

Affective underpinnings of surface approaches to learning and their relationship with sensation seeking

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Surface approaches to learning materials and tasks are a commonplace challenge to teachers, and they prove difficult to shift, even among students who are otherwise talented or motivated to learn. The present study investigates a theory that surface approaches are triggered by a suboptimal, aversive response to learning stimuli, which overrides external motivations and provokes avoidance responses akin to the drive for intensity and novelty of experience found among sensation seekers. The study finds a significant correlation between surface tendencies measured on a new scale and sensation seeking tendencies measured on the Arnett Inventory of Sensation Seeking (AISS).

Introduction

Tertiary study makes frequent calls on our capacity to reflect. Reading a textbook, for example, is ineffective unless accompanied by reflection on the content. Learning tasks are generally unproductive unless they trigger some form of generative thinking, and assessments are not indicative of learning achievement unless they genuinely assess the thoughtful application of principles to novel situations. In the Internet age more than ever, knowledge is cheap, but the ability to process that knowledge to achieve positive outcomes is still precious – and sought after by employers (see, for example, Eckhardt & Wetherbe, 2014; Lau & Lim, 2015; Lee & Choi, 2017).

The following research arose out of pedagogical concerns at a major regional university which promotes an ‘inclusive’ approach to tertiary education through its ‘open-door’ policy for students of variable educational backgrounds. High entry requirements are not a feature of such a policy, and the student cohort comprises a large number of students with only a modest history of academic achievement. We found that these students often displayed very pronounced surface approaches to learning. Even ‘good’ students would express a strong desire for tutorial questions to be supplied with written answers so that they could replicate answers, rather than construct cognitive schemata of general application (which would be the outcome if the questions and answers were appropriately used as worked examples). In assessments, they would match the question to a template based on similarity of surface facts, rather than relevant principles, often leading to seriously misconceived answers. If required to present an argument, they would either copy an argument from a known ‘correct’ answer to a different question, or search the Internet for a similar question (usually based on surface similarity only), and replicate someone else’s argument. When confronted with a new concept or a verbal reasoning process and slowly stepped through the conceptual structure or argument, they exhibit a low ‘give-up’ threshold, occasionally even saying things like, ‘my brain hurts’. Although the bulk of the students were international, such approaches to learning were by no means scarce amongst domestic students.

Despite extensive research, the prototypical characteristics of reflective processing are by no means set in stone. In 1996, Epstein, Pacini, Denes-Raj and Heirer (1996, p.390) cited 19 different terms to characterise this dimension of thinking, each of which emphasised different aspects of cognitive processing. Perhaps the most frequently cited attributes of reflective processing are its effortful, systematic nature, while non-reflective processing is characterised by effortless, heuristic automaticity. In teaching contexts, the distinction is often expressed in terms of deep and surface processing (Marton & Saljo, 1997; Prosser & Trigwell, 1999). Although the deployment of reflective processing is seen as an innate tendency (Komarraju, Karau, Schmeck & Avdic, 2011; Kozhevnikov, Evans & Kosslyn, 2014; van Seggelen-Damen, 2013), it is known to be sensitive to various moderating variables, such as the types of stimuli (Kuhn, Katz & Dean, 2004), cognitive abilities (Livengood, Sytsma, Feltz, Scheines & Machery, 2010), personal interests and motivation (Bruno, Galuppo & Gilardi, 2011; Steinhart & Wyer, 2009), and self-knowledge and self-reflection (Johnson et al., 2002; Silvia & Philips, 2011).

Explanations of this phenomenon based on motivation, linguistic issues or cognitive load were not supported by our pedagogical experience. Carefully researched graphical materials introduced to alleviate load and linguistic concerns were largely ignored, because graphics do not provide answers that can be copied. Students would often adopt quite effortful surface approaches to assessment tasks rather than a simple application of known principles, even when they had previously exhibited some understanding of those principles. In situations where the students themselves approached the tutor for assistance (and therefore were motivated to learn), they would balk at any response that involved conceptualisation rather than rote verbal formulation. Our experience mirrors that of Baron (2010):

[D]espite the creation of contexts that should facilitate deep learning, a number of students persist in taking a surface approach. In fact, some students will actively resist attempts to encourage them to adopt deep learning. This problem seems to run counter to the orthodox theories of deep and surface approaches to learning (p.125).

The ‘orthodox theories’ that Baron referred to cast surface and deep learning as ‘approaches to learning’, actively selected by students and often based on different types of motivation. See for example, the *Student Approaches to Learning* (SAL) theory of Marton and Saljo (1976); the *Study Process Questionnaire* of Biggs, Kember and Leung (2001); Kozhevnikov et al. (2014); and Beyaztas and Senemoglu (2015). Surface learning is there regarded as an approach whereby students choose to do the minimum that has to be done in order to pass the course and therefore respond to learning materials with strategies such as selective and rote learning (Biggs et al., 2001, p.135). The orthodox theories suggest that the approach selected by students can be manipulated by teaching methods that focus on motivation and engagement. This concept of ‘approaches to learning’ fails to account for the resistance described by Baron (2010) and experienced by colleagues and myself. By way of contrast, Pashler, McDaniel, Rohrer and Bjork (2008) and Kozhevnikov et al. (2014) found little empirical support for the theory of matching the teaching method to the particular learning or cognitive style of the students.

Our pedagogical experience led us to question the conceptualisation of ‘effort’ in the context of reflective learning. What we were addressing was not simply a resistance to effort, an attitude which might be regarded as mental laziness, but an automatic, aversive reaction to deep processing that manifests itself even when the student is motivated and diligent to succeed or seek help. Although the term ‘effort’ is routinely appended to the various definitions and descriptions of reflective or deep processing, the nature of that ‘effort’ has rarely been elaborated. In our experience, an aversive metaphor like ‘stress’ would be closer to the mark. In students who experience this aversive response to learning materials and tasks, knowledge is often seen as a combination of features immediately apparent on the surface, and learning as a replication of that. Frequently the learning strategies of such students involve as much as or more effort than deeper approaches, but the cognitive component of that labour is less reflective. We will refer to this as surface responding, to distinguish it from the multitude of surface approaches current in the educational literature. We would define surface responding as an automatic response to novel material in which the responder constructs meaning predominantly through surface features, rather than through exploration, elaboration or reflection. It is no doubt related to cognitive styles based on reflective personality and motivations like the need for cognition (van Seggelen-Damen, 2013), but by defining our own construct more specifically we aim to focus on a much narrower target – the immediate, possibly innate, automatic response.

Our own observations suggest that surface responding is not consciously selected by the student, but is an automatic reaction governed by the nature of the stimulation generated by learning material or tasks, which is at least not positive, and may be aversive. We theorised that this tendency is not limited to academic materials, but extends to any stimulus that affords the option of internal reflection (‘reflective materials’). Surface responders gain no positive stimulation from elaborative processing of reflective materials, and may experience an aversive (i.e. unpleasantly effortful or stressful) response which blocks any potential, favourable effect of external motivations or teaching practices.

Consistent with these tentative theories, we predicted that people who derive no positive, internal stimulation from novel material will tend to seek positive stimulation from other external sources. This links to theories in the field of sensation seeking which suggest that people seek through their behaviours to achieve an optimal level of arousal or stimulation (Arnett, 1994; Zuckerman, 1979, 2014). Zuckerman’s original conception of sensation seeking, perpetuated in his popular *Sensation Seeking Scale* (SSS-V), was described as “a trait defined by the seeking of varied, novel, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experiences” (Zuckerman, 1994, p.27). As such, it incorporated a non-normative behavioural connotation, reflected in two of the sub-scales of SSS-V – Thrill-Seeking and Disinhibition. In recent years, researchers on sensation seeking have sought to isolate measures of sensation seeking from its more delinquent, risk-taking behavioural manifestations, since these may depend on social or environmental factors rather than personality *per se*. Arnett’s standard inventory of sensation seeking (AISS) measures two factors seen as instrumental in sensation seeking – the tendency for novelty and the tendency for intensity of stimulation (Arnett, 1994). It does not model sensation seeking

as necessarily involving delinquent or non-normative behaviours, but nevertheless has been found to predict such behaviours (Arnett, 1994). Jackson goes further by, in our view, changing the conception of sensation seeking into an entirely different construct involving curiosity about the world and a drive for exploration of the environment (Jackson, Baguma & Furnham, 2009). Unsurprisingly, this new conceptualisation of sensation seeking, measured by Jackson's *Learning Styles Profiler*, is only moderately associated with Zuckerman's construct (Jackson, 2011), but in certain circumstances may be associated with favourable educational outcomes (Jackson, Baguma, et al., 2009; Jackson, Hobman, Jimmieson & Martin, 2009).

The preceding theorising led to an initial research question:

1. Do people who engage in surface responding experience a sub-optimal response to the current stimulus which leads to them seeking heightened stimulation from other sources?

To pursue this question, we hypothesised that people who tend to surface responding also have a tendency for sensation seeking as conceptualised by Arnett, which does not presuppose either risk-taking behaviours (as posited by Zuckerman) or curious, exploratory behaviours (as posited by Jackson). However, surface responding and Arnett's conceptualisation of sensation seeking are clearly not identical constructs. Surface responding refers to a relatively immediate mental state triggered by a stimulus, whereas the AISS is focused on physical behaviours, or at least extreme emotional states, such as those experienced in combat or when witnessing a car accident.

Consistent with the behavioural focus of sensation seeking, it has been found to negatively correlate with age (Arnett, 1994; Desrichard et al., 2008). As people grow older, their inclination towards sensation wanes. However, we theorised that surface tendencies do not, leading to the further research question:

2. Is surface responding a relatively stable tendency unaffected by age?

This led to the further hypothesis that, despite the hypothesised relationship between surface responding and sensation seeking, there is no significant relationship between the tendency to surface responding and age. In the following study, these hypotheses were tested.

Method

Participants

Seventy-seven international accounting students originally accepted the invitation by their lecturer to participate in a study designed to assess personality types associated with learning difficulties in their accounting degree. No incentives were offered. Fifteen students were subsequently excluded from the comparative analyses due to having missing values on some items. Inspection of age statistics showed that one student was an outlier,

aged 55 years when all other students were 37 years or younger. Initial analyses showed that that student's responses had a disproportionate effect on analyses involving age, so her responses were also excluded from subsequent analyses. This left 61 participants (mean age 26.4 years, range 21 to 37 years, 21 males and 40 females, 9 undergraduates and 52 postgraduates). For all but one of the students, English was not their first language, but all students had to satisfy English competency requirements for enrolling in a tertiary accountancy course.

Participants were categorised ethno-culturally, based on home country. The vast majority of the participants came from either East Asia (primarily China, but including Thailand, Vietnam and Nepal) or the Subcontinent (primarily India, but including Pakistan, Bangladesh and Sri Lanka). The composition of the participants by ethno-cultural background, gender and graduate level is shown in Table 1.

Table 1: Groupings of participants

	Male	Female	UG	PG	Total
East Asian	8	23	5	26	31
Subcontinental	11	10	3	18	21
Latin American	1	5	1	5	6
Russian	0	1	0	1	1
African	1	1	0	2	2
Total	21	40	9	52	61

Materials

The Surface Responding (SR) Inventory

An initial battery of 17 items was devised to assess participants' surface versus reflective cognitive response to novel material. Items included both educational scenarios (e.g. 'If I read a textbook and it is difficult to understand, I find it stressful and want to stop.') and general contexts (e.g. 'I find that I can get a pretty good idea of someone's personality within a few minutes of meeting them.'). Peer review led to two items being dropped, leaving the 15-item scale shown in Appendix A.

Arnett's Inventory of Sensation Seeking

Arnett's original sensation seeking inventory (AISS) included 20 questions, but several of those appeared to lack face validity for participants drawn from Asian cultures who have chosen to come to a Western country to study. For example, the item, 'I don't like extremely hot and spicy foods', is unlikely to tap into sensation seeking tendencies among people from the Subcontinent or areas of East Asia where spicy foods are the cultural norm. Also, the item, 'I can see how it would be interesting to marry someone from a foreign country', is unlikely to have its intended import to students who have already decided to study and work in a foreign country. Other items were omitted because they tapped into activities (like swimming and public speaking), which might have cultural or

gender-specific biases in Asian countries. This reduced the inventory to 15 items shown in Appendix B (the SS Inventory).

Format

The materials presented to the students consisted of a covering 'Information Sheet', which included the consent form, and an attached sheet headed 'Questionnaire' with the SR Inventory on the front and the SS Inventory on the back. The form asked participants, 'Which of these statements best applies to you?' The AISS normally uses answer options that include 'somewhat', a term which we felt could raise subtle linguistic issues, so we switched to the more familiar survey options, 'Strongly agree', 'Agree', 'Disagree' and 'Strongly disagree', for both inventories. Although Zuckerman's sensation seeking inventory has been criticised for employing 'forced-answer' formats, we felt that the benign, everyday nature of the items in both inventories used in this study did not warrant a more neutral option.

Procedure

Students attending different classes on particular days were asked by their lecturer to participate in a study designed to assess personality types associated with learning difficulties in their accounting degree. Students were told both orally and in the consent form that their participation was optional, and that they could simply decline to participate by drawing a line through the form, or by declining to answer particular questions. The questionnaire was then distributed to students and they were asked not to talk to each other about the questionnaire until they had completed their answers. This was monitored and enforced by the lecturer. Students were allowed as much time as they required to finish, and most were finished within 20 minutes.

Items were scored on a scale of 0-3 reflecting the range of four possible responses. Reverse-scored items are identified in the appendices. The overall score on a scale or subscale was averaged to a zero-based score out of 3 to allow easy cross-comparisons. A score of 1.5 on a scale would therefore indicate no tendency either way.

Results

Performance of the Sensation Seeking (SS) Inventory and subscales

Internal consistency of the 15-item SS inventory was assessed using Cronbach's alpha at .60, which is lower than the range of .83 to .86 reported by Arnett (1994) for the 20-item AISS, but close to the .61 reported by Roth (2003) after deleting three items to improve consistency, and the .62 and .71 for two samples reported by Desrichard, Vos, Bouvard, Dantzer and Paignon (2008) for a French version of the scale.

Independent samples *t*-tests (two-tailed) were conducted to compare males and females on the SS Inventory, showing a significant difference: $t(59) = 2.19$, $p = .032$. Consistent

with Arnett (1994) and Desrichard et al. (2008), males were found to be significantly more inclined to sensation seeking than females.

Performance of the Surface Responding (SR) Inventory

To test the internal consistency of this new scale, Cronbach's alpha was initially assessed in conjunction with inter-item correlations. This analysis suggested that four items should be excluded to enhance reliability – items 5, 10, 14 and 15. The composition of the SR Inventory was therefore settled on items 1-4, 6-9 and 11-13. This produced an 11-item inventory (set out in Appendix C) with reliability of .61, which was used in later analyses. Pearson's correlation between the educational items on the scale (items 1-4 and 6-9) and general items (items 11-13), treating each as subscales, was significant at $r(59) = .429$, $p < .001$. This was consistent with the theory that surface responding tendencies do generalise to non-educational contexts. Two-tailed t -tests showed no significant difference between males and females on the full scale, or on its educational and general components.

The relationship between surface responding and sensation seeking

The relationship between surface responding and sensation seeking was assessed by Pearson's correlation coefficient. A significant correlation was found between surface responding and sensation seeking, $r(59) = .307$, $p = .016$. The hypothesis that people who tend towards surface responding also tend towards sensation seeking was therefore supported.

Independent measures t -tests revealed no significant differences between undergraduates and postgraduates on either of the scales, nor were there any ethno-cultural effects. Consistent with previous research (Arnett, 1994; Desrichard et al., 2008), Pearson's correlation revealed a small to moderate negative correlation between age and sensation seeking, but in the present study it was not statistically significant: $r(59) = -.243$, $p = .059$. There was no significant correlation between age and surface responding.

Since sensation seeking may be influenced by both age and gender, and our sample was imbalanced with respect to gender, we explored the independent effects of these variables and surface responding on sensation seeking behaviours through regression analysis. The overall regression model was a significant predictor of sensation seeking, accounting for 17.7% of the variance with a moderate to large effect ($R^2 = .177$, adjusted $R^2 = .134$, $F(3, 57) = 4.09$, $p = .011$). Of the predictors, only surface responding achieved statistical significance (surface responding: $B = .266$, 95% CI [.024, .508], $\beta = .268$, $p = .032$; age: $B = -.013$, 95% CI [-.037, .010], $\beta = -.140$, $p = .270$; gender: $B = -.159$, 95% CI [-.339, .020], $\beta = -.221$, $p = .081$).

Discussion

The present study sought to explore the theory that surface approaches to learning are based on an automatic aversive response to stimuli which could also trigger more extreme

sensation seeking behaviours. As such, it would fall within the affective domain of Bloom's taxonomy, but its immediacy and automaticity distinguishes it from emotional or motivational responses that develop more slowly through conscious cognition. In fact, we would argue that the immediate affective response guides the cognitive response by prompting schemata for either deep or surface processing, or a behavioural response of complete avoidance. The hypothesised association between surface responding, framed as an automatic affective response to stimuli, and sensation seeking, conceived as a need for novelty and intensity of stimulation, was supported. The conceptualisation of surface responding as a more general, stable personality characteristic than sensation seeking was supported by the findings of a highly significant correlation between educational and general items in the SR Inventory, and by the absence of age and gender effects on surface responding. However, while age and gender effects have been reported for sensation seeking, in the present study, the small to moderate age effect on sensation seeking fell short of statistical significance.

From an educational viewpoint, this suggests that, for students who experience a suboptimal affective response to reflective materials, changes to the teaching methods aimed at altering that affective response are more likely to be successful than strategies that focus on promoting engagement or reorienting motivation. This is consistent with theories of specific inhibition of deeper processing developed by Klein (1948) and espoused by Baron (2010). The idea that the affective response to learning materials can and should be manipulated is also part of the cognitive-affective theory of learning propounded by Moreno and Mayer (Moreno, 2005, 2010; Moreno & Mayer, 2007).

Conclusion

When researching cognitive and learning styles, the multiplicity of definitions and constructs can become overwhelming (see Kozhevnikov et al., 2014 for a proposed synthesis). One reason for the problem is that the constructs are too loosely conceived and defined (Armstrong, Peterson & Rayner, 2012). Surface learning is often defined as a conscious strategy or approach to learning adopted in response to pedagogical manipulations. The reflective personality trait is closer to our conception of deep responding, but again it has a strategic connotation. It has been defined as "the active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusion to which it tends" (Dewey, 1933; van Seggelen-Damen, 2013). As such, it can explain learning preferences, but cannot explain the failure to engage in such behaviour when guided by the teachers to do so, or when undertaking a learning task in which reflection is implicit – for example, reading a textbook.

Pennycook and colleagues have investigated "the propensity to engage in analytic or deliberative reasoning in lieu of gut feelings or intuitions", as measured by the cognitive reflection test (CRT), which poses puzzle-like problems affording intuitive but wrong answers (Bialek & Pennycook, 2017). That construct may well be closely related to surface tendency, but the measurement instrument is very particular, involving unnatural 'trick'

questions requiring some degree of numeracy to answer, such that only 30% of university students might choose the correct, but non-intuitive answer (Bialek & Pennycook, 2017, p.3). Need for cognition, another related concept, is seen as a motivational tendency related to effort – a “stable individual difference in people’s tendency to engage in and enjoy effortful cognitive activity” (Cacioppo, Petty, Feinstein & Jarvis, 1996; van Seggelen-Damen, 2013; Cazan & Indreica, 2014). Although this definition includes an affective component, rather loosely depicted as enjoyment, by focusing only on positive affect the construct fails to account for the very real problem experienced in teaching when students resist deeper processing despite a clear motivation to do so.

The non-reflective response could also be seen as a resistance to any substantial engagement of working memory. The traditional view of working memory is that it embodies effortful, systematic processes, while processing in long term memory is based on automatic, effortless heuristics. However, this simplified picture has come under challenge in a number of ways. Baddeley’s original construct of an executive module controlling working memory processes has found little experimental support, and Baddeley himself seemed to retreat from that proposition, treating the executive merely as a theoretical placeholder or point of departure for psychological theorising about a phenomenon of which we have little understanding (Baddeley, 1996, 2003). An early approach to understanding the executive control of conscious thought was to ‘fractionate’ its components for separate investigation. Some discrete mechanisms that constrain processing have been isolated, like attention, task-switching and inhibition of habitual responses (Friedman & Miyake, 2004), but none of these control the style of subsequent processing, the reasoning process itself or the nature of any knowledge or learning thereby constructed. Higher level reasoning and learning appear to depend on procedural schemata activated in long term memory by stimulus control (Repovs & Baddeley, 2006). What is lacking is an understanding of what drives the system, and Baddeley approved the suggestion of Domasio (1994), Hume (1772/1993) and Lewin (1951) of conceptualising action as ultimately steered by emotion (Baddeley, 2003, p.837). According to that view, conscious cognitive processing is mediated by an affective response to the stimulus, which cues schemata either for surface or deep processing.

Limitations and implications for future research

For the purpose of this study, a new scale of surface responding was developed, which performed acceptably for an exploratory study, but would benefit from enhancement for diagnostic use. There are inherent difficulties in developing such scales because it is problematic to separate the affective reaction from the behavioural consequences, although (as in this study) the affective response may predict behaviour. The SR Inventory was designed to detect either the instantaneous affective reaction or the immediate, automatic behaviour or impressions generated by it. The idea was to test low-level reactions rather than consciously selected behaviours which may be influenced by a range of confounding variables. Future research could seek to discriminate between affective and behavioural components more precisely, and between more specific types of cognition (e.g. social cognitions, perceptions, reading, puzzle-solving, verbal reasoning,

etc.) to see whether surface responding is generalised across cognitive domains as well as the general non-educational contexts that were tentatively addressed in the present study. Different types of behavioural response should also be explored, especially since sensation seeking itself is a multifaceted construct that has attracted its own definitional controversies (see Zuckerman, 2014).

Although the SR Inventory did include some questions of a general, non-educational kind, most of the items were related to educational contexts, which were authentic for the student cohort from which the sample was drawn, but perhaps not for the general population. If future research supported the theory of lack of domain-specificity, it would raise the possibility of a more generalised test, suitable (for example) for mature-age students with no recent experience in the education system. Given the high attrition rates in tertiary education, such a test might provide a useful early warning of likely drop-out.

Limitations of the sample also offer scope for future exploration. The participants were international tertiary students almost exclusively from non-Western cultures having a maximum age of 37 years. While no ethno-cultural effects were found within the sample, such findings cannot automatically be generalised to Western cultures. The age limitation may also have masked any age effects present in more mature adults.

The affective response is theorised to be primarily unconscious, and therefore typically unreportable by the student, but the anecdotal evidence prompting the study (e.g. 'my brain hurts') suggests that the affective response may sometimes intrude into consciousness and be detectable by qualitative methods. It may be possible to incorporate questions into standard student evaluations of teaching to assess the students' affective reaction to learning materials and tasks. Taking this idea a step further, it may be possible to draw the affective response into consciousness and investigate it by interview methods similar to those developed for psychological therapy. Such methods may even be useful as an educational therapy for students suffering major mental barriers to learning in particular courses, since the goal of such therapies is to allow the individual to confront their psychological issues head on and resolve them through conscious rationalisation.

An important line of further enquiry is how the affective response is influenced by the type of content. Aversion to deeper processing is most obvious in students who have no innate talent for the particular domain under study. Students who struggle with a topic manifest clear stress as well as cognitive burden, and an early 'give-up' point. Talented students with no expertise in the domain show effort but not aversion. At the other extreme, students talented in the domain not only show a positive response, but apparently no effort, even though the particular material is also novel to them. This raises questions about whether the attribute of 'effort' or 'cognitive load' adequately addresses the affective response. The analogy with physical effort makes sense when one considers that lengthy and difficult processing can lead to both mental and physical tiredness. On the other hand, there is another dimension involving affect. Issues of cognitive load only arise if the student actually engages with the material or the task, whereas in many instances we find students giving up long before effort has a chance to kick in. In fact, we find students resisting deeper processing in favour of equally effortful alternatives.

Moreno (2010) also challenged the scientific validity of cognitive load theory on various grounds, partly because it presupposes that load is based on the processing *capacity* required, without regard to strategies that can enhance capacity by altering the affective response.

Regarding the affective response as immediate and automatic implies that it cannot be eliminated, at least not in the short term. For it to be alleviated, manipulations must occur at the stimulus and task level that reduce the aversion. Methods similar to aversion therapy may hold promise. Psychotherapists would seek to alleviate an automatic, aversive response by a controlled, graduated exposure to the aversive stimulus. The aversive response would not be avoided or side-stepped, but confronted in small, incremental doses. Pedagogy that introduces reflective thinking in graduated fashion would be consistent with this theory, and if practised, the aversive response could be expected to subside over time, in the same way that a phobic patient loses his or her fear of snakes through repeated, graduated exposure. Teaching strategies for engagement or external motivation at the course level will have no effect on the aversive response, although they may side-step it (at the cost of also side-stepping genuine transfer learning) or override it (at the cost of stress and anxiety). If the latter approach were adopted, one would expect substantial non-compliance and/or lack of enjoyment from learners with surface tendencies.

Further research might also investigate the effect of tertiary study itself, or particular types of tertiary study, on the tendency towards surface responding. Although the study suggests that surface tendencies are not significantly age-related, longitudinal studies of students progressing through their studies may identify natural, incremental improvements analogous to those targeted by the aversion therapies outlined in the previous paragraph.

The overarching conclusion is that academic learning may well require effort and stress, and pedagogy that avoids those experiences may also avoid learning. For the brain to grow the lasting connections that represent learning, it must be enlivened by thought processes, which, we would argue, inherently involve cognitive effort and stress. For that learning to be retained, it probably needs to be rehearsed repetitively, just as physical skills need to be practised, so the stress must be endured until the learning becomes embedded and automatic. It is only when it becomes automatic that the effort and stress is eliminated. Teaching methods that strive for student enjoyment and regard any student stress as a teaching failure miss that point.

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Appendix A: Surface Responding Inventory

Statement	Strongly agree	Agree	Disagree	Strongly disagree	Scoring
1 When I do practice questions, I prefer to have the answers in front of me.	A	B	C	D	<i>Normal</i>
2 Before attempting an assignment, I prefer to read all the relevant chapters in the textbook.	A	B	C	D	<i>Reverse</i>
3 I like problems where the correct answer is unclear and I have to think hard to discover it.	A	B	C	D	<i>Reverse</i>
4 I prefer multiple-choice questions to other exam formats.	A	B	C	D	<i>Normal</i>
5 I think the format of an answer is the most important factor in getting good marks.	A	B	C	D	<i>Normal</i>
6 When I successfully complete a course, I forget what I have learned very quickly.	A	B	C	D	<i>Normal</i>
7 I often find that I get the correct answer to a question without being able to explain why it is correct.	A	B	C	D	<i>Normal</i>
8 When teachers give me the answer to a problem, I find their reasons for the answer more useful than the answer itself.	A	B	C	D	<i>Reverse</i>
9 If I read the textbook and it is difficult to understand, I find it stressful and I want to stop.	A	B	C	D	<i>Normal</i>
10 I find that appearances are often deceptive.	A	B	C	D	<i>Reverse</i>
11 I prefer restaurants where the food is served very attractively on the plate.	A	B	C	D	<i>Normal</i>
12 I like jobs where I can do the work automatically without having to think about it.	A	B	C	D	<i>Normal</i>
13 I find that I can get a pretty good idea of someone's personality within a few minutes of meeting them.	A	B	C	D	<i>Normal</i>
14 When solving a problem, I become completely absorbed and forget the time.	A	B	C	D	<i>Reverse</i>
15 When something goes wrong at work, I think about it for a long time before deciding what to do.	A	B	C	D	<i>Reverse</i>

Normal scoring: A = 3, B = 2, C = 1, D = 0

Reverse scoring: A = 0, B = 1, C = 2, D = 3

Appendix B: Sensation Seeking Inventory

Statement	Strongly agree	Agree	Disagree	Strongly disagree	Scoring
16 If I have to wait in a long line, I'm usually patient about it.	A	B	C	D	<i>Reverse</i>
17 When I listen to music, I like it to be loud.	A	B	C	D	<i>Normal</i>
18 When taking a trip, I think it is best to make as few plans as possible and just take it as it comes.	A	B	C	D	<i>Normal</i>
19 I stay away from movies that are said to be frightening or highly suspenseful.	A	B	C	D	<i>Reverse</i>
20 If I were to go to an amusement park, I would prefer to ride the roller coaster or other fast rides.	A	B	C	D	<i>Normal</i>
21 If it were possible to visit another planet or the moon for free, I would be among the first in line to sign up.	A	B	C	D	<i>Normal</i>
22 I would never like to gamble with money, even if I could afford it.	A	B	C	D	<i>Reverse</i>
23 I would have enjoyed being one of the first explorers of an unknown land.	A	B	C	D	<i>Normal</i>
24 I like a movie where there are a lot of explosions and car chases.	A	B	C	D	<i>Normal</i>
25 In general, I work better when I'm under pressure.	A	B	C	D	<i>Normal</i>
26 I often like to have the radio or the TV on while I'm doing something else, such as reading or cleaning up.	A	B	C	D	<i>Normal</i>
27 It would be interesting to see a car accident happen.	A	B	C	D	<i>Normal</i>
28 I think it's best to order something familiar when eating in a restaurant.	A	B	C	D	<i>Reverse</i>
29 I like the feeling of standing next to the edge on a high place and looking down.	A	B	C	D	<i>Normal</i>
30 I can see how it must be exciting to be in a battle during a war.	A	B	C	D	<i>Normal</i>

Normal scoring: A = 3, B = 2, C = 1, D = 0

Reverse scoring: A = 0, B = 1, C = 2, D = 3

Appendix C: Surface Responding Inventory (Final)

	Statement	Strongly agree	Agree	Disagree	Strongly disagree	Scoring
1	When I do practice questions, I prefer to have the answers in front of me.	A	B	C	D	<i>Normal</i>
2	Before attempting an assignment, I prefer to read all the relevant chapters in the textbook.	A	B	C	D	<i>Reverse</i>
3	I like problems where the correct answer is unclear and I have to think hard to discover it.	A	B	C	D	<i>Reverse</i>
4	I prefer multiple-choice questions to other exam formats.	A	B	C	D	<i>Normal</i>
6	When I successfully complete a course, I forget what I have learned very quickly.	A	B	C	D	<i>Normal</i>
7	I often find that I get the correct answer to a question without being able to explain why it is correct.	A	B	C	D	<i>Normal</i>
8	When teachers give me the answer to a problem, I find their reasons for the answer more useful than the answer itself.	A	B	C	D	<i>Reverse</i>
9	If I read the textbook and it is difficult to understand, I find it stressful and I want to stop.	A	B	C	D	<i>Normal</i>
11	I prefer restaurants where the food is served very attractively on the plate.	A	B	C	D	<i>Normal</i>
12	I like jobs where I can do the work automatically without having to think about it.	A	B	C	D	<i>Normal</i>
13	I find that I can get a pretty good idea of someone's personality within a few minutes of meeting them.	A	B	C	D	<i>Normal</i>

Normal scoring: A = 3, B = 2, C = 1, D = 0

Reverse scoring: A = 0, B = 1, C = 2, D = 3

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