Explicit and Implicit Task Switching between Facial Attributes

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Abstract

We examined task switching to different attributes of faces (gender, emotion, occupation) when an irrelevant aspect of the face could also change (e.g., the facial emotion could change when participants alternated every second trial between gender and occupation decisions). The change in the irrelevant attribute either coincided with a repetition or a switch in the explicit task. The results indicated disruptive effects of changing the facial emotion and gender of the face when it was irrelevant to the main task, but no effect of changing the occupation of the person.The data are consistent with the implicit processing of facial emotion and gender but not of higher-order semantic aspects of faces (the person?s occupation), unless those aspects are task-relevant.

Index terms— emotion, gender, face processing, cognition, implicit task switching, explicit task switching, face categorization.

1 Introduction

n observer perceives several attributes while looking at a face, for example gender, emotion, or identity etc. Some of these attributes may be extracted explicitly according to the demands of a particular task (e.g., retrieving information about the occupation of an individual), whilst others may be extracted implicitly, even when irrelevant to the task at hand. Whether our ability to compute these different attributes depends on the same or different processes is a question that has been of considerable interest for cognitive science. The present study aimed to examine this issue by assessing the ability of participants to switch from one attribute to another as they explicitly performed particular face processing tasks, and also by assessing effects of switching an irrelevant face attribute across trials as people perform tasks. There may also be some variables that exert an effect on switching even when they are irrelevant to the task, but which may or may not switch across trials. Here we examined whether changing or maintaining the emotional state of a face across trials affected the ability to switch between judgments of gender and occupation, made to faces. If emotion is extracted implicitly, then switches in emotion across trials may affect performance -for example, it may be disruptive when the primary task (e.g., gender discrimination) is maintained across trials and beneficial a) Functional independence of facial attributes Bruce and Young (1986) presented an influential cognitive model of face processing based on the assumption that face processing involved several functionally independent processing modules. The model assumed that identification of a familiar face involves the formation of a view independent structural description, which could be compared with all known faces stored in Face Recognition Units (FRUs), followed by identification of particular person and retrieval of semantic information, after which there is activation of the phonological codes underlying the person's name. Alongside the processes that lead to face identification and the retrieval of semantic and name information, Bruce and Young posited the operation of other processes that extract (e.g.) facial emotion. Hence the model suggests that face recognition (e.g., judged by access to semantic information about a person) is distinct from processing facial emotion. Quite how facial gender is computed is less clear -it could be retrieved by recognizing the person, or it could be computed from the structural properties of the faces.

2 b) Asymmetric interference between facial features

Studies have employed speeded judgments to different dimensions of faces and shown that interference can arise when there is variation in some irrelevant attributes (so-called 'Garner interference'). For example, Atkinson, Tipples, Burt and Young (2005) demonstrated that gender did interfere with the emotion judgments to a face (happy vs. fearful), but the reverse pattern of interference did not occur (when the task was gender classification (male vs. female). The same results were found using morphed faces in a speeded classification task (Schweinberger, Burton, & Kelly, 1999). These asymmetries between the processing of facial attributes indicate that observers, generally, are capable of responding to some aspects of a face (such as its gender) while ignoring the emotion of that face, but emotion processing can be interfered with by variation in other facial attributes (Schweinberger & Soukup, 1998).

Another way to examine the relations between the processing of different facial attributes is to evaluate the effects of switching from one task to another -if tasks use overlapping processes, then the effects of task switching may be reduced. In addition, the implicit processing of face attributes can be assessed by measuring effects of changing this attribute on performance of the (other) explicit tasks. If the attribute is processed implicitly, then it may affect performance on the explicit tasks when the implicit attribute changes (especially if the change in the implicit attribute coincides with the main task being maintained or changing). Here we used this approach to examine the relations between processing the gender, occupation and emotion of faces. The experiments were designed following Rogers and Monsell (1995), where tasks switched across pairs of trials rather than trial blocks. This enabled the implicit property to be changed or maintained in a dynamic fashion, coinciding with or contradicting the maintenance or change in the main, explicit task. Participants were asked to make gender and occupation decisions (experiment 1), gender and emotion decisions (experiment 2) and occupation and emotion decisions (experiment 3) to faces and the effect of switching from one explicit task to another was measured. In addition, the other attribute (emotion in experiment 1; occupation in experiment 2 and gender in experiment 3) was varied. Are there differences in task switching between different explicit tasks (across the experiments), and are there effects of switching or maintaining the implicit property? We report effects of changing facial emotion and gender as an implicit manipulation but not effects of changing occupation.

3 Method a) Participants

Sixteen postgraduate students from the University of Birmingham (9 female and 7 male, ages 21-25 years, mean 23.25 years) with normal color vision, volunteered for the study in response to an advertisement. None had reported any injury, disease or eye surgery.

4 b) Materials and displays

Gender-occupation task stimuli.The stimuli were 16 faces in color bitmap images (standardized to 300 × 300 pixels & matched subjectively for luminance and contrast) of 8 famous singers and actors which depicted happy and neutral facial emotional expression. Half of the images were of women. The 8 photos of singers comprised Robbie Williams, Paul McCartney, Britney Spears, Madonna, while 8 photos of actors included Daniel Radcliffe, Rowan Atkinson, Kate Winslet, and Elizabeth Taylor. These stimuli were embedded in Rogers and Monsell's (1995) alternating-run task switching paradigm. Pilot testing ensured that the famous faces were recognizable by the sample population, and efforts were made to equate the famous faces in terms of stimulus quality (e.g., resolution) as well as face angle, race (white), emotional expression (positive & neutral), and attractiveness. Half of the pictures portrayed happy expression (smiling-obvious teeth). The experiment was designed in E-prime software **??**Schneider, Eschman, & Zuccolotto, 2002, version 1.2). The faces were presented in the lower right/left quadrants as a cue for the occupation task while presented in upper right/left quadrants as a cue for the gender task. For half of the participants, the experiment started with the presentation of the gender task. For the other half, the occupation task was presented first. While half the faces were happy the other half were presented with a neutral expression, so the emotion could change when the main task stayed the same or changed-creating a 2 (emotion switch or repeat) x 2 (main task switch or repeat) design. Each trial consisted of a fixation (+) displayed for 1000 ms, followed by a blank white screen, then the face appeared in upper/lower quadrants with a fixation cross (+) in the center of the screen. A manual response was made to the face.The stimuli were presented on a 14 inch laptop and remained on the screen until the response was made. Participants were presented with 241 trials experimental trials.

5 c) Procedure

The study received approval by University of Birmingham Ethic Research Committee.Upon arrival participants were given an informed consent form to review and sign. Upon consent, they were given a description of the procedure. Next, s/he was seated before the laptop at a comfortable viewing distance (approximately 60cm). Participants were told that this was a reaction time experiment, and that they must respond by pressing the fixed keys on keyboard as quickly as possible without sacrificing accuracy. The stimuli and the tasks were then explained (genderoccupation). On each trial, participants were presented with a face and they were required to judge gender (male/female) or occupation (actor/singer) of the face in 241 experimental trials of the gender and occupation task. Following the experiment, the results were saved and participants were debriefed and thanked for their participation.

6 III.

7 Results

RTs for the first trial were discarded because no task switch took place, thenoutliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participants' mean. Responses longer than 3,000 ms or shorter than 100 ms were omitted. The data are reported in two sections. First, the effect of explicit task switching was assessed with the data for the gender and occupation tasks. Second, the effect of implicit emotion switch was examined with the data averaged across gender and the occupation tasks on the switch and repeat trials.

8 a) Explicit task switching

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (switch vs. repeat) x task (gender judgment vs. occupation judgment) as within subject factors. The main effect of task switch was significantF(1, 15) =33.00, p<0.001,MSE=13881.18, ?p2=.68. RTs were slower on switch (M=961.94 ms) than repeat (M=792.72 ms) trials. There was a reliable main effect of task F(1, 15) =92.80, p<0.001,MSE=1385.76, ?p2=.86. The RTs were faster on the gender than the occupation task (M=832.50 vs. 922.16 ms respectively). There was a significant interaction between task switch and task F(1, 15) =10.04, p<0.01,MSE=1178.68, ?p2=.40 (Fig. 1). Pair wise comparisons revealed a significant difference in switch costs (switch -repeat trials) between the gender and occupation tasks t (15) = 3.16, p<0.01. The switch cost was larger for the occupation than for the gender task.

9 b) Effect of implicit emotion

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (switch vs. repeat) x emotion switch (emotion switch vs. emotion repeat) as within subject factors. The main effect of task switch was significantF (1, 15) =28.34, p<0.001, MSE=13433.04, ?p2=.65. RTs were slower on switch (M=954.41 ms) than repeat (M=800.15 ms) trials. The main effect of emotion switch was significant (1, 15) =42.51, p<0.001, MSE=4506.93, ?p2=.73. RTs were slower on emotion switch (M=931.99 ms) than repeat (M=822.57 ms) trials. There was significant interaction between emotion switch and task switch F(1, 15) =13.84, p<0.001,MSE=1006.10, ?p2=.48 (fig. 2). This was decomposed by analyzing the data separated for emotion switch and emotion repeat trials, for the task switch and task repeat conditions. For the task switch condition, there was a significant effect of emotion switchF(1, 15) =46.73, p<0.001,MSE=3304.14, ?p2=. 75. RTs on emotion switch trials were slower than emotion repeat trials t (15) = 6.83, p<0.001. For the task repeat condition, there was also significant effect of emotion (1,15) =23.13, p<0.001,MSE=2208.89, ?p2=. 60. RTs on emotion switch trials were slower than emotion repeat trials t (15) = 4.81, p<0.001. The interaction arose because the effect of switching the emotion of the face was larger on trials where there was a switch in the explicit task than on trials here the explicit task remained the same (Fig. 2). Error bars correspond to the average standard error.

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 1.

10 Discussion

The study showed that the occupation decision task showed larger effects of task switching than the gender decision task. This asymmetrical task switching effect cannot be attributed to selective inhibition of the easier task here, to enable switching to take place (see Allport & Wylie, 1999, for experiments on task switching with Stroop stimuli). An alternative account is that it was less easy for participants to disengage attention from the gender than the occupation task, and this slowed switches to occupation decisions.In addition to this, the experiment showed clear effects of repeating or switching the emotional state of the faces. RTs were faster if facial emotion stayed the same than if it changed. Interestingly, this effect of changing the emotional state was larger on switch than repeat trials in the explicit task. It may be that, when the explicit task switches, participants are distracted from the explicit switch by the change in the (implicit) emotional state of the face, and this slows performance on the explicit switch trial. Whatever the case, the data indicate that facial emotion was processed, even though it was irrelevant to the main tasks.

Experiment 2: gender and emotion decisions (implicit change in occupation)

V.

11 Method a) Participants

Sixteen postgraduate students from University of Birmingham (10 female and 6 male, ages 20-25 years, mean 22.81 years) with normal color vision, volunteered for the study in response to the advertisement. None had reported any injury, disease or eye surgery.

12 b) Materials and displays

Emotion-gender task stimuli. The stimuli and displays were same as in experiment 1 except that the faces were presented in the lower right/left quadrants as a cue for the emotion task while they were presented in the upper right/left quadrants as a cue for the gender task. For half of the participants, the experiment started with the presentation of emotion task. This was counterbalanced across participants. The occupation of the individuals could be repeated or switched across trials, and this created a 2 x 2 design where the explicit tasks either repeated or switched while there was either a repeat or switch of the implicit task (occupation).

13 c) Procedure

The procedure was the same as in experiment 1 except that the stimuli and the tasks were explained as emotion-gender. On each trial, participants were presented with a face and they were required to judge the emotion (happy/neutral) or gender (male/female) of the face in 241 experimental trials of the emotion and gender task. Following the experiment, the results were saved and participants were debriefed and thanked for their participation.

14 VI.

15 Results

As for the experiment 1, the effect of explicit task switching was assessed with the data for the emotion and gender tasks (relevant features) on the switch and repeat trials separately. Second, the effect of implicit occupation switches on the task switch and task repeat conditions was examined with the data averaged across the emotion and the gender tasks.RTs for the first trial were discarded because no task switch took place for the first trial, thenoutliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participants' mean. Responses longer than 3,000 ms or shorter than 100 ms were omitted. a) Explicit task switching Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (switch vs. repeat) x task (emotion judgment vs. gender judgment) as within subject factors. The main effect of task switch was significantF (1, 15) =153.05, p<0.001, MSE=17105.91, ?p2=.91. RTs were slower on switch (M=1179.12 ms) than repeat (M=774.60 ms) trials. There was a reliable main effect of the task F (1, 15) =73.11, p<0.001,MSE=3868.73, ?p2=.83. RTs were faster on the emotion than the gender task (M=910.37 vs. 1043.34 ms respectively). There was a significant interaction between task switch and task F (1, 15) =49. 81, p<0.001, MSE=2967.78, ?p2=.76. Pair wise comparison on the switch cost (switch minus repeat trials) between the emotion and the gender task was significant t(15) =7.05, p<.001. The switch cost for the gender task was larger than for the emotion task (Fig. 3).

16 b) Effect of implicit occupation switch

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (switch vs. repeat) x occupation switch (occupation switch vs. occupation repeat) as within subject factors. The main effect of task switch was significantF (1, 15) =140.59, p<0.001, MSE=17980.83, ?p2=.90. RTs were slower on switch (M=1179.12 ms) than repeat (M=774.60 ms) trials. There was no effect of occupation switch F(1, 15) =0.02, p=0.87,MSE=954.35, ?p2=. 00.The interaction between task switch and occupation switch was significant F(1, 15)=4.71, p<0. 05, MSE=629.31, ?p2=.23 (Fig. 4). There was a small cross over result in which responses on explicit task switch trials were slower when the occupation of the faces changed than when they stayed the same, while when the explicit task repeated, RTs tended to be faster when the occupations of the faces switched. However the effects of switching the occupations of the faces were not reliable, either for trials where the explicit task stayed the same and when it switched (t <2).

17 Discussion

As in experiment 1, there were again asymmetrical effects of task switching in the primary (explicit tasks), with task switch effects now being larger on the gender than the emotion decision tasks. Indeed the effects of task switching on the gender task were reliably greater here than in experiment 1 (t(30) =6.90, p<.001). Again this result does not reflect inhibition of the easier task, since the emotion decisions were faster than the gender decisions on repeat trials. Rather the results can be attributed to the difficulty in switching attention from face emotion to compute gender, slowing gender decisions on switch trials. In contrast to experiment 1, there were very weak effects of switching another aspect of the faces -the occupations performed by the actors. There was no main effect of implicit task switch, and though there was a borderline interaction between implicit and explicit task switching, the differences between repeat and switch occupation trials were not reliable for either the repeat or the switch trials in the explicit task. The data suggest only weak computation of an individual's occupation when this is not the explicit task that must be performed.

18 b) Materials and displays

Emotion-Occupation Task stimuli. The stimuli and displays were same as in experiment 1, except that the faces were presented in lower right/left quadrants as a cue for the emotion task while presented in upper right/left quadrants as a cue for the occupation task. For half of the participants, experiment started with the presentation of the emotion task. This was counterbalanced across participants, as the other half of participants performed occupation task first.

19 c) Procedure

The procedure was the same as in experiment 1, except that the stimuli and the tasks were explained as emotion and occupation decisions. On each trial, participants were presented with a face and they were required to judge the emotion (happy/neutral) or occupation (singer/actor) of the face in 241 experimental trials of the emotion and occupation task. Following the experiment, the results were saved and participants were debriefed and thanked for their participation.

20 IX.

21 Results

As for experiment 1, the data are reported in three sections. First, the effect of explicit task switching was assessed with the data for the emotion and occupation tasks (relevant features of the task) on switch and repeat trials separately. Second, the effect of an implicit gender switch was examined with the data averaged across the emotion and occupation task on switch and repeat trials. RTs for the first trial were discarded because no task switch took place for the first trial, thenoutliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participant's mean. Responses longer than 3,000 ms or shorter than 100 ms were omitted. a) Explicit task switching Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (switch vs. repeat) x task (emotion judgment vs. occupation judgment) as within subject factors. The main effect of task switch was significant$F(1, 15) = 204.06$, $p<0.001$,MSE=6515.87, ?p2=.93. RTs were slower on switch (M=1275.37 ms) than repeat (M=967.42 ms) trials. There was a reliable main effect of task $F(1, 15) = 151.29$, $p<0.001$,MSE=4439.44, ?p2=.91. RTs for the emotion task were faster than for the occupation task (1008.80 vs. 1205.69 ms, respectively). There was a significant interaction between task switch and task (1, 15) =37.85, $p<0.001$,MSE=4381.40, ?p2=.71 (Fig. 5). The task There was no interaction between task switch and gender switch $F(1, 15) = 2.41$, $p=0.14$,MSE=3652.20, ?p2=.13 (Fig. **??**). Fig. **??** : Mean reaction times (ms) on thetask switch and task repeat trials for the gender switch and gender repeat trials.Error bars correspond to the average standard error.

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 3.

22 Discussion

The effects of switching explicit tasks mirrored those found in experiment 2. There was an asymmetry in switch costs with the effects on occupation decisions being larger than those on emotion decisions. As emotion decisions were also faster than occupation decisions on repeat trials, the data cannot be attributed to inhibition of the easier task when switch costs would be larger on emotion decisions). However the results fit with the argument that facial emotion is difficult to disengage from, and hence switch costs are increased to the non-emotion task. Indeed, as for the effects of switching to the ender task in experiment 2, there were increased effects of task switching on occupation decisions ($t(30) = 5.30$, $p<0.001$) here relative to experiment 1 (when occupation decisions were paired with gender decisions). It should be noted here that switch costs changed as a function of the other explicit task it was paired with (i.e., larger when paired with gender decisions ($t(30) = 2.93$, $p<0.01$) than when the emotion decisions were paired with occupation decisions.Unlike the changes in the occupations of the faces, which had minimal effect when occupation decision was not the main task, changing the gender of the faces did affect performance here. RTs were slowed when faces changed gender than when the gender stayed the same, even though the gender of the individuals was irrelevant to the task. The data indicate that there is implicit processing of the gender of the faces. It is interesting that this evidence for implicit processing of facial gender occurred here even though famous faces were used. Quinn, Mason, and Macrae (2009) reported that the gender of famous individuals was not automatically coded. These data contradict this assertion and suggest that implicit task switching effects may provide a particularly sensitive way to measure whether facial attributes are processed.

23 a) General Discussion

This study provides clues from task switching for an asymmetric relationship between the processes underlying judgments of facial attributes. In experiment 1, gender was faster than the occupation task but the occupation task yielded larger switch costs. In experiment 2 emotion decisions were faster than gender decisions, but the gender task produced larger switch cost than the emotion task. In experiment 3, the emotion task, again was faster than the occupation task but the occupation task showed larger switch costs. These results counter the argument that asymmetric switch costs necessarily emerge because participants must inhibit the easier of two tasks to enable the harder task to be conducted. It is interesting that this result occurred here despite that fact that the stimuli (faces) were the same in all the tasks, and so the same stimulus could have cued the more automatic process, and this might need to be inhibited to enable performance to be effected. The failure to find larger switch costs on the easier tasks (gender in experiment 1 and emotion in experiments 2 and 3) suggests instead that the asymmetric switch costs may reflect the ease of disengaging attention from a more salient property of the stimulus (facial emotion or gender) compared with a less salient property (occupation). If participants maintained attention on the more salient property, then large switch costs would emerge on the other task.

As well as requiring participants to make explicit switches from one task to another, we also examined the effects of making an implicit switch, when an irrelevant attribute of the stimulus changed across trials (emotion, occupation and gender, in experiments 1-3 respectively). When emotion and gender changed, performance on the other tasks was affected. In experiment 1, changes in emotion affected both repeat and switch trials in the main tasks, with the effects on switching being stronger. To account for this, we suggest that participants found it difficult to select the appropriate aspects of the face to respond to -when both the emotional state of the face and the task changed. In experiment 3, effects of changing gender were also pronounced, but in this instance it affected performance equally in the repeat and switch trials of the main tasks. One reason why effects were less pronounced on switch trials in this case is that the switches involved facial emotion, which might be a relatively strong cue either to switch tasks or to repeat the task, so that equal effects of changing facial gender occurred in both instances. In contrast to these effects, switching the occupation associated with the face had minimal effect of gender and emotion decisions.

These results fit with the idea that facial emotion and gender are computed in a relatively automatic way, even when they are irrelevant to the main task. Hence changing the facial emotion or gender slowed performance, perhaps by distracting attention from the main task(s). In contrast to this, there was little evidence that the occupations of people are computed in other face processing tasks.

Within accounts such as that of Bruce and Young (1986) these results can be accommodated if emotion and gender are computed by slave systems, slave systems operating automatically. In contrast, access to semantic information from faces (related to peoples' occupations), depends on attention to the relevant aspects of the face. The data indicate that there is implicit processing of the gender of the faces. It is interesting that this evidence for implicit processing of facial gender occurred here even though famous faces were used. Quinn, Mason and Macrae (2009) reported that famous faces were not classified automatically for gender. The data here contradict this assertion and suggest that implicit task switching effects may provide a particularly sensitive way to measure whether facial attributes are processed.

24 XI.

25 Conclusion

We have provided evidence from a task switching paradigm that: 1. There are asymmetrical effects of switching between different judgments with face stimuli, and in particular it was difficult to switch from emotion judgments to make gender and occupation judgments. This is consistent with facial emotion being difficult to disengage from. 2. Judgment of facial attributes can be significantly influenced by changes in the emotion and gender of faces even when emotion and gender are irrelevant to the task at hand. These data indicate that emotion and gender are processed automatically. [1]

1

Figure 1: Experiment 1 :

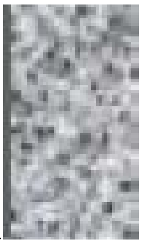
1 

Figure 2: Fig. 1 :

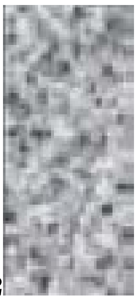
2 

Figure 3: Fig. 2 a

2 

Figure 4: Fig. 2 (

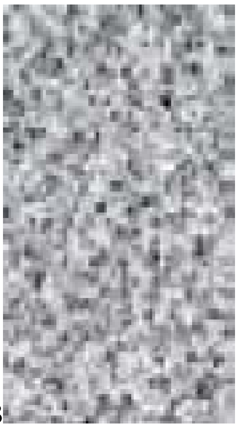
3 

Figure 5: Fig. 3 :

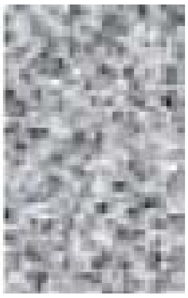
4 

Figure 6: Fig. 4 :

3 

Figure 7: Experiment 3 :

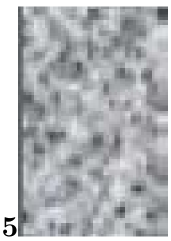
5 

Figure 8: Fig. 5 :

1

Gender		Occupation		
Switch		Repeat	Switch	Repeat
M (SD)		M (SD)	M (SD)	M (SD)
2 (.02)		1 (.02)	2 (.02)	2 (.01)

Table 1 a : Mean error rate (standard deviation) for the effect of implicit emotion switch in the gender and occupation task

Emotion Switch	Emotion Repeat
M (SD)	M (SD)
2 (.02)	1.5 (.01)

IV.

Figure 9: Table 1 :

2

Emotion		Gender	
Switch	Repeat	Switch	Repeat
M (SD)	M (SD)	M (SD)	M (SD)
3 (.02)	2 (.02)	2 (.02)	3 (.01)

Figure 10: Table 2 :

2

task

Occupation Switch	Occupation Repeat
M (SD)	M (SD)
2.5 (.02)	2.5 (.01)

VII.

Figure 11: Table 2 a

3

Emotion		Occupation	
Switch	Repeat	Switch	Repeat
M (SD)	M (SD)	M (SD)	M (SD)
2 (.02)	1 (.02)	2 (.02)	3 (.01)

Figure 12: Table 3 :

3

task	
Gender Switch	Gender Repeat
M (SD)	M (SD)
2 (.02)	2 (.01)
X.	

Figure 13: Table 3 a

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