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The Mode Shifting Index (MSI): A new measure of the creative thinking skill of shifting between associative and analytic thinking

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Abstract

Shifting between associative and analytic modes of thought appears to be a key thinking skill for creativity, enabling one to both generate and evaluate creative ideas. However, there currently exists no ready self-report means of assessing mode shifting. We developed a novel self-report measure of mode shifting, the Mode Shifting Index, (MSI) to fulfil this need. The MSI was administered to a sample ($N = 332$) comprising a group from a recognised area of creative endeavour requiring design skills, architecture, and two control groups from non-design domains, specifically medicine and other professionals and university students. MSI items were answered with respect to two different contexts: mode shifting on one's university course or within one's work (professional context) and outside of university or work in everyday life (everyday context). Principal components analyses revealed two components in each context: metacognitive awareness of shifting and shifting competence. Metacognitive awareness of shifting demonstrated validity by successfully capturing the increase in awareness of mode shifting expected from the architecture group relative to the two control groups. This effect was only reported within the professional context and architects themselves reported increased awareness of shifting in their professional compared to their everyday

context. These findings suggest that awareness of shifting could be a learned skill that can be selectively increased within a context in which it is particularly useful to shift, that is when engaged in a creative endeavour. The MSI shows promise as a tool for both furthering our understanding of and assessing mode shifting.

Keywords:

Mode Shifting
Metacognition
Creative Thinking
Creativity Assessment
Design

Author note

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1. Introduction

1.1. Mode Shifting

The well-known actor and writer John Cleese once commented that “creativity is not a talent, it is a way of operating....we need to be in the open mode when pondering a problem but, once we come up with a solution we must switch to the closed mode to implement it” (Popova, 2012). Cleese’s comments capture the notion that creative thinking is comprised of multiple processes and imply that to be creative one must be able to move between these different processes. More formally, theories of the creative thinking process propose that creativity requires generation of ideas that are then evaluated and honed for their

intended purpose and that this hinges upon the ability to switch or shift¹ between different modes of thinking (Gabora and Ranjan, 2013; Howard-Jones, 2002; Kaufman, 2011). Further, both generation and evaluation are dependent on associative and analytic modes of thinking. For instance, idea generation can involve the analytic decomposition of an object or concept into subcomponents that are then associated in new ways with each other or additional objects/concepts to generate a new idea (e.g. Finke, Ward and Smith, 1992; see Sowden, Pringle and Gabora, 2015 for a review). Further, to evaluate a new idea one may compare it to previous solutions, retrieved via a process of association. Thus, associative and analytic thinking are interwoven and both must be harnessed to effectively generate and evaluate creative ideas.

The process of shifting between associative and analytic modes of thought resembles Vartanian's (2009) proposal that individuals can modulate their attention along a spectrum from focused to defocused. Indeed others have explicitly made this link, with focused attention being a key characteristic of the analytic mode and defocused attention a key characteristic of the associative mode (Gabora and Ranjan, 2013; Howard-Jones, 2002). Laboratory studies have demonstrated that those able to modulate their attention to a greater extent score higher on measures of divergent thinking and creative potential (Vartanian, 2009; Vartanian, Martindale and Kwiatkowski, 2007; Dorfman, Martindale, Gassimova and Vartanian, 2008). Similarly both associative and executive-analytic processes have been shown to support divergent thinking

¹ We use the term shift instead of switch in order to reflect the notion of there being a balance between associative and analytic thinking rather than one mode being active while the other is inactive (see section 1.2. for more details).

ability suggesting that creative thinking involves the interaction of both (Beaty, Silvia, Nusbaum, Jauk and Benedek, 2014). Indeed, a body of recent neuroimaging research demonstrates that during creative thought the control brain network underpinning analytic thinking dynamically interacts with the default mode network underpinning associative thinking (Beaty, Benedek, Silvia and Schacter, 2016).

However, there is currently no means of assessing mode shifting outside of the laboratory experiment. Therefore, in the present paper we aim to develop a novel self-report measure of mode shifting, the Mode Shifting Index (MSI²), designed to assess this fundamental creative thinking skill.

1.2. Conceptual framework of Mode Shifting

The MSI was developed based on a novel conceptual framework of mode shifting shown in figure 1.

² Abbreviations in article: MSI = Mode shifting index, SP awareness= metacognitive awareness of shifting in a professional context, SE awareness= metacognitive awareness of shifting in an everyday context, SP competence= shifting competence in a professional context, SE competence= shifting competence in an everyday context.

Figure 1. Conceptual framework of mode shifting.

Near the bottom of figure 1, two different modes of thinking are represented within the conceptual framework. These are labelled, based on Gabora & Ranjan's (2013) theory, as associative and analytic modes of thought. The framework conceptualises the use of these two modes of thinking as controlled by a shifting mechanism. This shifts the balance of thinking by regulating the intensity of use of each mode such that one may be more active than the other, or both may be equally active (or inactive). We see this as related to Vartanian's (2009) mechanism of attentional flexibility. In line with our framework, neuroimaging findings demonstrate that the brain networks underpinning each mode show both competition and co-operation during creative cognition (Beaty, Benedek, Silvia and Schacter, 2016). In other words whilst at times the two

modes of thinking are like the two ends of a continuum, such that as one mode increases the other decreases in a competitive manner, at other times the two modes may simultaneously increase in a co-operative manner, whilst maintaining the balance of use of the two modes. Associative and Analytic thinking are treated as distinct modes in our framework in order to allow for both competitive *and* co-operative interactions between modes. Treating mode shifting as a continuum is undesirable as it suggests against the co-operation of associative and analytic modes during creative thought. For this reason we adopt the metaphor of a balance, rather than a continuum, between associative and analytic thinking with the balance controlled by the shifting mechanism. One's effectiveness at shifting depends on the operation of this mechanism.

Enveloping the shifting mechanism and modes of thinking is metacognitive awareness. This includes one's awareness of the individual modes of thinking, of the shifting process itself (Sowden, Pringle and Gabora, 2015), for example, monitoring when one is shifting or not and one's rate of shifting during a task, and thus awareness of how effective one is at shifting. Further, whilst the action of shifting can lead to awareness of the shifting process that awareness may also enable one to exert control on the operation of the shifting mechanism. This is related to Vartanian, Martindale & Matthew's (2009) argument that attentional flexibility is modulated by both top-down as well as bottom-up processing. It is important to note that within Vartanian and colleagues' experiments there is no measure of metacognitive awareness of mode shifting. The MSI in contrast aims to measure both the operation of the shifting mechanism and one's self-awareness of it. Finally, the surrounding ring, labelled retrospective memory,

represents that the MSI does not capture shifting at the time of occurrence but is instead a retrospective report of one's mode shifting in real-life.

A final crucial point about the conceptual framework is that the need to shift modes may differ based on the context and domain within which one is operating. When a person is operating in a context or domain requiring them to think creativity, such as when working on designing a building as an architect, they will need to repeatedly iterate between generating and evaluating ideas and hence, to shift between modes of thought (Gabora and Ranjan, 2013). In contrast when that same person is immersed in everyday activities outside of their role as an architect such as conversing with friends or walking the dog there may be less of a need to shift. Thus, in the present study, the MSI was administered to a sample engaged in professional design, specifically architects, and MSI scores within this group were compared to two groups from non-design domains. The reason for choosing architects is that this is a recognized area of creative endeavour requiring mode shifting in order to both generate and evaluate ideas (Cross, 2011; Dorst and Cross, 2011). It has also been argued that mode shifting is particularly important for architects (Lawson, 1997). Architects therefore represent a useful candidate group within which to examine if the MSI is capable of revealing increased levels of mode shifting compared to non-design control groups, expected to shift less. In addition, responses to MSI items were obtained with respect to professional and everyday contexts in order to examine if there is a context-dependent difference in mode shifting.

1.3. Development of the MSI

MSI items were constructed by adapting items from Norris and Epstein's (2011) rational-experiential inventory (REI). The REI measures the degree to which one uses two different modes of thought; termed associative-experiential and analytic-rational (Epstein, 2003). Two distinct factors representing associative-experiential and analytic-rational thinking have been found and replicated (Epstein, Pacini, Denes-Raj and Heier, 1996; Norris and Epstein, 2011). The two factors have also been found to be differentially associated with different measures; with a rational factor associated with measures of analytic ability such as academic achievement (Epstein, Pacini, Denes-Raj and Heier, 1996) and an experiential factor associated with measures of intuitive, affective and imaginative abilities; abilities argued to be underpinned by associative processing (Norris and Epstein, 2011). As such, adapting REI items should ensure that items constructed for the MSI accurately tap associative and analytic modes of thought. The MSI differs from the REI in that MSI items were specifically devised to tap shifting between these modes of thought. In contrast, REI items only capture trait dispositions in the degree to which people generally rely on each mode, not the process of shifting between them.

Fourteen MSI items were developed to measure the operation of the shifting mechanism. For example, items tapping rational thinking from the REI such as "I am not very good at solving problems that require careful logical analysis³", and REI items tapping experiential thinking such as "I often go by my instincts when

³ This item was reverse coded in the original REI.

deciding on a course of action” were adapted to produce items such as “I am good at tasks that require both logic and going with my gut feelings”. These items were designed to tap one’s effectiveness at shifting between associative and analytic modes; from herein termed shifting competence.

MSI items were also developed to measure metacognitive awareness of shifting. Items from the REI tapping rational thinking such as “I don’t like to have to do a lot of thinking”⁴ and REI items tapping experiential thinking such as “sometimes I like to just sit back and watch things happen” were adapted to produce items such as “While working on a task, I go through phases where I do a lot of thinking and other phases where I just sit back and muse over things/take a back seat”. These items were designed to tap one’s self-awareness of the extent to which one shifts between modes: from herein termed metacognitive awareness of shifting.

1.4. Summary

The aims of the present work were therefore to develop a novel self-report measure of mode shifting, the MSI, examine its psychometric properties and conduct an initial test of its validity. The fourteen MSI items were administered to three different groups: one comprised of architects and architecture students, another comprised of physicians and medical students and a third comprised of university students and professionals from non-design disciplines.

⁴ This item was reverse coded in the original REI

Architects and architecture students were sampled because they represent a group for which shifting is particularly useful (Lawson, 1997) and therefore would be expected to report high levels of mode shifting. Professionals and university students from non-design disciplines were included as a control group against which to compare the MSI scores of the architecture group. Physicians and medical students provided a second control group against which architect's shifting can be compared that are an approximate match to architects on intellectual ability and length of training. The inclusion of this control group was considered important based on evidence suggesting that both IQ and experience may moderate the relationship between mode shifting and creativity (Carson, Peterson & Higgins, 2003). If the group of architects reported elevated shifting in comparison to the group of physicians and medical students then that would provide evidence for the discriminant validity of the MSI.

MSI items were administered to each group with respect to two different contexts, within one's professional context and in everyday life outside of one's professional context; termed the everyday context. Principal components analyses (PCA's) were conducted to assess the psychometric properties of the MSI separately for everyday and professional contexts. In order to justify comparing MSI scores across different contexts it was important that shifting competence and metacognitive awareness of shifting emerged as the same two components of mode shifting within both everyday and professional contexts. If this requirement is met, then it is valid to compare MSI scores obtained in one context to MSI scores in the other. The four dependent measures on which we aimed to compare the three groups are shown in the cells of table 1 below.

Table 1. The four dependent measures on which groups compared.

	Professional context	Everyday context
Shifting competence	SP competence	SE competence
Metacognitive awareness of shifting	SP awareness	SE awareness

The MSI's validity was tested by examining if it captured the greater shifting competence and metacognitive awareness of shifting expected of the architecture group in comparison to the non-design control groups.

2. Method

2.1 *Sample*

Opportunity samples from three different groups were recruited online via social media and email links. Qualified practicing architects were recruited through personal contacts and at architecture events in Surrey and the greater London area. Architecture students and architecture professionals were also recruited worldwide via Twitter and Facebook requests. Physicians and medical students were recruited from personal contacts enrolled on university medicine courses or practicing physicians in the UK. Physicians and medical students were also

recruited worldwide via Twitter and Facebook requests. Professionals and students studying courses other than architecture or medicine were recruited on campus at the University of Surrey and worldwide via Twitter and Facebook requests.

The first group, labelled 'architecture', consisted of individuals currently undertaking a university or college course in architecture and practicing architects, who had previously qualified from a university or college course in architecture ($N = 150$). The majority of this group were enrolled on university architecture courses at undergraduate ($N = 106$) or postgraduate level ($N = 30$). A smaller number were practicing architecture professionally ($N = 13$). One participant was qualified but not currently practicing architecture and one participant failed to indicate their level of experience. These two participants were excluded from all analyses.

The second group, labelled 'medicine', consisted of individuals currently undertaking a university course in medicine and practicing physicians, who had previously qualified from a university course in medicine ($N = 42$). The majority were enrolled on medicine courses at university ($N = 26$). A smaller number were practicing medicine professionally ($N = 16$).

The third group, labelled 'other disciplines', consisted of those in employment other than architecture, medicine or another design profession, and students currently undertaking a university or college course other than architecture, medicine or design ($N = 148$). The majority of this group were also enrolled on

undergraduate ($N = 36$) and postgraduate ($N = 52$) courses at university. A sizeable number were practicing professionals ($N = 53$). Six participants did not provide sufficient information to establish their educational level or current employment and hence were excluded from all further analyses.

The principal components analyses were run on responses on the self-report measure pooled from the three groups described above ($N = 332$). It was beneficial to conduct the principal components analyses on as diverse a sample as possible, hence the inclusion of all three groups in the PCAs. A diverse sample helps maximise variance in shifting and avoid problems that may beset PCAs based on homogenous samples (Fabrigar, Wegener, MacCallum & Strahan, 1999). The PCA's were run on the total sample of 332 participants, with 216 females and 116 males. Ages ranged from 16 to 63 with a mean of 26.35 years ($SD = 8.74$).

2.2 Materials

2.2.1 Mode Shifting Index (MSI)

The Mode Shifting Index (MSI) was created for this study and its development is explained in section 1.3. The full set of items is shown in table 2. Items 4, 5, 7, 8 and 12 were devised to tap shifting competence and Items 1, 2, 3, 6, 9, 11, 10, 13, 14 were devised to tap metacognitive awareness of shifting.

Table 2. *Mode Shifting Index (MSI)*

Mode Shifting Index (MSI)				
<i>[Items marked with an asterisk were removed from the final version of the MSI- see section 3.1]</i>				
<p>The following are some 14 statements about feelings, beliefs, and behaviours.</p> <p>Please describe how true the statements are for you with respect to everyday tasks/ with respect to tasks you perform as part of your degree or in your current profession. Don't worry too much about any one item: first impressions are as good as any.</p>				
1	2	3	4	5
completely false	mainly false	undecided	mainly true	completely true
1. While working on a task, I often switch between thinking analytically and thinking intuitively*				
2. While working on a task, I often engage in focused in-depth thought during some phases and more intuitive thinking during others				
3. When working on a task, I like to think both in depth about the details and drift out of focus and let my mind wander (e.g. looking out of the window)				
4. I am good at tasks that require both logic and going with my gut feelings				
5. I am not good at tasks that have phases requiring hard focused thinking and other phases that require broadening your attention and letting your mind wander (e.g. looking out of the window)*				
6. It seems I go through different phases of thinking through a task and accomplishing it from start to finish				
7. I rely on both careful reasoning and on my intuitive impressions				
8. I rely on both my intuition and logic when making important decisions				
9. I find that using a combination of logic and going with my emotions works well for me in figuring out problems*				
10. I find that at times while working on a task my thinking and behaviour is driven more by my emotions and at other times it is driven more by reason and logic				
11. I find that at times while working on a task, I think or describe things using analogies or metaphors and at other times I don't use these and take a more reality-oriented view				
12. I am good at both figuring things out logically and going with my instincts when deciding on a course of action				
13. I find that I work best on certain problems when I am in a logical mind-set and best on others when my mind-set is less logical (e.g. more infused with emotions, unusual imagery, metaphors etc.)				
14. While working on a task, I go through phases where I do a lot of thinking and other phases where I just sit back and muse over things/take a back seat				

2.2.2. Procedure

The instructions informed participants that they would be presented with “14 statements about feelings, beliefs and behaviours”. They were asked to “describe how true the statements are for you” in two different contexts; “with respect to everyday tasks” (the everyday context) and “with respect to tasks you perform as part of your degree or within your current profession” (the professional context). All 14 items were presented to participants in one context, after which the same 14 items were presented in the other context. Within each context, the order in which items were presented to participants was randomized. Additionally, the order in which each of the two contexts were presented was counterbalanced across participants. Before completing items administered in the first context, participants were informed they would have to complete items in the two different contexts (everyday and professional). The reason for this was to ensure from the outset that participants were clear they would have to give responses for items in two distinct contexts. Participants rated the degree to which they agreed with the 14 statements about their mode shifting on a 5-point likert scale, with 1 indicating *completely false* to 5 indicating *completely true*.

3. Results

3.1. Principal components analyses of the Mode Shifting Index (MSI)

Two separate principal component's analyses (PCA's) were conducted: one on the fourteen items administered *in the everyday context* and one on the fourteen items administered *in the professional context*. The PCAs were conducted on all participants, collapsing across the three groups. PCA's were run in order to determine the psychometric properties of the MSI. Specifically, the measure needed to demonstrate that it could operationalize shifting as the same construct in the two different contexts (everyday & professional), revealing the two component processes of shifting (shifting competence and metacognitive awareness of shifting) in each. If shifting emerged as a very different construct in one context compared to the other then that would suggest the MSI is not capturing the operation of the same processes across different contexts. It was also important to determine that the principal components within both contexts evidenced good internal consistency.

Correlation matrices for items administered within an everyday and professional context were examined, with most items meeting the requirement for PCA that they correlate fairly well but not too strongly with each another (Field, 2009). There were however two exceptions. Within the professional context, item nine failed to significantly correlate with 12 out of the 13 other items. Within the everyday context, item five failed to significantly correlate with nine out of the 13 other items. It was thus decided to omit item five from the PCA on items

administered within the everyday context and to omit item nine from the PCA conducted on items administered within the professional context.

The remaining items (13 in the everyday context, 13 in the professional context) were submitted to separate principal components analyses (PCAs). Scree plots and parallel analyses (Thompson & Daniel, 1996) suggested two principal components were appropriate to extract in both PCAs. The two components extracted using the PCA on items administered within the everyday context explained 46 percent of the variance in self-reported shifting. The two components extracted on items administered within the professional context explained 44 percent of the variance in self-reported shifting. As is typical in PCA, structural coefficients (sometimes termed loadings) were rotated to facilitate the interpretation of principal components (Timmerman, Kiers & Smilde, 2007; Fabrigar, Wegener, MacCallum & Strahan, 1999). Components were subjected to an oblique rotation, specifically direct quartimin. This method of rotation has been found to produce satisfactory solutions and an oblique rotation was preferable given that we expected components to be correlated (Fabrigar, Wegener, MacCallum & Strahan, 1999). For both PCA's, structural coefficients from the pattern matrix greater than or equal to .4 were defined as salient loadings. These are displayed in tables 3 and 4.

Table 3. Rotated principal components analysis (PCA) matrix run on the 13 items administered with respect to the everyday context.

Item number	Item	Principal-components	
		I	II
14	While working on a task, I go through phases where I do a lot of thinking and other phases where I just sit back and muse over things/take a back seat	.75	–
13	I find that I work best on certain problems when I am in a logical mind-set and best on others when my mind-set is less logical (e.g. more infused with emotions, unusual imagery, metaphors etc.)	.69	–
3	When working on a task, I like to think both in depth about the details and drift out of focus and let my mind wander (e.g. looking out of the window)	.63	–
11	I find that at times while working on a task, I think or describe things using analogies or metaphors and at other times I don't use these and take a more reality oriented view	.62	–
6	It seems I go through different phases of thinking through a task and accomplishing it from start to finish	.56	–
10	I find that at times while working on a task my thinking and behaviour is driven more by my emotions and at other times it is driven more by reason and logic	.47	–
2	While working on a task, I often engage in focused in depth thought during some phases and more intuitive thinking during others	.51	-.25
1	While working on a task, I often switch between thinking analytically and thinking intuitively	.42	-.36
12	I am good at both figuring things out logically and going with my instincts when deciding on a course of action	–	-.83
4	I am good at tasks that require both logic and going with my gut feelings	–	-.76
8	I rely on both my intuition and logic when making important decisions	–	-.78
7	I rely on both careful reasoning and on my intuitive impressions	–	-.64
9	I find that using a combination of logic and going with my emotions works well for me in figuring out problems	–	-.64

Note. Structural coefficients below .20 are represented by a dash (–). Structural coefficients above .40 are in boldface. Extraction method: Principal components analysis. Rotation method: direct quartimin.

Table 4. Rotated principal components analysis (PCA) matrix run on the 13 items administered with respect to the professional context.

Item number	Item	Principal-components	
		I	II
12	I am good at both figuring things out logically and going with my instincts when deciding on a course of action	.80	–
7	I rely on both careful reasoning and on my intuitive impressions	.79	–
8	I rely on both my intuition and logic when making important decisions	.76	–
4	I am good at tasks that require both logic and going with my gut feelings	.76	–
1	While working on a task, I often switch between thinking analytically and thinking intuitively	.58	-
14	While working on a task, I go through phases where I do a lot of thinking and other phases where I just sit back and muse over things/take a back seat	-.21	.79
3	When working on a task, I like to think both in depth about the details and drift out of focus and let my mind wander (e.g. looking out of the window)	–	.79
11	I find that at times while working on a task, I think or describe things using analogies or metaphors and at other times I don't use these and take a more reality oriented view	–	.52
6	It seems I go through different phases of thinking through a task and accomplishing it from start to finish	–	.45
2	While working on a task, I often engage in focused in depth thought during some phases and more intuitive thinking during others	.38	.45
10	I find that at times while working on a task my thinking and behaviour is driven more by my emotions and at other times it is driven more by reason and logic	.31	.40
13	I find that I work best on certain problems when I am in a logical mind-set and best on others when my mind-set is less logical (e.g. more infused with emotions, unusual imagery, metaphors etc.)	.32	.40
5	I am not good at tasks that have phases requiring hard focused thinking and other phases that require broadening your attention and letting your mind wander (e.g. looking out of the window)	-	.24

Note. Structural coefficients below .20 are represented by a dash (–). Structural coefficients above .40 are in boldface. Extraction method: Principal components analysis. Rotation method: direct quartimin.

From tables 3 and 4 it can be seen that both PCAs run on items administered with respect to everyday and professional contexts revealed very similar components. Items 2, 3, 6, 10, 11, 13 and 14 loaded onto component I in the everyday context (table 3) and component II in the professional context (table 4). These items were all devised to measure metacognitive awareness of shifting. Items 4, 7, 8 and 12 loaded onto component II in the everyday context (table 3) and component I in the professional context (table 4). These items were all devised to measure shifting competence. The PCA therefore revealed the theorized components of mode shifting, metacognitive awareness of shifting and shifting competence, within both professional and everyday contexts.

Item one, which loaded on the metacognitive awareness component (I) in the everyday context but on the shifting competence component (I) in the professional context, was excluded from subsequent analyses. Item nine, which loaded on the shifting competence component (II) in the everyday context but was not included in the PCA run on items within the professional context was also excluded from subsequent analyses. This enabled a valid comparison of scores on shifting across everyday and professional contexts to be conducted in subsequent analyses. Item five, included in the PCA run on items within the professional context, failed to load on either component I or II and thus was omitted from subsequent analyses.

The final structure of the MSI therefore consisted of four different scales, each examining a different component of shifting (metacognitive awareness or competence) across the two different contexts (everyday and professional). The

four scales were labelled as shifting competence in a professional context (SP competence), metacognitive awareness of shifting in a professional context (SP awareness), shifting competence in an everyday context (SE competence) and metacognitive awareness of shifting in an everyday context (SE awareness). The internal consistency of each scale was assessed using Cronbach's coefficient alpha (1951). The results revealed a good level of internal consistency for shifting competence in a professional context ($\alpha = .80$). They also revealed acceptable levels of internal consistency for shifting competence in an everyday context ($\alpha = .78$), metacognitive awareness of shifting in a professional context ($\alpha = .73$) and metacognitive awareness of shifting in an everyday context ($\alpha = .74$) (George & Mallery, 2001). Scores from items making up each of the four scales were summed and used as four separate measures of mode shifting in subsequent analyses.

The inter-correlations between scores on the four different scales are shown in table 5. The presence of inter-correlations between the four different scales suggests that they capture some shared variance in mode shifting. Based on our conceptual framework of mode shifting it was expected that shifting competence would be correlated with metacognitive awareness of shifting. The reason for this is that the MSI requires one to report how effective one is at shifting, knowledge of which is only available through self-awareness of how well one's shifting process is operating. Scores on metacognitive awareness of shifting and shifting competence were indeed correlated within both everyday (SE awareness & SE competence) and professional contexts (SP awareness & SP

competence). The correlations for the same components across contexts (SP awareness & SE awareness; SP competence & SE competence) are also higher than the correlations between different components, which makes sense. The lowest correlations are evidenced when you fully cross components with contexts (SP awareness & SE competence; SP competence & SE awareness). This pattern of correlations makes good sense and provides further evidence that the components captured by the MSI are sound. The correlations between SP awareness and SP competence ($r = .49$) and SE awareness and SE competence ($r = .47$) are only moderate in size. Therefore the scales measuring metacognitive awareness of shifting and shifting competence are still capturing a large portion of unique variance, supporting our decision to distinguish between the different facets of shifting.

Table 5. Showing inter-correlations between scores across the four MSI components ($N = 332$).

	$r(c \& d) = .47^{**}$	
	c. SE awareness	d. SE competence
a. SP awareness	.60 ^{**}	.34 [*]
b. SP competence	.38 ^{**}	.58 ^{**}
$r(a \& b) = .49^{**}$		

Note.

Pearson's correlation coefficients are displayed for all correlations. $r(a \& b)$ is the correlation coefficient between the scales labelled a & b. $r(c \& d)$ is the correlation coefficient between the scales labelled c & d.

^{**} $p < .01$

In summary, the principal components analyses provided evidence that the MSI captures the components of mode shifting predicted within our conceptual framework. Metacognitive awareness of shifting & shifting competence emerged as separable components. These same components emerged when items were

administered in everyday and professional contexts, evidence to support the requirement that the MSI captures the same components of mode shifting across everyday and professional contexts. The MSI also demonstrated good psychometric properties.

3.2. Assessing the validity of the MSI scales: do they capture expected differences in mode shifting?

Scores on the four MSI scales were compared across the three groups: architecture, medicine and other disciplines. Group differences on metacognitive awareness of shifting and shifting competence were examined within everyday and professional contexts separately.

3.2.1 Examining differences in metacognitive awareness of shifting as a function of group and context in which shifting occurs.

A mixed ANOVA (Group (3) –architecture, medicine, other disciplines) was run on metacognitive awareness of shifting scores obtained with respect to the two different contexts (Context (2)- everyday, professional). This revealed a significant main effect of group ($F(2, 329) = 10.34$, $p < .001$, $\eta_p^2 = .06$) and context of shifting ($F(1, 329) = 4.19$, $p = .04$, $\eta_p^2 = .01$). It also revealed a significant interaction between group and context of shifting ($F(2, 336) = 16.29$, $p < .001$, $\eta_p^2 = .09$). This interaction, displayed in figure 2 shows a clear between-group difference in metacognitive awareness of shifting in the professional context but no real difference within the everyday context. These effects were explored further through contrast analyses.

Figure 2. Interaction between professional discipline (architecture, medicine, other disciplines) and context (Everyday and Professional) on mean metacognitive awareness of shifting scores. Error bars represent 95% confidence intervals.

Contrast analyses were performed with the critical value of $p < .05$ Bonferroni-corrected to adjust for conducting 7 contrasts ($p < .05 / 7 \approx p < .007$). Analyses revealed that metacognitive awareness of shifting in the professional context was higher within the architecture group ($M = 28.22$, $SE = .32$) compared to the other disciplines ($M = 25.66$, $SE = .36$, $p < .001$) and medicine groups ($M = 24.36$, $SE = .52$, $p < .001$). Metacognitive awareness of shifting in the everyday context did not significantly differ between architecture ($M = 27.04$, $SE = .33$) and other disciplines groups ($M = 26.25$, $SE = .38$, $p = .12$) or between architecture and medicine groups ($M = 26.40$, $SE = .53$, $p = .35$).

Further, within the architecture group, metacognitive awareness of shifting was significantly higher in the professional context ($M = 28.22$, $SE = .32$) than within

the everyday context ($M = 27.04$, $SE = .33$, $p < .001$). In contrast, within the medicine group, metacognitive awareness of shifting was significantly higher in the everyday context ($M = 26.40$, $SE = .53$) than within the professional context ($M = 24.36$, $SE = .52$, $p < .001$). Within the other disciplines group, metacognitive awareness of shifting was not significantly different in the professional ($M = 25.66$, $SE = .53$) compared to the everyday context ($M = 26.25$, $SE = .38$, $p = .06$).

When the above comparisons were restricted to only include the practicing professionals in each of the three groups a very similar pattern of differences between the means for metacognitive awareness of shifting were found as those reported above when analyses were run on the full sample with the architects showing greater shifting awareness than the other groups. The only difference was that the practising architects showed as much metacognitive awareness of shifting in the everyday as in the professional context. However, the much smaller sample size and reduced statistical power meant that the analyses failed to reach statistical significance (see supplementary material, figure 4 for more details).

3.2.2. Examining differences in shifting competence as a function of group and context in which shifting occurs.

A mixed ANOVA (Group (3) –architecture, medicine, other disciplines) was run on scores on the shifting competence scales in the two different contexts (Context (2)- everyday, professional). This revealed non-significant main effects of group ($F(2, 329) = 2.40$, $p = .09$, $\eta_p^2 = .01$) and context of shifting ($F(1, 329) =$

.10, $p = .75$, $\eta_p^2 = .00$). It did however reveal a significant interaction between group and context of shifting ($F(1, 329) = 6.35$, $p = .002$, $\eta_p^2 = .04$). This interaction, displayed in figure 3 suggests there are some between-group differences in shifting competence between the architecture group and the other disciplines and medicine groups, but these differences vary across contexts. These effects were explored further through contrast analyses.

Figure 3. Interaction between professional discipline (architecture, medicine, other disciplines) and shifting context (Everyday and Professional) on mean scores of shifting competence. Error bars represent 95% confidence intervals.

Contrast analyses with a Bonferroni corrected significant $p < .007$ revealed that shifting competence in a professional context was higher in the architecture group ($M = 16.24$, $SE = .20$) in comparison to the other disciplines group ($M = 15.36$, $SE = .23$, $p = .004$). However, shifting competence in a professional

context within the medicine group ($M = 16.21$, $SE = .33$) did not differ significantly from that reported by the architecture group ($p = .94$). Shifting competence in the everyday context did not significantly differ between architecture ($M = 16.18$, $SE = .19$) and other disciplines groups ($M = 15.95$, $SE = .21$, $p = .41$) or between architecture and medicine groups ($M = 15.55$, $SE = .33$, $p = .12$).

Further, within the other disciplines group, shifting competence was significantly higher in the everyday ($M = 15.95$, $SE = .21$) compared to the professional context ($M = 15.36$, $SE = .23$, $p = .002$). Within the architecture group, shifting competence did not differ significantly between the professional ($M = 16.24$, $SE = .20$) and everyday context ($M = 16.18$, $SE = .19$, $p = .74$). Within the medicine group, there were also no significant differences in shifting competence between the professional ($M = 16.21$, $SE = .33$) and everyday context ($M = 15.55$, $SE = .33$, $p = .03$).

When the above comparisons were restricted to only include the practicing professionals in each of the three groups a similar pattern of differences between the means for shifting competence were found as those reported above when analyses were run on the full sample (see supplementary material, figure 5 for more details). It should be noted that again, probably due to the much reduced sample size, analyses failed to reach statistical significance.

4. Discussion

4.1. Psychometric properties and validity of the Mode shifting Index (MSI)

The novel self-report measure of mode shifting, the MSI, developed in the current paper, demonstrated both strong psychometric properties and validity as a measure of mode shifting. Two components of mode shifting emerged that mapped on to those hypothesized in our conceptual framework. These same two components, metacognitive awareness and shifting competence, emerged for responses to MSI items in both everyday and professional contexts. Each component demonstrated internal consistency and the patterns of correlations between scores on different components obtained across contexts made conceptual sense.

Evidence demonstrated the validity of MSI metacognitive awareness as a measure of mode shifting. Specifically, a group of architects and architecture students reported increased metacognitive awareness of shifting in the professional context compared to a group consisting of non-design professionals and university students and another group consisting of physicians and medical students. Further, whereas the architects showed greater awareness of mode shifting in a professional compared to an everyday context the medicine group showed the opposite pattern. The finding that medicine and architecture groups, who are an approximate match on intellectual ability and length of training, differ on metacognitive awareness of shifting in a professional context is

preliminary evidence for the discriminant validity of this MSI component from intellectual ability. It is important to note that there were no significant between-group differences in metacognitive awareness of shifting reported within the everyday context.

There was partial evidence to support the validity of MSI shifting competence as a measure of mode shifting. The group of architects did report increased shifting competence in the professional context compared to a group consisting of non-architectural professionals and non-architectural university students. However, shifting competence in the professional context did not differ between the group of architects and the group consisting of physicians and medical students. There were no significant between-group differences in shifting competence reported within the everyday context.

4.2. What do findings reveal about the nature of mode shifting and its assessment using the MSI?

The analyses of group differences on the MSI raise two key issues important for our understanding of mode shifting. Firstly, group differences in metacognitive awareness of shifting and shifting competence were only observed within the professional context. This was a robust finding and suggests that mode shifting could be a learned skill: a “way of operating” that can be selectively increased within a context in which it is particularly useful to shift. In the present paper, this useful context was the architect group’s professional context in which they work or study. The case has previously been made by Kaufman & Beghetto

(2013) that it may be useful to express one's creativity in certain contexts but refrain from expressing it in others where conformity is more useful, and indeed knowing when to and when not to express one's creativity may be a learned metacognitive skill. Our findings, support Kaufman & Beghetto's (2013) claim. It makes sense that within a creative domain like architecture increased awareness of mode shifting would be beneficial but within everyday life there is less obvious benefit for architects in expressing a high awareness of mode shifting.

Importantly, our findings also have a bearing on the debate concerning whether mode shifting is triggered by bottom-up processes or whether it is applied voluntarily in a top-down fashion (Vartanian, Martindale & Matthew's, 2009). There is evidence that strategy shifts on simple cognitive tasks are mediated by voluntary processes (Haider, Frensch and Joram, 2005). The present findings demonstrating that a self-report measure like the MSI is sensitive to predicted group differences in mode shifting does indeed suggest conscious awareness of shifting. Further, findings showing that architects reported increased awareness of mode shifting within their professional versus their everyday context suggests that at least some aspects of shifting can be selectively and consciously deployed.

The possibility that mode shifting may be a learned skill has previously been proposed (Howard-Jones, 2002). The MSI seems ideally suited to use in future research examining this possibility. From a practical point of view, Howard-Jones (2002) suggests that teaching strategies could be designed giving students practice at shifting between the different modes of thought so that they can learn

how to freely shift. The MSI also seems ideally suited to the purpose of providing a quick and easy assessment of such teaching strategies.

The second key issue, important for our understanding of mode shifting, concerns the difference between metacognitive awareness of shifting and shifting competence. While the architecture group reported both higher metacognitive awareness of shifting and shifting competence in the professional context compared to control groups the pattern of between-group differences for metacognitive awareness of shifting was much clearer than for shifting competence. It makes sense that an individual would be better able to self-report their awareness of shifting on the MSI than their competence performing shifts. The failure to reveal the same extent of effects for competence as metacognitive awareness of shifting may therefore be due to the MSI providing a weaker 'signal' for shifting competence. Further work is necessary to demonstrate whether the MSI can distinguish between a focal 'creative' group from a recognized area of creative endeavour and control groups in terms of shifting competence.

4.3. Limitations

The positive findings discussed must be considered in light of several limitations. Firstly, only a relatively small number of participants in each of the three experimental groups were practicing professionals in their field. The large majority of participants in each group were university students. It should be noted that the pattern of means found for the analyses performed on the full

sample were very similar to those found when we restricted the sample to only include practicing professionals in each group. However, analyses conducted on the restricted sample of practicing professionals were underpowered and further work with larger numbers of practicing professionals in a recognised domain of creative endeavour compared to control groups is needed to establish the validity of the MSI across a broader demographic.

The self-report nature of the MSI, while an advantage for gaining a quick measure of mode shifting, is also a limitation. As noted in the conceptual framework, self-reported mode shifting is dependent on one's ability to retrospectively self-reflect on one's mode shifting in everyday and professional contexts. There may exist individual differences in one's ability to successfully do this. Further, perceptions of one's mode shifting may be different from actual mode shifting in practice (see Kaufman (2012) for a related view with regard to self-report measures of creativity). Clearly, significant further validation is required to examine if those scoring higher on MSI metacognitive awareness of shifting and shifting competence score higher on objective measures of mode shifting.

The findings in the present study are based on correlations. Further work is needed to tease apart whether those in an area of creative endeavour (e.g. architects) develop their skill in mode shifting as a result of their training or whether people choose to study and work in an area of creative endeavour because of their existing shifting ability.

Finally, we did not control for differences between the architecture, medicine and other disciplines groups on factors related to creativity like fluid intelligence (Nusbaum and Silvia, 2011) and personality (Furnham and Bachtiar, 2008). We only controlled for intelligence in an approximate way with the inclusion of the medicine control group. Future work should examine if the between group differences in mode shifting found in the present study are independent of differences on these other factors.

5. Conclusion

The aim of the present paper was to develop a novel self-report measure of the crucial creative thinking skill of shifting between associative and analytic thinking processes. The resulting measure, the Mode Shifting Index (MSI), was found to have good psychometric properties and revealed the novel finding that mode shifting consisted of two different components; metacognitive awareness of shifting and shifting competence. Furthermore, the metacognitive awareness of shifting component demonstrated validity, capturing the increase in awareness of mode shifting expected of a group from a recognized area of creative endeavour requiring design skills compared to two non-design groups, from medicine and other disciplines. Evidence for the validity of the shifting competence component was weaker. Architects also reported increased awareness of mode shifting within a professional compared to an everyday context. Together, these findings suggest that awareness of shifting could be a learned skill: a “way of operating” that can be selectively increased within a context in which it is particularly useful to shift. Findings demonstrate the MSI

to be a promising tool for both furthering our understanding of the role of mode shifting in creativity and as a quick, effective self-report measure for assessing mode shifting in practice.

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