A factor-analytic investigation of computer ‘addiction’ and engagement

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Evidence supporting the application of Brown’s (1991, 1993) conception of behavioural addiction to computing behaviour is presented. Questionnaire items tapping Brown’s addiction criteria were factor-analysed along with others, including computer apathy—engagement and computer anxiety—comfort items of Charlton and Birkett (1995). Items relating to some of Brown’s criteria (tolerance, euphoria, and cognitive salience) were found to be complex, an Addiction factor loading upon them but an Engagement factor loading more highly. Items tapping other criteria (conflict, withdrawal, behavioural salience, and relapse and reinstatement) were shown to be factor pure, with only the addiction factor loading highly upon them. It is concluded that Brown’s conception of behavioural addiction can be applied to computer-related behaviour, although the relationship of milder facets of addiction, which are also merely indicative of high engagement, to computer-related addictions is non-unique. It is also concluded that classifying individuals as exhibiting pathological computer use using checklists based upon adaptations of DSM criteria for pathological gambling is likely to overestimate the number of people addicted to computing activities.

Recently, particularly with respect to the Internet, research into the possibility that some people are spending excessive amounts of time, and sometimes money, on computing activities has increased. It is claimed that such behaviours can be educationally and vocationally damaging, and be harmful to social relationships. One of the more active psychologists in this area is Griffiths (1995, 1996, 1998), who has applied Brown’s (1991, 1993) six criteria for behavioural addiction to Internet usage. These criteria originate from research into gambling addiction and have much in common with some of the criteria appearing in checklists for the diagnosis of pathological gambling used in recent versions of the DSM (American Psychiatric Association, 1987, 1994), and adapted for other research efforts examining apparent computer over-usage (e.g. Griffiths & Hunt, 1998; Young, 1996a). However, much of the research is characterized by conceptual confusion, and the present study aimed to clarify matters by examining

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whether Brown's behavioural addiction criteria constitute a distinct and unitary set of
criteria when applied to computing behaviour, or whether some of the criteria relate to
the non-pathological concept of high computer engagement (Charlton, 1999; Charlton
& Birkett, 1995, 1998, 1999). The study's main focus was upon the applicability of
Brown's criteria to computing behaviour, because Brown's scheme represents a
conception of addiction specifically formulated to apply to behavioural addictions
in general, and is therefore a particularly good candidate scheme for categorizing com-
puting behaviour. But the study also had implications as to whether the DSM scheme
for the classification of pathological gambling is a useful model for the classification of
computing behaviour as pathological or non-pathological.

Pathological computing behaviours

Early literature on over-zealous computing behaviour tended to be anecdotal and
concentrated upon the negative effects of such behaviour, usually exhibited by
programmers, in vocational settings. For example, Weinberg (1971) discussed program-
ners so caught up with programming that they failed to document their work properly,
and discussed the problems that this caused with future maintenance of programs.
Similarly, Weizenbaum (1984) contrasted 'compulsive programmers' with professional
and dedicated programmers. The latter were said to perceive computer usage as just
one stage in the problem-solving process, only interacting with the computer when the
problem-solving process demanded it: they saw the computer as a means towards
the end of problem-solving. However, compulsive programmers were said to treat
problems as means towards interacting with the computer. Again, such interaction
was said to take place at the expense of other important tasks such as documenting and
planning. Finally, Kuiper (1992) noted the existence of 'Space Cadets' in commercial
and industrial computing departments: individuals who "...spend an incredibly large
percentage of their waking hours in front of a computer terminal and have few, if any,
other interests or ambitions", viewing their work as "...entertainment" and looking
upon their company's computing installation as their "...personal playground" (quotations
from Kuiper, 1992, p. 115).

More recent work has focused upon both Internet-mediated and non-Internet-
mediated computer game playing and chat room dialogues (e.g. Griffiths, 1997; Griffiths
& Hunt, 1998; Young, 1996b). Here, possible over-involvement extends beyond work-
ing environments to educational and home environments. For example, expenditure of
large amounts of student time, which should be devoted to studying, upon 'surfing' has
been judged a cause for concern. Such activities are encouraged by free and easy
Internet access within colleges and by the large amount of unstructured time students
have while at college (Moore, 1995 cited by Griffiths, 1998). Thus, lecturers at several
US universities have expressed concern at student performance and lack of integration
as a result of Internet use (Young, 1999). Such concerns have been borne out from
a student perspective too, with one survey showing 58% of students as variously
reporting a worsening of study habits or grades, absence from classes, or being
disciplined because of excessive Internet use (Young, 1996a). Worries that people
can become over-involved with the Internet are deepened by longitudinal research
linking increased use with reduced intra-familial communication, decreases in the size
of an individual's social networks, and increases in loneliness and depression, albeit
that some of these effects are small (Kraut, Patterson, Lundmark, Kiesler, Mukopadhyay,
& Scherlis, 1998).
Conceptual problems with research on pathological computing behaviours

The idea that any instance of over-zealous computing behaviour can be labelled an addiction is controversial, this controversy involving a number of issues. For example, contrary to most addictive behaviours, computer usage is generally encouraged. Also, there is the idea that addictive behaviours ought to constitute some kind of societal threat, usually by threatening social order. But, although excessive computer use might impair corporate efficiency or educational performance, lead to marital strife, etc., it is unlikely that society will face large-scale problems resulting from people's needs to fund over-zealous computing behaviour through criminal activity, that criminal activity will result from such behaviour, or that such behaviour will lead to destitution.

In addition to the above controversy, much of the research on Internet over-usage, and computer over-usage in general, suffers from a lack of clarity and inconsistency in terms used to label the phenomena at issue (Grohol, 1998; Wallace, 1999), and this constitutes a barrier to research progress (Wallace, 1999). For example, consistent with DSM-IV (American Psychiatric Association, 1994), Young (1996a) defined Internet addiction as 'an impulse-control disorder which does not involve an intoxicant', and used criteria adapted from those for the impulse-control disorder of pathological gambling to assess the presence of pathological Internet use. However, she used the terms addiction and dependency interchangeably in her writing. Griffiths and Hunt (1998) also used the term 'dependent' in a study of computer game players using criteria adapted from those for pathological gambling in DSM-III-R (American Psychiatric Association, 1987). But usage of the label 'dependent' ignores the fact that its application is restricted to drug and interpersonal contexts in both DSM-III-R and DSM-IV. 'Addiction' does not appear in either DSM edition and, in general, this term has fallen out of use in clinical contexts in favour of dependency, because of its 'value-laden' and 'emotionally charged' nature (Brown, 1991). Nevertheless, Brown refers to addiction in his work, finding the concept of dependence too constraining with its emphasis on the ingestion of substances, and opining that 'Addiction-like phenomena...occur in association with non-substance ingesting...activities...' (Brown, 1991, p. 107). Thus, it is argued that behaviours in themselves can be addictive, and there is evidence that the performance of addictive behaviours results in changes in neurochemistry, specifically increases in dopamine levels, for those addicted (Young, 1998). The concept of addiction has therefore been applied to behaviours such as sex, running, food consumption, and gambling (e.g. Griffiths, 1996; Peele, 1985). In labelling pathological computer use, the present paper adopts the term addiction, since Brown's work is central to the research reported.

Another conceptual confusion is that between pathological and non-pathological computing behaviours. In the main, it is this problem that the present research addressed. This issue can be highlighted by considering Shotton's (1989, 1991) commonly cited study of highly zealous computing behaviour. Here, there was scant evidence that the behaviour of a sample of assumed computer-dependent individuals was maladaptive. In general, computer dependency was pictured in a positive light, a negative impact upon educational performance being one of the few negative consequences observed. This work compared supposedly computer-dependent individuals with control groups and the general population, and failed to find the increased prevalence of social and marital strife among computer dependents often cited by anecdotally orientated works. In fact, Shotton's respondents considered that the positive outcomes of their behaviour far outweighed the negative. Individuals reported desirable cognitive outcomes, such as improved analytical and reasoning skills, greater
technological knowledge, and enhanced job prospects. Desirable personal developmental and emotional outcomes were also reported: greater confidence, self-esteem, and prestige, and less stress, boredom, and depression. There were also social benefits, a wider circle of friends resulting from people seeking advice. The latter benefits could be seen as therapeutic, since many of the participants used their computing interactions as a refuge from social interactions with which they felt uncomfortable.

What united Shotton's computer-dependents was "...the need... to use computers in a manner which is usually extremely time-consuming, often with little thought to the output... in a manner which seems to suggest an interaction difference from that with other artefacts" (Shotton, 1989, p. 21). This author labelled her participants computer-dependent largely based on a 1952 definition of drug dependency as follows: "...an individual is said to have developed dependence on a drug when there is a strong, compelling desire to continue taking it" (Shotton, 1989, p. 5). But this definition does not require the existence of negative consequences: a notion now emphasized in definitions of excessive appetitive behaviours (e.g. Orford, 1985). It therefore seems unlikely that the bulk of Shotton's participants exhibited pathological behaviour. The same is true in Griffiths and Hunt's (1998) study of adolescent computer game players, where a subset of participants were identified as dependent but where, again, there were few negative consequences of dependency.

Rather than classifying them as computer-dependent, it appears more reasonable to classify both Griffiths and Hunt's and Shotton's dependents as highly engaged. Here, a range of non-pathological computing behaviours has been specified, running from very high engagement, where individuals spend a great deal of time in computing activities, without deleterious effects, to very low engagement, where extreme apathy is displayed towards computing. The Engagement–Apathy subscale of the Computer Apathy and Anxiey Scale (CAAS) was designed to index such behaviour (Charlton & Birkett, 1995). Use of this subscale shows students on programming-oriented courses to be more highly computer-engaged than those on more business-orientated computing courses (Charlton & Birkett, 1998). For the former type of student, engagement is also positively related to course performance (Charlton & Birkett, 1999). There is evidence, then, that high computer engagement constitutes a strongly positive non-pathological orientation towards computers.

Brown's conception of addiction and the present study

Although labels for some phenomena vary slightly in different publications, fundamentally, Brown (1991, 1993) adopted a checklist approach with six facets required for the existence of addiction. Paraphrasing Griffiths (1996), these are salience (the activity dominates the person's life), euphoria (the gaining of a 'buzz' or a 'high' from the activity), tolerance (the need to engage in the activity to a progressively greater extent to acquire the same 'buzz'), withdrawal symptoms (experiencing unpleasant emotions or physical effects when the activity is halted), conflict (the activity leads to conflict with other people or self-conflict), and relapse and reinstatement (the activity is resumed with just the same vigour subsequent to attempts to abstain). Different types of conflict exist: inter-personal conflict, where there is conflict with other people, intra-psychic conflict, where internal conflict results from one's behaviour, and conflicts with other activities, where behaviour involving the object of addiction takes preference over activities such as work and socializing (Griffiths, 1998). There are also different types of salience, for example, cognitive salience where an activity dominates a person's
mental life, and behavioural salience where an activity dominates a person’s behaviour (Brown, 1991; Griffiths, 1996).

All six facets involved in Brown’s notion of addiction can be present in the case of adolescent fruit machine gambling (Griffiths, 1996). Also, salience, euphoria, conflict and possibly withdrawal symptoms, but not tolerance and relapse and reinstatement, have been observed in connection with computer games (e.g., Griffiths, 1995). Finally, though survey studies purporting to identify Internet addiction have tended to use criteria for addiction that vary somewhat from the criteria identified by Brown, there is some limited evidence from case studies that Brown’s conception of addiction can be correctly applied in this context (Griffiths, 1998). Nonetheless, Griffiths (1998) concluded that further research is required in this area, and the research reported here took a step towards this goal.

The present study attempted to clarify the confusion between pathological concepts such as addiction and dependency on the one hand, and the non-pathological concept of high engagement on the other hand. Such confusion may be one reason why empirical studies such as those of Shotton (1989, 1991) and Griffiths and Hunt (1998) have detected few deleterious effects of assumed dependency. The study drew upon Charlton and Birkett’s concept of computer engagement and Brown’s conception of behavioural addiction. To locate the position of Brown’s criteria in factor space, items tapping the criteria were factor-analysed together with items from the CAAS Engagement—Apathy and Comfort—Anxiety subscales and a few other items aimed at tapping addiction and computer comfort. It was reasoned that if the criteria, which reflect many of the DSM criteria for pathological gambling, were shown to form a distinct and unitary group, this would clear the way for Brown’s conception of addiction, and DSM-related conceptions, to be applied unambiguously in research into computer overusage. Alternatively, if the addiction criteria were shown to be non-unitary and/or related to high engagement, this would call for a re-appraisal of the extent to, and manner in which, both conceptions of addiction can be applied to computing-related behaviour.

Method

Design

A correlational design was adopted, data for 47 variables being factor-analysed. Because the study explored the extent to which engagement, addiction, and possibly even comfort factors loaded or did not load upon items tapping Brown’s criteria, exploratory, rather than confirmatory, factor analyses were employed.

Participants

Data were obtained from 404 students on various modular undergraduate degree programmes and HND courses at a higher education institution in Northern England. Approximately half the students were on programmes comprising either mainly computing or electronic engineering, and around half were on programmes comprising either mainly psychology or humanities. Selection across this broad spectrum enabled sampling of students whose reactions to computers would be expected to exhibit a wide degree of variation. Sex data were missing for 13 students, otherwise there were 193 males (age range 18–59 years, mean age approximately 26 years, SD approximately
9 years) and 198 females (age range 18–52 years, mean age roughly 26 years and SD roughly 9 years). Participation was voluntary but, to encourage questionnaire completion, students returning questionnaires were entered into a raffle with three cash prizes totalling £60.

**Materials**

An adapted version of the CAAS (Charlton & Birkett, 1995) was used. Items on both the original and adapted versions consist of a series of statements regarding computers (roughly half pro and half anti), to which responses are given on a 5-point Likert-type scale ranging through Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree.

Adaptation of the CAAS consisted of the addition of items tapping Brown’s six behavioural addiction criteria, other items aimed at rounding out a possible addiction factor and a few additional computer comfort–anxiety items. The 10 items tapping Brown’s six criteria are given in Table 1. The nature of some of these items took into account some of those adapted by Griffiths and Hunt (1998) from the DSM-III-R criteria for pathological gambling and used in their study of adolescent computer game dependence. Note that the three conflict items tap the existence of negative vocational, familial, and social consequences, and reflect one of the checklist items for pathological gambling in DSM IV. In addition to including this item, the DSM-HIV takes negative consequences into account by including two items dealing with the financial consequences of gambling. While such problems are likely to be more catastrophic for gambling than for computing, financial factors are still a possible source of conflict in the latter domain (e.g. excessive telephone bills resulting from Internet use — Griffiths, 1998). Thus, while not explicitly mentioned among Brown’s criteria, possible financial problems were represented by an item tapping overderependence on computing, included to round out an addiction factor (see item C6 in Table 2).

<table>
<thead>
<tr>
<th><strong>Table 1.</strong> Items tapping Brown’s criteria for behavioural addiction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Salience (cognitive):</strong> I rarely think about computing when I am not using a computer (C45)</td>
</tr>
<tr>
<td><strong>Salience (behavioural):</strong> I never miss meals because of my computing activities (C47)</td>
</tr>
<tr>
<td><strong>Salience (behavioural):</strong> I often fail to get enough sleep because of my computing activities (C43)</td>
</tr>
<tr>
<td><strong>Euphoria:</strong> I often experience a buzz of excitement while computing (C10)</td>
</tr>
<tr>
<td><strong>Tolerance:</strong> I tend to want to spend increasing amounts of time using computers (C39)</td>
</tr>
<tr>
<td><strong>Withdrawal symptoms:</strong> When I am not using a computer, I often feel agitated (C42)</td>
</tr>
<tr>
<td><strong>Conflict (inter-personal):</strong> Arguments have sometimes arisen at home because of the time I spend on computing activities (C9)</td>
</tr>
<tr>
<td><strong>Conflict (with other activities):</strong> My social life has sometimes suffered because of my computing activities (C4)</td>
</tr>
<tr>
<td><strong>Conflict (with other activities):</strong> Computing activities have sometimes interfered with my work (C40)</td>
</tr>
<tr>
<td><strong>Relapse and reinstatement:</strong> I have made unsuccessful attempts to reduce the time I spend computing (C46)</td>
</tr>
</tbody>
</table>

The final item in Table 1 can also be said to detect the presence of intra-psychic conflict. That is, attempts at reducing computing time imply the presence of pressures on an individual to moderate their behaviour, and that an individual would wish to yield to such pressures were it possible for them to do so in the face of their strong inclination
to continue the behaviour. This type of conflict is closely related to the concept of
dissonance, where dissonance between actual behaviour and desired behaviour has
been said to be central in understanding the nature of addiction/dependence (Orford,
1985), and a ‘...pattern of oscillation, or vacillation...', has been said to be ‘...a
reflection of conflict...' (Orford, 1985, p. 231).

Procedure
A letter accompanying questionnaires assured students that their individual responses
would be entirely confidential, be used for research purposes only, and would in no way
affect their academic progress. Questionnaires were distributed and collected by course
tutors shortly after induction week in the first semester of the academic year. It was
left to tutors' discretion as to whether students completed questionnaires immediately
or took them away and completed them.

Results
Two sets of analyses were initially computed on the 47 variables in the data set: one each
for subgroups of students studying male-dominated (computing and electrical engineer-
ing; N = 182) and female-dominated (psychology and humanities: N = 222) academic
subjects. Scree plots associated with two initial principal-components analyses (PCA)
suggested the presence of three factors for both solutions. Subsequently, two principal
axis factoring (PAF) runs with oblique (direct oblimin) rotation were performed, with
three factors being specified in place of Kaiser's criterion.

In addition to exhibiting the same number of factors, factor patterns and factor
interpretations for solutions for the two student subgroups were subjectively similar.
Nevertheless, to ensure the validity of combining the two subgroups and reporting an
analysis for the full data set, two objective procedures were employed as recommended
by Tabachnick and Fidell (1989). First, to examine the similarity of both patterns and
magnitudes of loadings, correlations between loadings for pairs of factors were
computed for the two subgroups. Comparisons of the three factor pairs gave Pearson's
r coefficients of .94 for the first factor, .93 for the second factor, and .93 for the third
factor. However, these coefficients expressing the highly similar nature of the solutions
could have been partially attributable to the large number of low loadings resulting from
the high number of variables analysed (Tabachnick & Fidell, 1989). Therefore the
similarity of loading patterns was also assessed by means of Cattell's salient similarity
index. This index attained values of $s = .85$ for the first factor, $s = .77$ for the second
factor, and $s = .82$ for the third factor. All these indices were significant at $p < .0005$
showing that the loading patterns were reliably similar. Note that the similarity of
solutions for the computing/electronic and psychology/humanities groups dispels a
concern that the outcomes of analysis might have been distorted by impression
management with respect to some members of the former group seeking to display
their eagerness to engage in computing to tutors in charge of questionnaire
distribution and collection.

By all criteria examined then, pooling of data for the two subgroups was warranted.
PCA and obliquely rotated PAF were therefore performed on the 404 cases comprising
the full data set. Again, and not surprisingly, three factor solutions consistent with those
for the two subgroups were obtained. It is the obliquely rotated PAF solution that is
reported.
Table 2. Item listings and oblique factor pattern loadings for the three-factor PAF solution

<table>
<thead>
<tr>
<th>Factor 1 — Computer Engagement</th>
<th>Factor 2 — Addiction</th>
<th>Factor 3 — Comfort</th>
<th>$h^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C25.</strong> It is important for me to be good at computing</td>
<td>.66</td>
<td>-.03</td>
<td>-.04</td>
</tr>
<tr>
<td><strong>C20.</strong> I like the challenge that learning to use computers presents</td>
<td>.64</td>
<td>.05</td>
<td>.07</td>
</tr>
<tr>
<td><strong>C23.</strong> I can’t understand why people like computers</td>
<td>-.57</td>
<td>.13</td>
<td>-.16</td>
</tr>
<tr>
<td><strong>C11.</strong> The less I have to do with computers, the better</td>
<td>-.55</td>
<td>.00</td>
<td>-.39</td>
</tr>
<tr>
<td><strong>C16.</strong> It would not matter to me if I never used a computer again</td>
<td>-.55</td>
<td>-.01</td>
<td>-.16</td>
</tr>
<tr>
<td><strong>C39.</strong> I tend to want to spend increasing amounts of time using computers</td>
<td>.55</td>
<td>.36</td>
<td>-.12</td>
</tr>
<tr>
<td><strong>C27.</strong> I feel happy at the thought of using a computer</td>
<td>.55</td>
<td>.12</td>
<td>.28</td>
</tr>
<tr>
<td><strong>C29.</strong> When I see a computer, I feel drawn towards it</td>
<td>.52</td>
<td>.36</td>
<td>-.07</td>
</tr>
<tr>
<td><strong>C14.</strong> I pay little attention when people talk about computers</td>
<td>-.52</td>
<td>-.06</td>
<td>-.17</td>
</tr>
<tr>
<td><strong>C35.</strong> Computing is unimportant in my life</td>
<td>-.50</td>
<td>-.14</td>
<td>-.04</td>
</tr>
<tr>
<td><strong>C31.</strong> I would hate to go without using a computer for more than a few days</td>
<td>.48</td>
<td>.37</td>
<td>-.06</td>
</tr>
<tr>
<td><strong>C34.</strong> I feel a sense of power when I am computing</td>
<td>.44</td>
<td>.23</td>
<td>-.18</td>
</tr>
<tr>
<td><strong>C10.</strong> I often experience a buzz of excitement while computing</td>
<td>.43</td>
<td>.39</td>
<td>-.01</td>
</tr>
<tr>
<td><strong>C45.</strong> I rarely think about computing when I am not using a computer</td>
<td>-.41</td>
<td>-.31</td>
<td>.12</td>
</tr>
<tr>
<td><strong>C15.</strong> Computer jargon sounds stupid to me</td>
<td>-.40</td>
<td>.07</td>
<td>-.33</td>
</tr>
<tr>
<td><strong>C32.</strong> I like to watch documentaries about computers on television</td>
<td>.39</td>
<td>.34</td>
<td>.05</td>
</tr>
</tbody>
</table>

Factor 2 — Computer Addiction

| C17. | I am sometimes late for engagements because of my computing activities | .03 | .73 | -.01 | .55 |
| C43. | I often fail to get enough sleep because of my computing activities | -.01 | .73 | .05 | .53 |
| C4. | My social life has sometimes suffered because of my computing activities | -.07 | .72 | .11 | .50 |
| C1. | I sometimes neglect important things because of an interest in computers | .04 | .69 | .17 | .56 |
| C12. | I think that I am addicted to computing | .15 | .67 | .05 | .56 |
| C9. | Arguments have sometimes arisen at home because of the time I spend on computing activities | -.02 | .67 | .09 | .45 |
| C40. | Computing activities have sometimes interfered with my work | -.03 | .63 | .02 | .39 |
Table 2. Cont.

<table>
<thead>
<tr>
<th></th>
<th>Factor 1 (Engagement)</th>
<th>Factor 2 (Addiction)</th>
<th>Factor 3 (Comfort)</th>
<th>$h^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6.</td>
<td>I often feel that I spend more money than I can afford on computing</td>
<td>.07</td>
<td>.61</td>
<td>.00</td>
</tr>
<tr>
<td>C46.</td>
<td>I have made unsuccessful attempts to reduce the time I spend computing</td>
<td>-.10</td>
<td>.58</td>
<td>-.04</td>
</tr>
<tr>
<td>C47.</td>
<td>I never miss meals because of my computing activities</td>
<td>-.05</td>
<td>-.49</td>
<td>-.03</td>
</tr>
<tr>
<td>C42.</td>
<td>When I am not using a computer, I often feel agitated</td>
<td>.10</td>
<td>.49</td>
<td>-.08</td>
</tr>
<tr>
<td>C37.</td>
<td>I have never used computing as an escape from socialising</td>
<td>.01</td>
<td>-.48</td>
<td>.01</td>
</tr>
<tr>
<td>C24.</td>
<td>I try to make my sessions with computers last as long as possible</td>
<td>.41</td>
<td>.44</td>
<td>-.01</td>
</tr>
<tr>
<td>C36.</td>
<td>I spend little of my spare time computing</td>
<td>-.32</td>
<td>-.41</td>
<td>-.19</td>
</tr>
</tbody>
</table>

Factor 3 — Computer Comfort

<table>
<thead>
<tr>
<th></th>
<th>Factor 1 (Engagement)</th>
<th>Factor 2 (Addiction)</th>
<th>Factor 3 (Comfort)</th>
<th>$h^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5.</td>
<td>I have problems in understanding computers</td>
<td>-.07</td>
<td>-.18</td>
<td>-.71</td>
</tr>
<tr>
<td>C13.</td>
<td>I don’t feel in control when I use a computer</td>
<td>-.09</td>
<td>-.08</td>
<td>-.70</td>
</tr>
<tr>
<td>C22.</td>
<td>I do not feel anxious about using computers</td>
<td>-.05</td>
<td>.14</td>
<td>.69</td>
</tr>
<tr>
<td>C8.</td>
<td>I find computers threatening</td>
<td>-.21</td>
<td>-.08</td>
<td>-.66</td>
</tr>
<tr>
<td>C44.</td>
<td>My thoughts often become jumbled when I have to use a computer</td>
<td>-.12</td>
<td>.30</td>
<td>-.62</td>
</tr>
<tr>
<td>C3.</td>
<td>Computers are too scientific for me</td>
<td>-.26</td>
<td>-.06</td>
<td>-.60</td>
</tr>
<tr>
<td>C2.</td>
<td>I have never been worried about an inability to cope with computers</td>
<td>-.16</td>
<td>.25</td>
<td>.60</td>
</tr>
<tr>
<td>C28.</td>
<td>Computing is too technical for me</td>
<td>-.37</td>
<td>.03</td>
<td>-.53</td>
</tr>
<tr>
<td>C38.</td>
<td>I am calm when using a computer</td>
<td>.23</td>
<td>-.02</td>
<td>.52</td>
</tr>
<tr>
<td>C41.</td>
<td>I seldom worry about making a catastrophic mistake when I am computing</td>
<td>-.11</td>
<td>.08</td>
<td>.50</td>
</tr>
<tr>
<td>C26.</td>
<td>The possibility of failing at a computing task does not worry me</td>
<td>-.28</td>
<td>-.04</td>
<td>.50</td>
</tr>
<tr>
<td>C18.</td>
<td>I find computers hard to tolerate</td>
<td>-.46</td>
<td>.10</td>
<td>-.48</td>
</tr>
<tr>
<td>C30.</td>
<td>I have never tried to avoid using computers</td>
<td>.24</td>
<td>.05</td>
<td>.47</td>
</tr>
<tr>
<td>C33.</td>
<td>I have never felt ill at the thought of having to use a computer</td>
<td>.08</td>
<td>-.10</td>
<td>.46</td>
</tr>
<tr>
<td>C7.</td>
<td>Computers make my life easier</td>
<td>.36</td>
<td>.02</td>
<td>.39</td>
</tr>
<tr>
<td>C19.</td>
<td>I often get irritated with computers</td>
<td>-.34</td>
<td>.13</td>
<td>-.38</td>
</tr>
<tr>
<td>C21.</td>
<td>I prefer to use a pen and paper, rather than a word processor, when preparing the final copy of a piece of writing</td>
<td>-.26</td>
<td>-.04</td>
<td>-.35</td>
</tr>
</tbody>
</table>
The three factors in the solution accounted for around 43% of variance in total. Factor 1 accounted for around 28% of variance, Factor 2 for around 11% of variance, and Factor 3 for 4% of variance. Table 2 gives item communalities, rotated factor pattern loadings and item wordings. Items tapping Brown’s criteria are printed in bold.

The presence of a number of complex items can be seen in Table 2. In particular, taking loadings of greater than ± .32 as high, it will be noted that while Factor 2 loaded highly upon items tapping Brown’s tolerance and euphoria criteria (C39 and C10), Factor 1 loaded even more highly upon them. A similar pattern was also evident for the cognitive salience item (C45), but the loading of Factor 2 upon this item was marginally below the criterion for a high loading.

From item wordings, Factor 1 can be interpreted as Computer Engagement, the factor loading highly upon 7 of the 8 items included from the original Engagement–Apathy factor of Charlton and Birkett (1995): C25, C20, C16, C29, C14, C31, C32 (Factor 2 loaded more highly upon the 8th item: C24).

Factor 2 loaded highly upon 9 items tapping all six of Brown’s criteria for behavioural addiction (C43, C4, C9, C40, C46, C47, C42, C10, C39), but the cognitive salience item (C45) marginally failed to reach the criterion for a high loading, as mentioned above. However, as previously noted, three of the Brown items (C39, C10, and C45) loaded more highly upon Factor 1. Factor 2 also loaded highest upon all but 1 (C34) of the other items aimed at tapping addiction (C17, C1, C12, C6, C37, C36). Given all this, it is reasonable to label this factor Computer Addiction.

Factor 3 can be labelled Computer Comfort, this corresponding closely to the CAAS Comfort–Anxiety factor, loading highly upon 9 of the 12 items from this CAAS subscale (C5, C13, C8, C3, C28, C18, C7, C19, C21). It is easy to see why the Engagement factor loaded more highly upon the other 3 items from the CAAS Comfort–Anxiety Subscale: C23, C11, and C15. Indeed, from a face validity perspective, this aspect of the present analysis can be said to be more satisfactory than the analysis of the CAAS in Charlton and Birkett (1995). In addition, the factor loaded highly upon items not in the CAAS, which were explicitly aimed at tapping comfort–anxiety (C22, C44, C2, C38, C41, C26, C30, and C33).

The Engagement factor exhibited reasonably sized positive correlations with both the Addiction factor (.38) and the Comfort factor (.34), but the correlation between the latter two factors was negligible (.08). The magnitude of the first two coefficients justified the use of oblique rotation (Tabachnick & Fidell, 1989).

Summarizing the results, with the trivial exception of the Addiction factor’s marginal failure to load upon the cognitive salience item, the analysis showed that this factor loaded upon all the items tapping the behavioural addiction criteria, thereby supporting the idea that computer addiction is a unitary construct. However, items tapping the tolerance, euphoria, and cognitive salience criteria were not uniquely related to addiction, the Engagement factor loading even more highly upon these complex items.

**Discussion**

Although Brown’s criteria were shown to constitute a unitary construct in the domain of computing behaviour, the results revealed a blurring of the distinction between addiction and engagement. In addition to the complex nature of some of the criteria, this blurring was emphasized by the moderate correlation between the eponymous factors. It was useful to obtain replication of the CAAS Computer Comfort–Anxiety
dimension as a third factor despite the addition of novel items, but this factor is not discussed further, owing to its marginal relevance to present issues.

While Griffiths (1998) referred to all six of Brown's criteria as 'core components' of addiction, the present results suggest a refinement of this view with respect to computing behaviour. Here, the Engagement factor loaded more highly upon the two items tapping Brown's tolerance and euphoria criteria and an item tapping cognitive salience than did the Addiction factor. Nevertheless, this latter factor also loaded highly upon the aforementioned items in addition to exhibiting pure loadings on items tapping withdrawal, relapse and reinstatement, conflict, and the two remaining (behavioural) salience criteria. This suggests the existence of two groups of criteria and a possible developmental model, whereby, before reaching addiction, one progresses through a stage of high engagement at which there are no major negative consequences of highly zealous computing behaviour, and during which milder peripheral facets of addiction are present (tolerance, euphoria, and cognitive salience). The model would specify that these three phenomena persist when the addiction stage is reached, where the stronger core facets of addiction become apparent: withdrawal symptoms, relapse and reinstatement, conflict, and behavioural salience.

The split in the salience items was informative. The cognitive facet was a milder peripheral facet, but the behavioural facet, as indexed by computing interfering with eating and sleeping, was a core facet. These latter items are indicative of a tendency towards self-neglect and a lack of control over computing behaviour as the behaviour comes to dominate a person's life. If such behaviours are chronic, this can lead to problems with health and everyday functioning. For example, Young (1996a) has cited instances of prolonged nocturnal Internet usage leading to sleep deprivation, excessive fatigue, and depressed immune system functioning. In contrast, while indicating that computing activities loom large in a person's mental life, the cognitive salience item implies no such lack of behavioural control.

Reference to the definitions of Brown's behavioural addiction criteria suggests that the division into milder peripheral and stronger core criteria is likely to be a general property of the criteria themselves, rather than a specific property of items used to tap these criteria in the present study (in addition to implying generalizability of findings in the domain of computing, this implies that, in principle, the present observations should apply to other behavioural addictions). The concept of cognitive salience (the activity dominating a person's mental life) and the definitions of euphoria (the gaining of a 'buzz' or a 'high' from the activity) and tolerance (the need to engage in the activity to a progressively greater extent to acquire the same 'buzz') do not involve negative consequences for the individual, and the occurrence of harmful consequences is central to the labelling of appetitive behaviours as excessive (Orford, 1985). Rather, these definitions either emphasize or imply that the individual is finding the activity enjoyable. In contrast, the concept of behavioural salience (the activity dominating a person's behaviour to the extent that self-maintenance is neglected) and the definitions of conflict (the activity leads to conflict with other people or self-conflict) and withdrawal symptoms (experiencing unpleasant emotions or physical effects when the activity is halted) do emphasize negative consequences. Although the definition of relapse

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1 The term 'core' here means criteria that are central to the diagnosis of addiction. It is not contended that the phenomena represented by these criteria are central to the process of addiction (Brown, 1997 notes that many authors mistakenly see tolerance and withdrawal phenomena as central to the addiction process, rather than as secondary products of it).
and reinstatement (the activity is resumed with just the same vigour subsequent to attempts to abstain) does not directly involve negative consequences, such consequences are likely to be a major cause of an individual attempting to abstain from an activity.

The existence of milder and stronger criteria for pathological computing behaviour, with the former also indicating high engagement, implies that people who are classified as computer-dependent or computer-addicted might often be more accurately said to be highly computer-engaged, as was argued earlier with respect to the work of Shotton (1989, 1991) and Griffiths and Hunt (1998). In this latter study, 62 participants from a sample of 387 adolescents (382 of whom had some game playing experience) were classified as dependent, based upon affirmation of at least 4 out of 8 items adapted from the DSM-IIIR criteria for pathological gambling (and reflecting Brown’s behavioural addiction criteria). However, though being more likely to report themselves as aggressive, the self-reports of those classified as dependent indicated neither a greater tendency towards truancy in order to play computer games nor stealing to buy games. Also, school work did not suffer.

Social desirability effects could be one reason for Griffiths and Hunt’s findings. However, remembering that it was only necessary to endorse 4 out of 8 criteria to be classified as dependent, one wonders whether the majority of participants were so classified based largely on their endorsement of items tapping milder criteria. Certainly, conflict did not appear to be a major problem here. Indeed, the authors argued that dependency (defined mainly by the presently discussed set of 6 criteria) might not be completely relevant to computer game playing. Alternatively, they suggested that their dependency scale might be more an index of ‘preoccupation’ than dependency. There are echoes here of the present distinction between high engagement and addiction.

The above signals problems with studies of computing behaviour using the DSM criteria for pathological gambling as a model. For a diagnosis of pathological gambling, both DSM-IIIR and DSM-IV require the endorsement of a specified number of criteria from a larger number on a checklist. In the DSM-IIIR, this was referred to as a polythetic format and was contrasted with monothetic formats, such as that of Brown, in which all criteria specified have to be met. The present outcomes suggest that adaptation of DSM criteria for pathological gambling in conjunction with its polythetic format is likely to overestimate the number of people addicted to computing activities because of a failure to recognize the distinction between milder, engagement-related criteria and stronger criteria.

Although 6 of the present 10 items constructed to tap Brown’s criteria were very similar to 6 of Griffiths and Hunt’s 8 criteria, comparison of the present frequency data with those of Griffiths and Hunt is complicated by the imperfect match between items used in the two studies. Nevertheless, it is possible to make a rough comparison by dichotomizing the present data (forming the 2 possible responses to each item consistent with addiction into 1 category, the 2 possible responses consistent with non-addiction into another, and excluding ‘Neither Agree nor Disagree’ responses) and considering the pattern of responses. Adopting a cut-off point of 5 out of 10 addictive responses for the present study to give a cut-off score proportionately the same as that used by Griffiths and Hunt (4 out of 8) to classify participants as dependent, 8.4% (34) of the present participants would be classified as pathological computer users. While this percentage is similar to the 8.1% of college student Internet users said to exhibit pathological Internet use in a 1997 study of Morahan-Martin and Schumacher.
cited by Griffiths (1998), it is lower than the apparent 16% who could be classified as dependent game-players in Griffiths and Hunt's study. This difference in percentages is probably attributable to the difference in age groups studied (adolescents in Griffiths and Hunt's study versus adults, with a skew towards young adults, in the present study) and the high attraction of the specific type of activity studied to the age group in question in the Griffiths and Hunt study. More interestingly with respect to the present argument, 62% (21) of the present 34 participants apparently classifiable as exhibiting pathological behaviour exceeded the present cut-off score only because they endorsed mild criteria, with 41% (14) of the 34 endorsing all three of these criteria. These observations give an idea of the degree to which studies, such as those of Griffiths and Hunt (1998) and Young (1996a), adopting the DSM polythetic pathological gambling approach to the study of pathological computer use can overestimate the extent of the problem. Finally, if an even more stringent criterion were adopted, requiring the endorsement of items relating to all six of Brown's facets of behavioural addiction for classification as addicted, none of the present 404 participants would have been so classified. Thus, no participant endorsed all the mild criteria and the core criteria (counting endorsement of the withdrawal, relapse and reinstatement items and at least one of the behavioural salience items, together with at least one of the conflict items for the latter group of criteria).

In alleviating the classification problems highlighted in this paper, future research might investigate abandoning simple checklist formats in favour of more sophisticated approaches. For example, logistic regression methods could be used to develop predictive equations. In such equations, the criteria presently identified as milder indicators of pathological computing behaviour would have lower weightings than the stronger criteria. Also, the idea that there is a developmental progression through high engagement to addiction opens up the possibility of a Guttman-scaling approach to measurement and assessment in this area. The latter approach would contrast with the former in acknowledging the existence of a continuum of computing behaviours with differing degrees of non-pathological and pathological activity and a gradation between the two, rather than a discreet division between non-pathological and pathological usage (Orford, 1985). Other addiction/dependence researchers might also consider the utility of graded developmental type approaches to diagnosis in their domains of expertise. At the very least, these researchers might profit from considering the conceptual division between high engagement and addiction/dependence in resolving classification problems at the boundaries between non-pathological and pathological behaviour.

The above discussion agrees with Griffiths (e.g. 1998) in implying that only a very small minority of people are likely to exhibit addiction to certain computing activities in the sense that they generally meet all six of Brown's criteria. The overestimation of the prevalence of such behaviours adds a second string to criticisms that some researchers using polythetic checklist approaches in the study of pathological Internet use adopt unrealistically low cut-off points when labelling behaviour as pathological (Griffiths, 1998). At a minimum, in lieu of adopting the possible approaches discussed above, the present findings suggest that if researchers persist with polythetic formats based upon criteria for pathological gambling, they should adopt more stringent cut-off points to take account of the fact that some criteria are not necessarily indicative of...
pathological behaviour. An alternative polythetic approach would be to validate a list of new criteria that are unambiguously associated with addiction to computing activities.

Modelling of the psychological and environmental conditions under which high engagement develops into addiction constitutes an important topic for future research. The importance of such work would be increased if research were to confirm the generalizability of the engagement-addiction distinction to other populations (e.g. computing workers) and behaviours. Modelling would profit from Brown's more recent ideas in which he has incorporated his criteria, together with other psychological phenomena, into The Hedonic Management Model of Addiction. This highly complex developmental model views addiction as resulting from the discovery of a "... means of manipulating hedonic tone to sustain long periods of euphoria or relief from dysphoria." (Brown, 1997, p. 52). The model specifies that the discovery of a specific activity that enables reliable manipulation of hedonic tone leads "...to the strengthening of an acquired drive for particular feeling states as a goal associated with the performance of the addictive activity" (p. 29) and that a positive feedback loop develops: strengthening of the drive leads to increased salience of the activity as a means of reward, which in turn strengthens the drive. Whether such a process is initiated is dependent upon an individual's circumstances, for example, the availability of other sources of reward. Thus, one condition under which high computer engagement might turn to addiction is where an individual is socially isolated or finds face-to-face communication problematic, limiting the possibilities of direct social interaction as an alternative source of reward (Griffiths, 1998, presents a case study of such an instance).

The present research considered computing in general, the identity of the particular computing activities that participants had in mind when responding to specific items being unknown (clarity in addressing the present research agenda necessitated that no attempt be made to target items at specific activities). However, certain computing activities are undoubtedly more useful and reliable than others in facilitating the manipulation of hedonic tone. One such class of activities is that involving variable-ratio reinforcement schedules, for example, chat-room dialogues and Internet-mediated multi-user dungeon-type adventure games (Wallace, 1999). It is easy to speculate how such schedules, inherent in coding-testing-debugging cycles, might also be partially responsible for the behaviour of Weinberg's (1971) and Weizenbaum's (1984) overzealous programmers.

Any future research on modelling the transition from high engagement to addiction might also include demographic factors. Here, with participants split into those taking male-dominated (computing and electronics) and female-dominated (psychology and humanities) courses, analysis of factor scores for the present three factors with respect to sex and age (not fully reported in the interests of brevity) revealed only two significant findings. Males on female-dominated courses exhibited higher addiction scores than their female course colleagues, and there was a significant positive correlation between age and computer engagement for participants on male-dominated courses.

The largely null sex difference findings suggest that the more positive male orientation towards computing often observed in studies carried out in the previous two decades may be on the wane, this possibly being attributable to the greater diversity of computing applications now on offer. Though the greater male addiction scores on female-dominated courses could be simply a remnant from the times when computing was a largely male-dominated domain (e.g. Shotton's, 1989, computer dependents were almost exclusively male), Martin (1992) has suggested that it is more socially accept-
able for males than females to be obsessive. These issues have been discussed in greater depth by Charlton (1999). We can only speculate upon why computer engagement tended to increase with age on male-dominated courses. One possibility is that younger students, having grown-up seeing computers as everyday objects, are less in awe of their capabilities and are therefore not as fascinated by them. Although it is possible to produce *a posteriori* explanations of the patterns of these demographic findings across the two broad types of course, until such patterns are replicated in further studies, such speculation is probably unwarranted.

To conclude, the present work suggests that computer addiction is a viable psychometric construct, and case studies outlined by Griffiths (1998) and Young (1996b) illustrate that, for certain individuals, addiction, by its very definition, constitutes a significant problem. However, it is likely that, in many cases, addiction is confused with non-pathological high engagement, and that the classification procedures currently used are likely to lead to overestimation of the numbers of people addicted to specific computing activities. A possible developmental model was also suggested, with people passing through a stage of high engagement on the way to addiction. Finally, it might be useful for researchers into other addictions to consider the implications of the present work for their areas of interest.

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**References**


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