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Gender, task contexts, and children's performance on a computer-based task

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Gender differences in response to computers have been widely reported. This study addresses the question of how far the context in which a computer task is presented can affect girls' and boys' on-task performance. In an experimental study involving 60 ten and eleven year-olds, we examine the effects of differential contextualisation on girls' and boys' performance on a computer-based perceptual-motor skills task. Our findings illustrate that even with a single, standard piece of software, children's performance can be substantially affected by the context in which that software is presented. The results suggest that gender differences in children's responses to computer tasks are relatively labile, and highly context sensitive. The implications and possible explanations for these findings are considered.

Introduction

Women have had a long history of making valuable contributions to the development and application of computers (Lockheed, 1985), and computer-technology is not and never

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has been the exclusive preserve of men. However, in recent years there has been a growing concern that young women and girls are becoming increasingly "absent" from the domain of computing.

During the early years there is very little difference between girls and boys in terms of how they see computers, their liking for computer technology, or their involvement in computer-based activities (Bergin, Ford, & Hess, 1993; Williams & Ogletree, 1992). As they get older, however, girls' engagement with IT begins to decline (Lage, 1991) and data spanning the full age range of compulsory schooling indicate that overall, computers are being used more by boys and male teachers than by girls and female teachers (Bannert & Arbinger, 1996; Kay, 1992; Straker, 1989). International comparisons show that such gender differences in response to computers amongst students are widespread (Janssen Reinen & Plomp 1997; Pelgrum & Plomp, 1993). Gender differences in participation in computer-related activities are found also in the home. Parents more frequently purchase computers for boys and boys also make more use of computers in the home than girls (Fife-Schaw, Breakwell, Lee, & Spencer, 1986; Lockheed, Nielsen, & Stone, 1985; Robertson, Calder, Fung, Jones, & O'Shea, 1995). Whilst this use is primarily for games, gender differences in use are reported for all home computer activities (Linnakylä, 1996; Martin, 1991).

Whilst many studies report that girls are less positive about computer-use than boys (Martin, 1991; Shashaani, 1993; Todman & Dick, 1993) we need to be extremely cautious in interpreting such findings and we should certainly not attempt to generalise from them. This is especially true given that once attempts are made to control for exposure to computers, the gender differences in attitudes observed in many studies either reduce or completely disappear. For example, Gressard and Lloyd (1987) found that gender did not explain any additional variance in attitudes towards computers once computer experience and mathematics anxiety had been entered into the regression equation. Similarly, Campbell (1989) found no gender differences in computer anxiety once effects due to computer access had been controlled for. Other studies on attitudes and experience have also found that more experience is associated with more positive attitudes (Dyck & Smither, 1994; Martinez & Mead, 1988; Sutton, 1991; Williams, Ogletree, Woodburn, & Raffeld, 1993) and lower levels of anxiety (Maurer, 1994). So, whilst girls and young women may appear to be "absent" from the domain of computer use, many are in fact positively disposed towards computer technology.

Despite the large discrepancies recorded in girls' and boys' use of computer technology, very few gender differences *in performance* on computer-based tasks have been observed (Littleton, 1996). Both girls and boys work effectively on programming tasks (e.g., Finlayson, 1984; Light & Colbourn, 1987; Linn, 1985; Webb, 1984) electronic database search tasks (e.g., Eastman & Krendl, 1987), on simulation exercises (e.g., Cummings, 1985; Johnson, Johnson, & Stanne, 1985) and on science tasks (Issroff, 1994). Where gender differences have been found there is evidence to suggest that varying the contextualisation or "gender marking" of the software makes a substantial difference to the relative performance of the boys and girls. In our own work, for example, using a computer-based route planning task known as "King and Crown", we found marked differences in performance favouring boys. Similar differences were not evident, however, when we examined the relative performance of boys and girls using a structurally identical, but less superficially gender--stereotyped, version of the same task known as "Honeybears" (Littleton, Light, Joiner, Messer, & Barnes, 1998). This finding suggests that there is a need for us to develop an understanding of the particular contexts and situations which constitute girls' and boys' experience of computing activities and understand more fully the ways in which the context of a computing activity may either constrain or facilitate performance and engagement with computer-tasks.

In this study we examine the effects of differential contextualisation on girls' and boys' performance on a computer-based perceptual-motor skills task involving tracking a moving line. This task was adapted from a "physical" (i.e., non-computer-based) task which had some history of being used to investigate task presentation effects (Davies, 1989; Hargreaves, Bates, & Foot, 1985). We wanted to investigate whether boys' and girls' on-task performance would vary when a single task was presented in three different contexts – a *technician's skills test*, a *beautician's skills test* and a *game*. The first two contexts were included to allow an investigation of how the contextualising of a neutral task in a gender-specific manner might affect the children's performance on, what is described as a test. The third context allowed us to examine how the girls and boys would perform on the task when it was no longer characterised as a test, but as a game.

Method

Participants

The participants were 60 ten and eleven year-old children, 30 boys and 30 girls (mean age=11 years 3 months). The sample was drawn from two state junior schools in Southampton, UK and two voluntary-aided middle schools in Bedford, UK. All four schools had comprehensive intakes. The study was conducted between 1996 and 1997.

Design

The design of the study was a between-participants factorial design. There were two factors: gender (two levels: male and female) and task context (three levels: "masculine"--technician's skills test, "feminine"-beautician's skills test, and "game"-electric eel game). Within each of the levels half the children were drawn from schools in Southampton, whilst the other half were drawn from schools in Bedford. Each child was randomly assigned to one of the conditions and completed just one version of the experimental task.

The task

The task was a specially designed computer version of a physical device in which the participant attempts to guide a wire ring around a bent wire frame without making contact with the wire. The screen version consisted of a double cursor framing an irregular line, which moved across the screen at a regular speed. Figure 1 shows the starting set up as it appeared to the child. Note that the window labels could be changed so as to display a "masculine" role label-technician's skills test, "feminine" role label-beautician's skills test, and "game" label-electric eel game as appropriate.

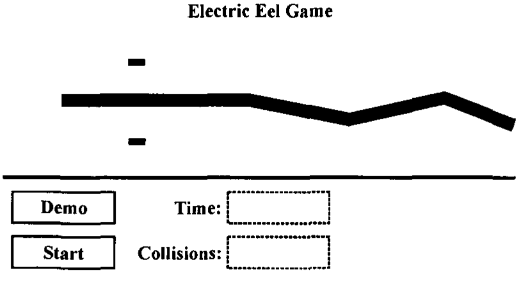

Figure 1. The perceptual motor skills task

The line moved from right to left across the screen. The objective was to use the mouse in order to raise and lower the cursor in such a way that the line would pass smoothly through the "gap", without hitting the cursor "ring". If there was contact, a "beep" sounded and the line stopped until the cursor was moved so as to free up the line again.

A pilot study had established parameters for the task which ensured that even high--performing children would be likely to incur a few hits. The task was entirely controlled by the mouse, with no keyboard input required. It was presented on a Macintosh PowerBook laptop computer.

Procedure

Each child was seen individually, in a quiet side room in the school. The task, with its appropriate label, was loaded on the screen before the child came in. After the child had been seated in front of the computer, the experimenter sat to one side of the computer and gave a scripted introduction. For example, in the case of the "feminine" context the instructions were as follows: "I'm interested to see how children of your age get along with some computer programs. I'm trying out a few different things today, so I'd appreciate it if you didn't talk about it until everyone's had their go. The one I'd like you to do is designed as a test to see how good people will be as beauticians." The ending of this introduction was amended according to condition. In the case of the masculine context the children were told that the program was "designed as a test to see how good people will be as technicians". In the case of the game context, the children were told that the program was "designed as a computer game and is called electric eel."

The experimenter then ran a 10-second demonstration during which she controlled the mouse and described the task saying: "I'll just show you what you have to do. Using the mouse you have to track this line as it comes on to the screen. If you hit the line you will here a noise like this. Try to avoid hitting the line." During the demonstration, the experimenter contrived to make one or two hits. The child then ran the demonstration for themselves as a practice session. Just as each child began to embark upon the session from which their performance data were derived, the experimenter reinforced the context by saying "OK, now it's your turn to do the beautician's skills test /technician's skills test/ electric eel game."

The experimenter then recorded details of the performance measure, the number of hits incurred, and the screen was then cleared so that the next participant would not see the previous scores. All the children were debriefed at the end of the study.

Results

A two-factor analysis of variance, using "hits" as a dependent measure, revealed no significant main effects nor any evidence of a significant interaction between gender and context. However, it is apparent from Table 1 that the standard deviations in two of the three conditions for the girls are markedly higher than elsewhere. The underlying distributions show no evidence of bimodality, but given the relatively small number of children per cell, the *heterogeneity* in the girls' performance within two out of the three conditions was potentially masking evidence of gender related performance differences. It was thus decided to undertake a further series of posthoc comparisons. These revealed evidence of a significant simple main effect of gender in the game context ($F(1,54)=6.62$, $p<.05$) with the performance of the girls being significantly worse than that of the boys. There were no significant simple main effects for either of the two skills tests.

The pattern of results thus suggests that the operative distinction is that between "game" and "test" contexts. If the context factor is treated as having only these two levels, the resulting two-factor analysis of variance shows not only a significant main effect of gender, ($F(1,56)=4.545$, $p<.05$) but also a small but significant interaction between gender and context ($F(1,56)=4.35$, $p<.05$) (see Figure 2). The resulting model explains 12% of the variance in the number of "hits" made by the children.

Table 1
Mean number of hits, standard deviations, and number of children for each condition

Gender		Context			Total
		Beautician	Technician	Electric Eel	
Female	*M*	28.3	21.6	37.7	29.2
	SD	18.95	11.44	24.61	
	n	10	10	10	
	min	6	4	4	
	max	71	43	84	
Male	*M*	27.7	21.8	19.4	22.97
	SD	9.99	13.87	11.39	
	n	10	10	10	
	min	8	12	8	
	max	41	58	45	
Total	*M*	28.0	21.7	28.55	26.08

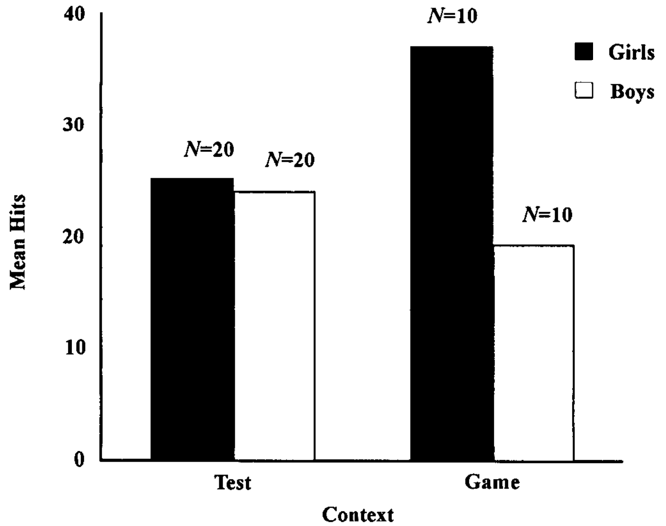

Figure 2. The mean "hits" for girls and boys in the "test" and "game" conditions

Pairwise contrasts of cell means reveal that where the task is introduced as a *test* there is no trace of a performance difference between the girls and the boys ($F(1,39)=.002$, *n.s.*). By contrast, when exactly the same task is introduced as a game the boys' and girls' performance diverges to a point where there is a significant gender difference in performance favouring the boys ($F(1,19)=6.73$, $p<.05$). Moreover, the girls performed significantly better when the task was described as a *test* than when it was described as a game ($F(1,29)=4.36$, $p<.05$).

An alternative to dealing with the large variance in two of the conditions amongst the girls is to drop one markedly outlying data point within each of these conditions. This reduces the mean and standard deviation in the beautician condition to 23.56 and 12.27 respectively, and the mean and standard deviation for the game condition to 32.55 and 19.59 respectively. Reanalysis along the lines set out above using this approach yields exactly the same pattern of statistically significant results as was obtained using the full sample.

Discussion

The data presented here suggest that the gender specificity of the "test" contextualisation had no effect on the performance of girls and boys. The data also reveal that generally the boys' performance appears to be very little affected by the context of the task presentation. This is not a ceiling effect, as there was considerable room for improvement. The girls' performance, on the other hand, was affected by the particular context encountered, deteriorating dramatically in the "game" context. Why might this be so?

In attempting to address this question it is perhaps worth noting, albeit briefly, that an answer cannot easily be found within the mainstream cognitive psychology literature. To the archetypal cognitive psychologist, a task is a task is a task. It possesses clear demand characteristics. It can be defined essentially from the outside. Its meaning is determinate. The act of differentially contextualising a task should, in theory, make no difference to a participants' performance on that task. Yet here there is compelling evidence that it can matter considerably. It is vital, then, that we recognise how and why participants' "readings" of a task can, in certain circumstances, impact profoundly on their performance on-task.

In terms of explaining our findings, we can offer four possible accounts. All involve the recognition that the interaction between the experimenter, the task and the child is of paramount importance. An experimenter does not simply "deliver" a set of instructions to a participant. In introducing a task to a participant the experimenter is creating a crucial frame of reference, constructing a context within which the child is enjoined to work. The participant attempts to build an understanding of what is expected and of the intentions and motives of the experimenter through a process of interpretation and re-interpretation of the experimenter's action and interaction.

As noted above, the interaction between experimenter and participant in an experimental setting is a subtle exercise in "sense making", which will be shaped in part by the wider cultural context within which the interaction is located. In this particular study the experiment is being conducted within a school setting. Conducting research studies with children in schools undoubtedly affords many distinct advantages, for example, relative ease of access to large numbers of participants. But such an arrangement may have considerable implications for the data which result from such studies. Responses may be determined by a complex contextual system, which extends far beyond the immediate interaction between experimenter and participant, and which is inseparable from the way that education and educational activity is defined in our culture.

We know from the wider educational literature that, as a group, girls tend to be interested in and sensitive to the social context of schooling. They are highly skilled at "making sense of school" and are more motivated than boys are to understand what it means to be a pupil and what it means to "do" school tasks (Barber, 1994; Davies & Brember, 1995). A first line of explanation of girls' performance in the "game" context might thus reflect their uncertainty regarding how to read the intentions and motives of an unfamiliar adult who, when working in a classroom setting during lesson time, instructs them to play a computer game. What is the purpose of such activity? The playing of computer games is not part and parcel of recognised daily classroom activity. Thus there is a mismatch between the girls' understanding of what constitutes an appropriate "school task" and the task they were asked to perform. The girls do not know how to make sense of this interaction with the experimenter. They are unsure as to the purpose and meaning of the activity they have been asked to undertake, since computer gaming has nothing to do with the business of schooling.

Seen in these terms, then, the girls' substantially better performance in the "test" conditions reflect the fact that the intentions and motives of the experimenter and the purpose of the activity is less ambiguous and more appropriate to a school context. Although the unfamiliar adult is asking them to perform a computerised vocational skills test, which they would not be familiar with, a test is an activity wholly appropriate to the classroom context. Tests are an integral feature of the school experience. Moreover, adults who are not members of teaching staff (for example educational psychologists) can often be seen in school administering tests to children.

This account rests fundamentally on the assumption that girls possess preferences for "purposeful" activity and that they demonstrate sensitivity to context in a way that boys tend not to. This is an assumption which has some grounding in the wider educational literature. For example, data from the Assessment of Performance Unit in Science reveal that within the domain of science, girls take into account the circumstances within which a task is set, whereas boys, as a group, consider the task in isolation from its context (Murphy, 1993).

A second possible explanation, also predicated on the notion of girls' sensitivity to context, concerns the cultural significations of the context "game". There is a vast amount of literature pointing to the significant association between gender and frequency of electronic game playing (Griffiths, 1991). Males have considerably more computer-game experience than females, both in childhood (Subrahmanyam & Greenfield, 1994) and adulthood (Greenfield, Brannon, & Lohr, 1994). They have "learned how to learn" video games and have played and practised on them extensively and enthusiastically. Girls on the other hand tend not to be enthusiastic game players. For example, when interviewing children about their thoughts on video-games Stutz (1991) found that, in general, the girls were less keen than boys on gaming because they saw the computer world as being biased towards the male perspective. They were therefore discouraged from taking an interest in them (Stutz, 1996). It is therefore possible that the contextualising of the activity as a "game" effectively categorises the task as an activity somehow more appropriate for boys. Disengagement from the task then leads to a relative decrease in the girls' performance. A variant on this might posit that the description of the task as a game places the girls in a position of relative inexperience and it is an anticipation of failure which becomes a self fulfilling prophecy.

The further alternative is simply that the girls view the activity of gaming as a frivolous, unimportant activity and that their performance on the task is of little consequence. Aspects of identity are not bound up being a "computer gaming expert". The context of a "test", on the other hand, may signal the need to try to perform well. Getting good marks on tests in school is bound up with their sense of pupil identity, which we know is of importance to girls. So the lower performance of the girls in the game condition may simply reflect the fact that their reading of the task was one where outcome was not particularly important to them. Less good performance is not an indicator of "failure", rather a reflection of a lack of "concern".

It would be hard to demonstrate experimentally which of these explanations could best account for the girls' response to the categorisation of the task as a game. Careful post-task interviewing of the female participants could have a role to play here. Unfortunately, such data are not available to us in this study. It may, however, be possible to distinguish the first of the explanations ventured above from the others. The first explanation rests on the notion that encountering a game in a school context is particularly problematic . If this is the case, then we should not expect this pattern to be replicated if the same study were to be undertaken in non-school settings.

This study's findings resonate with those of other researchers interested in children's interactions with computer technology. For example, Malone (1981) studied the software preferences of school children and discovered that males had a preference for games or toys which provide interactive opportunities simply for their own sake. Girls on the other hand preferred purposeful software which might be classified as tools. Findings such as those reported by Malone and those presented here are of some significance just at the moment, because of the growth of the "edutainment industry" aimed at both home and school markets. Games are supposed to be synonymous with motivating children to learn and making learning fun. Currently, we hear a good deal about the potential of software with game-like qualities to promote learning (Griffiths, 1996) and computer game formats are increasingly being used as vehicles for educational tasks. The findings reported here suggest that, if we are concerned about fostering girls' enthusiasm for computers, then the presentation of a task as game may be more of a hindrance to than a support for learning and engagement with a task.

Whatever ultimately underpins the pattern of data presented here, what is clear is that we need to develop a fuller understanding of the particular contexts and situations which constitute girls' and boys' experience of computing activities. Only by studying the nature of these contexts will we come to understand the way in which particular situations and contexts may either constrain or offer the affordances necessary for initiating and supporting learning and engagement with computer-tasks and technology.

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Des différences liées au sexe concernant l'informatique ont été très souvent mentionnées dans la littérature. L'objet de la recherche est d'examiner l'effet du contexte dans lequel la tâche informatique est présentée sur les performances des garçons et des filles. Dans une étude expérimentale auprès de 60 enfants de 10 et 11 ans, les auteurs étudient les effets différentiels de la contextualisation dans une tâche perceptivo-motrice présentée sur ordinateur. Les résultats montrent qu'avec exactement le même logiciel standard, les performances peuvent être sensiblement affectées par le contexte dans lequel le logiciel est présenté. Ils montrent aussi que les différences de réponses entre garçons et filles sont relativement labiles et très sensibles au contexte. Les auteurs examinent les explications possibles et les implications de leurs resultats.

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Collaborative learning; gender and computing.

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Current theme of research:

Use of computers in education, medicine, and forensic science

Most relevant publications in the field of Psychology of Education:

Samuels, C., Butterworth, G., Roberts, A.D., Graupner, L., & Hole, G. (1994). Facial aesthetics: Babies prefer attractiveness to symmetry. *Perception, 23*, 823-831.

Roberts, A.D. (1995). Shared understanding of facial appearance – Who are experts? In Gorayska, B. (Ed.), *Advances in cognitive technology – The search for a humane interface*. North Holland.

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Current theme of research:

Processes and mechanisms of self conceptualisation.

Most relevant publications in the field of Psychology of Education:

Oosterwegel, A. (1995). Private goals and social influences: The complexity of studying self-system development. In A. Oosterwegel, & R.A. Wicklund (Eds.), *The Self in European and North American Culture: Development and Processes* (pp. 103-126). Dordrecht, The Netherlands: Kluwer.

Oosterwegel, A. (1996). Het zelf-concept bij kinderen van 6 to 18 jaar (The self-concept of children from 6 to 18 years old). In Bosch, Bosma, Oudshoorn, Rispens, & Vijt (Eds.), *Jaarboek Ontwikkelingspsychologie, Orthopedagogiek en Kinderpsychiatrie* (vol. II, pp. 184-215). Houten, NL: Bohn Stafleu Van Loghum.

Oosterwegel, A., & Oppenheimer, L. (1993). Development of the self-concept: How children perceive their own and others' ideas about themselves. *Journal of Applied Developmental Psychology, 14*, 443-460.

Oosterwegel, A., & Oppenheimer, L. (1993). *The self-system: Developmental changes between and within self-concepts.* Hillsdale, NJ: Lawrence Erlbaum.