onion model as a basis for studying the learning process of students, few studies actually tested whether this model is a good representation of concepts belonging to the cognitive and learning style field. Following recent calls for a more student-centred learning environment (Whetten, Johnson, & Sorenson, 2009), this study aimed to empirically test the assumptions of Curry's onion model. The uniqueness of this research in comparison with earlier research in this area is fourfold: the joint focus on concepts of three layers of the onion model simultaneously; the examination of their link with learning outcomes; the use of appropriate statistical methods to investigate the assumed relationships of the concepts of the onion model; and the combination of a cross-sectional and a longitudinal study. As mentioned in the introduction, previous research in this area only considered concepts of two layers of the model simultaneously, thereby neglecting learning outcomes, using correlations or analysis of variance to empirically test the relations between the concepts, and taking a cross-sectional approach.

First of all, this study showed that the causal relationships between different concepts in the cognitive and learning style field should be further investigated to strenghten our understanding of the effects of student characteristics on learning outcomes. This also implies that learning outcomes should be taken into account in this type of research, as these outcomes are crucial to gain insights into how student characteristics influence students' learning. To gain further clarity about the abovementioned mixed results, we suggest to continu the empirical validation of the onion model, using a broad range of existing uni- and multidimensional cognitive and learning styles scales.

Secondly, this study showed that further longitudinal research is needed to test the stability of different concepts. Whereas different authors consider cognitive styles to be stable (Messick, 1996; Peterson et al., 2009a, 2009b), this study did not yield evidence for that assumption. Therefore, it might be that students are more flexible in using different cognitive and learning strategies during the learning process than we might assume. If this is the case, further research should take into account the specific learning situation of students, as this specific situation might have the biggest impact on how students make use of their cognitive and learning abilities. An important limitation of this study is related to the fact that the data were collected in one business school,in the context of one particular course, so cross-validation of our results in diverse contexts will be very important.

To conclude, as this study showed no solid empirical proof for the assumptions of the onion model, we can state that some caution is needed when using conceptual models such as the onion model to investigate the learning process of students. Although a clear and straightforward theoretical model is attractive to bring order in a multitude of related concepts, these models need to be investigated empirically to test their assumptions in practice. Hence, further research of this kind, using bigger samples and taking a cross-sectional as well as a longitudinal approach, is needed to strengthen our understanding. We are convinced, however, that this preliminary study can already contribute to further conceptual clarification in the field of individual learner differences and to relevant knowledge for educational practice by providing better insights into the influence of diverse individual learner differences on student learning outcomes.

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Table 1. Causal relation between cognitive style, approaches to studying, and didactical preferences to academic achievement (standardised path coefficients) (Sample 1, *N* = 113)

	Approaches to studying			**Didactical preferences**				**Academic achievement**
	Deep	*Strategic*	*Surface*	*Active*	*Passsive*	*Individual*	*Group*	
Cognitive styles								
Knowing	.20***	-.01	.01					
Planning	.08	.20	.20					
Creating	.19*	.07	-.28**					
Approaches to studying								
Deep				.59***	.19	.42**	.19	
Strategic				.65***	.11	.28	.54***	
Surface				.04	.17	-.14	-.23*	
Didactical preferences								
Active								.19
Passive								-.46
Individual								-.05
Group								.41

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 2. Correlations and comparison of means of cognitive styles and approaches to studying, measured at T1 and T2 (Study 2, *N* = 162)

	Time 1		Time 2		r	Paired-sample t-test	d
	M	*SD*	*M*	*SD*		*t*	
Approaches to studying							
Deep approach	3.83	.48	3.93	.53	.60	-2.80**	.20
Strategic approach	3.78	.47	3.62	.57	.48	3.92***	.31
Surface approach	2.16	.52	2.34	.61	.46	-3.88***	.32
Cognitive styles							
Knowing	4.04	.63	3.75	.68	.50	5.59***	.44
Planning	3.91	.68	3.64	.76	.61	5.37***	.37
Creating	4.10	.56	3.96	.60	.74	4.19***	.24

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 1. Path analysis to test causal relationship