Studies in the nature and consequences of Computer-Mediated Ostracism

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Declaration of Authorship

I, Emma McHarg, hereby declare that this thesis and the work presented in it is entirely my own. Where I have consulted the work of others, this is always clearly stated.

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Abstract

Ostracism has been shown to have a variety of negative effects on the target, though the reported nature of these has varied due to differing manipulations of the phenomenon. The experiments reported attempt to characterise the consequences of computer-mediated (CM) ostracism using a range of approaches. Investigation of on-line social behaviour in Internet chat rooms revealed similar patterns of group behaviour, including ostracism, to those reported in face-to-face communication. Fourier analyses revealed periodic structure to the comments made in CM group communication qualitatively similar to that previously reported in dyadic face-to-face communication. Identity changes and ostracism occurrences were also found to be periodic. The power spectra produced by these analyses revealed that comments, identity changes and ostracism typically showed a gradient of $1/f$ - $1/f^2$, a characteristic common to many physical and biological systems but not previously reported in social communication.

Further experiments revealed that level of anonymity did not modulate a reduction in comments made by CM ostracised participants. Thus the partial anonymity conferred by CM communication cannot account for the differential effect of ostracism in CM and face-to-face contexts. Experiments on the effect of ostracism upon cognition revealed that ostracised participants reacted significantly slower on a Stroop task, but made fewer errors. Performance on a Remote Associates Task was bifurcated whereby those who accurately estimated the extent of their exclusion performed significantly worse than non-ostracised participants. Ostracised participants who under-estimated their exclusion performed similarly to non-ostracised participants.

Many of these findings are consistent with a hypothesis that ostracism may be considered a form of (social) pain whose consequences may be mediated by neural substrates that partially overlap with those implicated in responses to physical pain. The findings suggest that a full characterisation of individual and situational differences in ostracism effects may require a combination of techniques, from neuro-imaging to traditional social psychological methodologies.

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Introduction

"Physiology and psychology cover, between them, the field of vital phenomena; they deal with the facts of life at large, and in particular with the facts of human life."

- Wilhelm Wundt (1874/1904)

The constant refinement of psychological techniques and paradigms over the last century has, to a large extent, obscured the roots of Psychology within experimental philosophy and its extant discourses are somewhat distal from its original motivation to address the fundamental question "What does it mean to be human?" Just as the advent of new techniques and technologies of the 19th century served to shape the investigation of the human condition, the emergent technologies of the 21st century provide a broad spectrum of tools that both inform psychological investigation and anticipate the possibility of Psychology returning to the agenda hinted at by Wundt 150 years ago.

Emerging social and technical innovations provide both challenges to, and opportunities for, our understanding of the human condition. With the increasing opportunity for social exchange provided by new technologies such as the Internet, the task of managing patterns of interaction across a variety of media may produce different experiences of the social world than were possible previously. Hand in hand with these changes in our management of human interaction are a plethora of strategies for its investigation, ranging from traditional social psychology, through psychophysics, to fMRI. The present investigation represents an attempt to harness new and old empirical techniques and discourses, in order to identify some of those

social and technical changes that may provide tools for the investigation of how interpersonal interaction is constrained. The implementation of such tools may help to address the question of how one specific aspect of interaction, ostracism, may be better understood in a range of contexts.

Ostracism is a phenomenon which has a long history at both a societal and individual level and is also common across many other social species. Its commonplace occurrence in human interaction in a variety of settings means that it constitutes a phenomenon amenable to investigation from a wide variety of approaches. In such a wide investigation, we aim to converge the cumulative techniques and discourses of over a century of Psychology back to its roots within experimental philosophy in order to address the fundamental articulation of our phenomenology, society and physiology. A recurrent theme that emerges throughout the investigation is that of how the impact of technology such as the Internet is both the object of study and a tool for study. This dual-position has lead to both insights and challenges that have motivated the eclectic blend of approaches in that which follows.

Chapter 1 introduces previous research on the consequences of ostracism in both face-to-face and online settings, while chapter 2 addresses the background to research in identity management and computer-mediated communication to better understand the new setting in which ostracism will be studied. Chapters 3 & 4 report the first empirical work of the thesis, an exploratory study of group behaviour (including ostracism) and identity management in an Internet setting using both descriptive and quantitative methodologies. Chapter 5 reports the second empirical work of the thesis, an experiment investigating the effects of altering certain aspects of the computer-mediated environment on the effects of

ostracism. In chapter 6, some newer psychological techniques are introduced. More specifically, how these approaches have already been shown to, and may continue to be, useful in answering the questions raised regarding the effects and consequences of ostracism. Chapter 7 reports the third and final empirical work of the thesis – an investigation into the effects of ostracism upon cognition, in light of the new approaches outlined.

Chapter 1 - Ostracism

The term "ostracism" has its origins in the politics of ancient Greece and more specifically, Athens. Before the democratisation of Athens the practice of exile had been widely used to settle political rivalries. This, however, led to frequent and often violent changes of power between small groups of elite citizens, as exiles sought support from foreign allies and returned to re-seize power from those that had exiled them (Forsdyke, 2005). By contrast, during the democratisation of Athens, the process of "ostracism" (named after the small pieces of pottery (ostraka) which were used to cast votes) became controlled by the people, with an annual vote as to whether an ostracism should be made and, if so, who should be ostracised. Under Athenian law, an individual who had been ostracised was required, on penalty of death, to leave the city for 10 years. Those chosen for ostracism tended to be rich, powerful and politically active individuals, possibly in order to neutralise political confrontation or prevent potential tyranny, although the precise reasons for ostracism from Athens were not always clear (e.g. Forsdyke, 2000). Eventually, towards the end of the 5th century, the process of ostracism as a State based method of political control largely died out in Athens. While this form of ostracism is no longer in use, a new version of societal ostracism has emerged, whereby the State has the capacity to impose residential restrictions on certain individuals (e.g. sexual deviants, Walsh, 2007). This is in many ways the exact antithesis of Greek ostracism: where in Athens the individuals in the population could exercise control over the powerful, in modern State ostracism, the powerful exercise control over the individual.

The political use and purpose of ostracism may have changed over the millennia, but the use of interpersonal ostracism is a common experience to most individuals (e.g. the "silent treatment": deliberately not speaking to a person in their presence; Faulkner, Williams, Sherman & Williams, 1997; "the act of being excluded or ignored"; Williams, 1997). While these everyday, interpersonal experiences may be considered on a different scale to these State actions, the effects and consequences for the individual targets (and sources) remain significant and wide-ranging. In many cases of ostracism, there are reports of increases in affective distress (e.g. Williams & Sommer, 1997), increased aggression towards others (Twenge, Baumeister, Tice & Stucke, 2001) and reductions in cognitive ability (Baumeister, Twenge & Nuss, 2002).

One of the earliest investigations of ostracism was conducted by Geller, Goodstein, Silver & Sternberg (1974). To induce ostracism, one participant was left in a room with two confederates for ten minutes. In half of the trials, the participant was included in a conversation with the confederates, and in the other half of the trials, the participant was ignored by the confederates (sources of ostracism). The results showed that those who had been ignored (targets) made fewer comments per minute than control participants, even in the very first minute of the ostracism period. On a post-test questionnaire, targets of ostracism were significantly more likely than non-ostracised participants to choose adjectives such as "alone", "withdrawn" or "shy" to describe how they felt, rather than "relaxed", "comfortable" or "friendly". Targets were also significantly more likely to rate both themselves *and* the sources less favourably on a social presentation scale. Finally, in a behavioural measure, whereby participants had an opportunity to financially reward the confederates, but at some cost to themselves, it was found

that participants who had been included all gave away more money than they kept, whereas 5 of the 19 targets kept more money than they gave away, and were less likely to give away as much money. This early experiment demonstrated that ostracising people could be very effective at lowering their opinions of themselves, and also led targets to withhold, or at least minimise, benefits from the sources.

Research into ostracism diminished over the following years, but in 1997 Williams reawakened interest in the area with a new model of social ostracism, which he later refined in 2009. Williams (1997) argued that the negative effects of ostracism on the target were a result of a unique challenge to what he termed four basic human needs: self-esteem, control, belonging and a sense of meaningful existence. The ostracised individual, as characterised by Williams and co-workers, has a lower sense of self-esteem, control, belonging and meaningful existence. Under Williams' scheme, response to ostracism is consequently likely to include behaviours which may repair these needs, for example by taking control of a situation or by increasing group affiliative behaviour (such as conformity or increased effort on tasks which may benefit the group).

In a later refinement to the model, Williams (2009) introduced a temporal component to the model. Immediate response to ostracism is charactersied by negative affect and distress at being ostracized, and this immediate aftermath is termed "reflexive" – an instinctive response to an aversive stimuli. After a short period of time, the target of ostracism moves into what Williams termed a "reflective" response to ostracism. This secondary response is more likely to take contextual factors, such as whether the target actually wants to be included in that group or whether the perceived source of ostracism simply did not see them, are taken into account. Once these factors have been considered, any response to

ostracism may significantly reduce from the initial, reflexive response in terms of behavioural efforts to regain pre-ostracism levels of the four needs and in terms of overall recovery time.

The model also described different types of ostracism, based on the dimensions of visibility, motives, quantity and clarity. These different dimensions are posited to have an effect on the eventual impact of ostracism on the target. Visibility refers to the physical relationship between source and target of ostracism, such that physical ostracism is physically removing the self from the situation, for example, leaving the room. Social ostracism involves remaining physically present, but removing emotional contact with the source, for example, by refusing to speak to the target and avoiding eye contact. The motives for ostracism may be fairly innocuous and result in minimal impact on the target – for example, cases where ostracism is misperceived ("not ostracism") or cases where it is culturally normal (e.g. in a lift, on a train – "role-presecribed"). Further possible motives for ostracism which may mediate its impact on the target include defensive ostracism (where the source fears negative evaluation from target) and punitive ostracism. The quantity of ostracism may be high or low, in that it may occur briefly or over a long period of time. Finally, the clarity of the ostracism may also affect the target, in terms of how obvious the ostracism is to the target.

Empirical evidence for the model has been provided by a number of research studies, using different methods to induce ostracism. For example, Williams, Bernieri, Faulkner, Grahe & Gada-Jain (2000) ignored each other for a day at a time and recorded their reactions in diaries. In Williams & Sommer (1997), participants were left in a waiting room with two confederates who began to throw a ball to each other, either including the participant in the "spontaneous" game, or

leaving them out. With the move into computer-mediated experimentation by Williams, Cheung & Choi (2000), an alternative form of this manipulation was developed, named "Cyberball". In this manipulation, participants logged onto a computer to play a game designed to test mental visualization ability. The game consisted of three icons representing the three players and a virtual ball. On their turn, each player could select another player to "throw" the ball to. The participants believed that the other two players were connected to the game remotely, whereas in fact, they were pre-programmed by the experimenters such that the participant received the ball on a set proportion of throws.

A series of studies, both on- and off-line, by Williams and colleagues reported reductions in self-reported levels of the four basic needs proposed by Williams as a result of being ostracised for even a short (circa 5 minutes) period of time. Williams and co-workers also argued that in response to these threats in the short-term, the targets of ostracism endeavoured to repair the damage in a variety of ways, such as increased conformity in a later task (Williams, Govan, Croker, Tynan, Cruickshank & Lam, 2002), increased compliance (Carter-Sowell, Chen & Williams, 2008), working harder on collective tasks (Williams & Sommer, 1997) or showing increased desire for control over another individual (Lawson Williams & Williams, 1998, as cited in Williams, 2009). A later study by Warburton, Williams & Cairns (2006) suggested that while increased aggression may be evident after ostracism (somewhat contrary to the previous findings regarding increased pro-social behaviour) this effect could be moderated by a manipulation of the targets' sense of control. Ostracised participants who had no control over an auditory task before an aggression measure (amount of hot sauce given to a third party) showed higher levels of aggression than both ostracised participants who

were given the opportunity to take control of the auditory task and non-ostracised participants. The ostracised participants with control and non-ostracised participants showed similar levels of aggression. Thus, repair to the need for control appeared to modulate negative behavioural responses from the ostracised participants. Jamieson, Harkins & Williams (2010) report that while performance on an antisaccade task was reduced in ostracized, relative to included participants, this pattern could be reversed when participants were able to compare the performances of other players. This effect was mediated by scores on a test of belonging, indicating that those who felt their need to belong threatened tended to improve their performance in a comparative situation, in an attempt to make themselves more attractive to the group.

Further research indicated that the negative effects of ostracism are not limited to the initial sources of ostracism that the participant may feel a need to be liked by. Zadro, Williams & Richardson (2004) showed that even when the source of ostracism is known by the target to be a computer programme, targets still reported lowering in reported levels of all four needs. Further still, Gonsalkorale & Williams (2007) reported that even when the source of ostracism is an outgroup despised by the target (e.g. the Ku Klux Klan), the negative effects of ostracism are precipitated. Moreover, van Beest & Williams (2006) reported that even when targets of ostracism were awarded more prize money than their included counterparts, thereby introducing a benefit to ostracism, the targets again reported a lowering on each of the four "basic" needs proposed by Williams. However, Gonsalkorale, Carter-Sowell, Sloan & Williams (2008, as cited in Williams, 2009) reported that recovery from ostracism in the KKK situation (i.e. return to pre-ostracism levels of the four needs) was faster when the source of ostracism was a

member of the KKK than a member of the same political party as the target. Thus, while a negative response may be elicited by ostracism even in apparently unusual circumstances, it would appear that those circumstances may be taken in consideration in a reflective state and affect recovery time.

Smith & Williams (2004) report that a manipulation where the target of ostracism simply did not receive text messages after an initial contact was also sufficient to elicit the previously reported decreases in reported levels of each of the four needs. Jones, Carter-Sowell, Kelly & Williams (2009) report that participants who were not passed information from their group ("out-of-the-loop") also reported lower levels of the four needs. Thus, it would appear that the negative effects of ostracism are manifest in the absence of social comparators.

Most of these investigations yielded very similar results and were consistent with Williams' model and the predictions of need-threat and attempted repair. An alternative method of inducing ostracism, using computer-mediated communication, revealed a qualitatively similar, but quantitatively different pattern of results. Williams et al (2002), in an explicit comparison of face to face (social ostracism) and online (cyberostracism) settings, reported that although participants were still acutely aware of being ignored online, and recorded lower levels on each of the four needs as a result, this effect was significantly less than in face-to-face situations. The reasons for this are, as yet, still unclear, but one other behavioural difference was noted. Williams et al (2002) observed that targets in online discussions continued to contribute, even commenting on the fact they were being ignored, and also became visibly more agitated, getting up and walking around more. Williams et al (2002) termed this type of behaviour virtual bravado, and, based on this observation, analysed the proportion of comments made by targets of

ostracism in face-to-face and online settings. The researchers found that those in the online setting made significantly more comments, proportionately, than those in face-to-face settings.

Thus, both online and face-to-face ostracism results in lowered self-reported levels of self-esteem, control, belonging and sense of meaningful existence. Behavioural consequences of ostracism and the reported aversive impact were consistent with an attempt to repair these needs in a variety of ways, from increased conformity to taking further control, when possible. However, other behavioural consequences diverged, such as the reported increase in number of comments made by ostracised participants in online ostracism and the reduced aversive impact in online ostracism compared to face-to-face ostracism.

A separate group of researchers, led by Baumeister and Tice, have investigated what they term social exclusion. They and a variety of co-workers, have used two manipulations to induce feelings of exclusion. The first manipulation involves the participant being told that nobody from a group they just met wants to work with them on the next task (manipulation 1). The second manipulation comprises false feedback from a personality test indicating that the participant will probably end up alone later in life (manipulation 2). Over the course of these studies, they have reported a variety of different reactions to these induced feelings. Twenge, Baumeister, Tice & Stucke (2001) reported that excluded participants were more aggressive towards others, unless the potential target was actively positive towards them. The mechanism for this aggression post-exclusion is not yet well understood, but DeWall, Twenge, Gitter & Baumeister (2009) suggest that a hostile cognitive style may become more prominent after exclusion, such that neutral cues were more likely to be interpreted as aggressive or hostile by excluded than non-

excluded participants. However, Twenge, Zhang, Catanese, Dolan-Pascoe, Lyche & Baumeister (2007) reported that aggressive responses could be reduced if participants took part in a friendly social exchange with an experimenter immediately after the exclusion manipulation.

Twenge, Catanese & Baumeister (2002) suggested that self-defeating behaviour was also more likely in excluded participants. Participants were given a range of choices to make during a waiting period. Excluded participants were more likely to choose a high risk lottery choice than control groups, to make unhealthy choices about which snacks to eat, read entertainment magazines rather than a health questionnaire and take a resting rather than running pulse. They also spent more time playing games or reading a magazine when left alone rather than preparing for a test. Twenge, Catanese & Baumeister defined these behaviours as self-defeating, as in all cases the healthy or sensible, but more difficult, option was overlooked by the excluded participant.

Baumeister, Twenge & Nuss (2002) found that excluded participants performed worse on an IQ test, both attempting fewer questions and giving more incorrect answers than controls. In further experiments to test the hypothesis that social exclusion caused some form of cognitive deficit, the researchers found that excluded participants performed significantly worse than controls on a difficult reading comprehension task, but no differently on a simpler test. They also reported that the deficit was in the recall rather than encoding aspect of the task. In a final experiment the authors found that excluded participants showed a specific deficit in tasks that required logical or analytical thinking, but performed equally well on a simple recall task. On the basis of these findings it was suggested that exclusion yields a deficit in *"...controlled processes and executive function…"*

(p.824) but that recall in general is unaffected. However, by contrast with the reported findings of Jamieson, Harkins & Williams (2010), there was no comparative component to this task which may have motivated the participants who felt excluded to improve their performance.

Twenge, Catanese & Baumeister (2003) proposed that excluded people *"enter the defensive state of cognitive deconstruction" (p421)*, essentially trying to partially dissociate themselves from their environment, both internally and externally, to protect themselves against the negative feelings aroused by exclusion. Excluded participants were shown to perceive time to be passing slower, be more present than future oriented and less able to defer gratification. Excluded participants were also more likely to agree with the statement "Life is meaningless" and showed increased lethargy on tasks that required some sort of executive function. Finally, excluded participants were more likely to choose a chair facing away from a mirror than facing it, which Twenge et al argue demonstrated a desire to avoid self-awareness. Interestingly, and contrary to the findings of Williams and co-workers, no significant difference in mood measures between the excluded participants and controls was found. The authors proposed that this may be due to a "numbing" of emotion in the excluded participants. Twenge et al proposed that this combination of outcomes represented a measure of the "deconstructed state" brought about by exclusion.

The emotional "numbness" reported in the Twenge et al paper is a, perhaps surprising, finding common to all of the Baumeister group's experiments. While Williams et al report a negative affective impact of ostracism, Baumeister et al have consistently found neither a significant difference between excluded and included participants in the affective measure (Positive And Negative Affect Scale

(PANAS): Watson, Clark & Tellegen, 1988) they have administered, nor a mediational role of mood on outcome. Thus, in the Baumeister account of exclusion, emotion and mood have little or no role to play in any behavioural response.

Baumeister, DeWall, Ciarocco & Twenge (2005) suggested that all of these reported outcomes were a result of a general impairment of self-regulatory capacity. In an experimental test of this proposal, Baumeister et al reported that excluded participants were less able to regulate their behaviour in a variety of situations, such as giving up earlier on impossible tasks, eating more biscuits or performing worse on dichotic listening tasks. They also reported that if the excluded participants were offered rewards to complete tasks, then the same differences did not emerge, suggesting that it was more lack of willing than lack of ability. Similarly, DeWall, Baumeister & Vohs (2008) reported that these self-regulatory deficits in excluded participants could also be eliminated if they were informed that the task was an indicator of how well they would get on with other people, but not if told it was an indicator of health. Thus, argued the authors, providing a social motivator for improved performance could remove the behaviours, whereas without such motivation, excluded participants demonstrated self-regulatory deficits.

In contrast with the rather dissociated, aggressive excluded person which emerges from the research outlined above, however, this group have also reported findings which may suggest a more positive social outcome. Maner, DeWall, Baumeister & Schaller (2007) reported that excluded participants expressed a greater preference to make new friends, work with other people and rated other people as more friendly and sociable than non-excluded participants. There were two limits to this

apparent desire to make social contact: Firstly, this did not extend to the original partner who had excluded them, only novel partners. Secondly, participants who scored low on a measure of negative evaluation fear showed affiliative tendencies, whereas those who scored high in this measure did not. This tendency to seek out positive social contact was also evidenced by DeWall, Maner & Rouby (2009) at a lower attentional level. Compared to non-excluded participants, excluded participants were quicker to locate smiling faces in a crowd of faces, spent longer looking at smiling faces in sets of four faces and took longer to disengage attention from smiling faces in a dot-probe task.

Thus, the picture of an excluded person that emerges from Baumeister and co-workers is rather, though not entirely, negative. Excluded individuals display an apparent inability to regulate their own behaviour, such that they may behave in an aggressive or self-defeating way. Crucially, excluded individuals were found to display very little emotion in any of the Baumeister et al experiments, contrary to much expectation within the field and the findings of Williams and co-workers. However, recent work has suggested that these individuals also display a desire to connect, socially, after exclusion, and that this process starts at a very early processing stage. Baumeister (2007) sums this up by describing the excluded individual as wanting social contact, but being afraid of further rejection. While any potential sign of positive social contact will be taken up by the individual, they are afraid to take the first step towards such contact. Without such a sign, they may instead become wary of others and potentially aggressive towards them.

The findings of Baumeister and co-workers indicate an effect of exclusion across a wide range of fields, including early perceptual processes, (such as attention direction), cognitive and self-regulatory deficits, emotional numbing and aggressive responses.

Clearly, there are many differences between the Williams and Baumeister groups, both in the empirical findings and in the characterisations of ostracised or excluded individuals. These differences have not gone unnoticed by the respective researchers:

"…the present studies investigate how social exclusion affects intelligent thought about matters having nothing to do with social belonging per se. Other work has found that social exclusion can have specific and positive effects on cognitive processes pertaining to belongingness and the self…" (Baumeister, Twenge & Nuss, 2002, p826)

"Ostracism…may produce different reactions from participants than did our manipulations… Future research should explore why some manipulations of the need to belong produce pro-social behaviour and others produce antisocial behaviour" (Twenge et al, 2001, p1067)

"In addition, experiences of ostracism (conceptually similar to social exclusion) usually lead to self-reports of emotional distress…" (Twenge, Catanese and Baumeister, 2002, p607)

"…two of these studies were not experimental, and all manipulated ostracism (a somewhat different concept and experience)." (Twenge, Catanese and Baumeister, 2003, p414)

"Although the authors (Tice et al) found that exclusion and rejection leads to anti-social behaviours, I think it is just as plausible to suggest that their participants were merely attempting to regain a sense of control or recognition." (Williams, 2001)

"The key question is, Under [sic] what conditions will targets attempt to improve their image and strengthen their need to belong, and under what conditions will they choose to take control, even to the extent that their behaviours become antisocial and violent?" (Williams, 2001)

These comments are clearly contradictory, not only between but within research groups. For example, in 2002 Twenge, Nuss & Baumeister refer to ostracism as "conceptually similar to social exclusion" but in 2003, the same authors describe ostracism as "a somewhat different concept and experience". While no definitive resolution has been proffered, one plausible explanation offered by both camps of researchers is related to the temporal location of the perceived ostracism. Williams' methods of manipulation (most notably, Cyberball) place ostracism in the current moment, whereas the Baumeister manipulation through personality test locates the ostracism firmly in the future. This may then lead to a more reflexive (to use Williams' terms) response to ostracism from Williams' methodology but a more reflective response from Baumeister's methods. However, this difference is not unequivocally evident across the wide range of measures used by both groups (as Baumeister's more temporally immediate method of ostracism, informing the participant that nobody in the group wanted to work with them, produced similar responses to the temporally dislocated "future alone" manipulation, e.g. Baumeister et al, 2005) and as such may still struggle to provide a full explanation of the empirical discrepancies.

There are points of crossover between the two groups that may hint at a more united future. For example, both Williams (Warburton, Williams & Cairns 2006) and Baumeister (Twenge, Baumeister, Tice & Stucke, 2001) have reported aggression in their ostracised participants. While this fits better with the Baumeister model than Williams', both groups have also reported that this aggression can be mediated by other factors, such as control (Warburton, Williams & Cairns 2006) or positive social contact (Twenge et al, 2007). These mediating factors could be argued to fit with Williams' need-threat-repair model, whereby increasing (or repairing) control and belonging reduce further negative behavioural outcomes. Equally, Lawson Williams & Williams' (1998, as cited in Williams, 2009) reported findings regarding increased desire for control may be dependent on interpretation of the dependent variable in the experiment. Participants, post-manipulation, were given the opportunity to ask a confederate to turn their heads as many times as they felt necessary to "read" non-verbal cues before guessing which playing card they were looking at. Ostracised participants requested significantly more head turns than non-ostracised participants which Williams interpreted as regaining control. However, this taking of physical control over another person could also be construed as aggressive behaviour rather than an outright desire for control. Similarly, Williams et al's (2002) reported increase in conformity could again be considered as passivity, as suggested by Twenge et al (2003), rather than a desire to be accepted by the group, as suggested by Williams. The issue of self-regulation, critical to Baumeister et al's approach, has not been directly addressed by Williams et al, while the emotional "numbness" reported by Baumeister et al in nearly all their published work is directly contradictory to Williams' reports of negative affect and lowered four needs, though again this could be related to a

reflexive or reflective response to ostracism. However, Williams (2001) did note of his ostracized participants that, behaviourally: *"It was as though they had been hit with a stun gun" (p. 159).*

In summary, there are huge effects of ostracism across a wide range of human experience. The affective response is currently a matter of some debate, but at worst may lead to affective distress in the target of ostracism and at best, emotional numbness. Behaviourally, a variety of outcomes have been reported. Aggressive behaviour, not only towards the original source of the ostracism but also to new interaction partners, has been reported in the literature, along with an increased desire to control situations where possible. However, there may also be pro-social behaviours as a consequence of ostracism, with ostracised people working harder on a collective task or conforming more to group norms. Finally, there are also implications for the cognitive ability of targets of ostracism, with several reports of lowered ability to self-regulate behaviour and reduced ability in logical thinking and higher level reasoning. The differences between Williams' and Baumeister's groups findings centre around two main points. Firstly, while Williams and co-workers report a reduction in self-reported levels of self-esteem, belonging, control and meaningful existence, presumed by the group to indicate affective distress, Baumeister's group report quite the opposite. In all of the experiments by Baumeister's group, excluded participants scored no differently than included participants on the affective measure used. The second major set of differences relate to the behavioural outcomes – while Williams (mainly, though not exclusively) reports efforts from ostracised participants to behave in a pro-social manner, many of the Baumeister groups' report increased aggression and lower

self-regulation, leading to self-defeating behaviours, rather than behaviours likely to make the individual attractive to a group.

The differences and the similarities in the findings of these respective groups of researchers indicate that there is still much to be understood about ostracism, and Williams' research in online ostracism has opened up a new medium through which these issues may be explored and controlled. For example, Twenge, Catanese and Baumeister (2003) describe the excluded person as lethargic and passive, which is consonant with many of the observations that Williams made of targets in face-to-face ostracism experiments. However, the online ostracism manipulations seem to show a very different picture of the target of ostracism, as they are more likely to continue to contribute to discussions and can be seen to become visibly more agitated (Williams et al, 2002). This discrepancy constitutes a point at which to begin further investigation into how to further unite, or draw apart, the two characterisations of the excluded individual. Clearly, the methods of inducing ostracism and outcome measures of its effects need further clarification in order to interpret any future findings – an issue we return to in chapter 6. However, before embarking upon an investigation of ostracism using computer-mediated communication, previous social psychological research on the relationship between the individual and the group and how this may be represented in this new medium must be explored. The extent to which this relationship in computer-mediated communication relates to that observed in face-to-face interactions is of critical importance for any interpretation of online experimentation on ostracism.

Chapter 2 – Social Identity and Computer-Mediated Communication

"A man has as many social selves as there are individuals who recognize him."

- William James, 1890, p294

While the negative experience of ostracism, as outlined in the previous chapter, can lead to a number of potentially damaging outcomes, the nature of the specific challenge that it poses to the individual is unclear. Williams (2009) posits that the negative effect of ostracism is due to a unique challenge to four basic needs (belonging, control, self-esteem and a sense of meaningful existence). However, before invoking such a range of needs, or considering how "basic" they may be to the well-being of the individual, an understanding of the nature of ostracism relies upon a construction of the individual and the group, and an understanding of how these may interact. Ostracism may, therefore, be considered in terms of a threat to the individual's concept of self, through exclusion from a social group.

Interest in the relationship between the individual and the group, or between the personal and collective (or social) self, has a long history within Psychology. One theory in this area, Social Identity Theory (hereafter SIT) (Tajfel, 1978; Tajfel & Turner, 1979), has formed the basis for much of the research conducted on group identity (e.g. Brown, 1984; Brown & Abrams, 1986) since its conception. However, the issue of multiple identities is of particular interest. It appears reasonable to suggest that most people would recognise that they have a particular social identity for each situation, leading to, or indeed manifested by, different behaviour in those situations. The mechanisms by which such identities are managed or selected have yet to be definitively resolved. One area of social and

technical innovation that has motivated a prolific expansion of research (e.g. Waskul & Douglass, 1997; McKenna & Bargh, 1998, 2000; Weisband & Atwater, 1999) and potential for the management of self is computer-mediated communication (CMC,) particularly since the advent of the Internet. However, much of the earlier research (e.g. Reid & Deaux, 1996; Shih, Pittinsky & Ambady, 1999) on multiple identities was not related to this new arena, which surely provides the sternest test of any proposed theory of multiple self-management. In an Internet setting, the incidence of identity change is high (see chapters 3 & 4), enabling people to create new personae, adapt their own and change quickly and frequently between them all. In this extreme context, previous theories, ideas and findings about identity may be supported or may completely break down. In light of Williams et al's (2002) finding that the negative effect of ostracism persists in online communication, the relationship between group and individual in this new context becomes of critical importance. Further, the effect of the potentially increased ability to change identity and the mechanisms by which those identities may be managed assumes a pivotal role in the management of self and insult to it through ostracism. This chapter introduces the research on social identity both in face-to-face and CMC contexts, and examines how consonant the findings in the two domains may be.

The importance of our understanding of identity, and the management of the multiple identities that we may possess, may be eloquently demonstrated in the work of Linville (1985). She proposed the self-complexity model, which states that people with more identities enjoy a buffer against stress, compared to people with a lower number of identities. If a negative event affects one identity, an individual with many identities will have others to fall back on to protect their

sense of self-esteem. If that person has few identities, then they are more likely to be negatively affected by that event. The clear theoretical implication of this for ostracism is that if an individual suffers ostracism in one particular identity, they may experience less negative affect if they have a higher number of other identities to fall back on than if they have a low number.

The question of how multiple identities may be structured, selected and managed by the individual has been addressed by a number of researchers. Two very different positions emerged in the work of Reid & Deaux (1996) and Trafimow, Triandis & Goto (1992). Reid & Deaux (1996) proposed a model in which there are several "baskets", each containing one social identity and several attributes that would be associated with that identity. For example, in one "basket" could be an identity as a friend, and this would carry attributes such as fun, advice giver and so on. Another identity could be that of student, which could also contain fun, but also industrious or conscientious. Attributes could be connected to certain identities either by culturally shared representations or through personal experience. Deaux, Reid, Mizrahi & Ethier (1995) had previously outlined a structure for social identities, with clusters for each type of identity emerging. They found five such clusters, defined as: personal relationships, vocations, political affiliations, stigmatised groups and ethnic or religious groupings.

This several basket model is different to, and in response to, the model proposed by Trafimow, Triandis & Goto (1991). This model suggested that the concepts of identity were arranged separately, in what was termed a "two basket" model, where all of the attributes that a person believes they have are stored in one basket, and all their identities in another. This model presumes that there are two separate and non-overlapping self-representations, where the store of identities represents the

collective self and the attribute store represents the private self. These approaches represent a spectrum of the views available, from complete integration to functional antagonism. These two theories represent very different ways of understanding what it is to be human – Reid & Deaux see identity as a holistic endeavour, with each identity containing social and personal components. Trafimow and co-workers, on the other hand, see social and personal identity as entirely separate entities. While these approaches are fundamentally different in their approach to the construction of identity, however, they both agree that individual and social components are basic building blocks which may be manipulated to produce an particular sense of self and set of behaviours in any given situation.

Beyond the issue of how identity may be constituted, the rules and modulatory factors that may determine social identity selection for any given situation has also been examined by various researchers. Brewer (1991) suggested the concept of optimal distinctiveness in order to address the issue of how identities may be selected. The basis of this suggestion was the assertion that people have conflicting needs, one to be a part of the group, and another to be unique (cf Baumeister and Leary, 1995; Snyder & Fromkin, 1980). She argued that when selecting an identity, or a level of identity, e.g. English, British or European, these two needs must be met. In order to balance the group and uniqueness needs, the individual may select a level of identity which provides an appropriate level of similarity to the group while maintaining an appropriate level of difference from other group members. For example, if in a situation where one feels very different, the level of identity is likely to change to include more people in the in-group, so the individual will feel less outstanding. However, if the group becomes very

large, then the individual will select a level of identity that includes fewer people, which then distinguishes that person from other members of the very large group.

A conflicting view of identity selection may be identified in the work of Turner, Oakes, Haslam & McGarty (1994). Their assertions are highly reliant on cognitive metaphors, suggesting two factors which influence a decision about taking on an identity. The first factor is termed readiness, or accessibility; in the process of selecting an identity, there will be some influence of previous experience, along with present motives and needs. The second factor is cognitive fit, i.e. how well the identity and its attributes will fit the situation the individual is in. There are two types of fit that the individual could assess: Firstly, comparative fit, which ensures that the difference between the individual and members of the in-group on that dimension is less than the difference between the individual and the members of the outgroup. Secondly, is normative fit, which assesses how well the content of that identity fits with the current circumstances. Finally, the identity which most closely satisfies these factors will be selected. In Turner and co-workers' view of the management of social and personal identities, it is only possible to have one salient identity at any one time, necessarily pushing out all others. As such it shares many of the predicates of Deaux and Reid's construction of identity. Key to this functional antagonism, is the notion that different identities compete and work against each other.

The conflicting emphases of these two accounts of how identity is chosen is striking: Brewer suggests that identity selection is almost entirely based on the relationship between the individual and the group, and is motivated by the balancing of opposing needs regarding proximity to in- and out-group members. Turner et al, on the other hand, take a more individualistic and cognitivistic

approach, whereby the selection of identity, while related to the group situation, is more to do with how the individual accesses and assesses the appropriateness of a potential identity to the cognitive demands of the situation. Both of these approaches yield more questions. For Brewer, if identity selection is motivated by balancing opposing needs, then in what way is identity anything more than the satisfaction of these presumably immutable needs? Does this approach represent nothing more than a re-description of the problem faced by the individual, rather than a theory regarding how this problem is actively solved? For Turner, this approach seems to assume the existence of multiple identities set up for different situations and selecting from amongst them, without allowing much room for the construction of identity in response to social situations.

Regardless of how the selection of identity is solved, once an identity has been selected it has a behavioural effect, as demonstrated by Shih et al (1999). They reported that the quantitative performance of an individual could be affected by which identity was salient. Asian-American females were asked to complete mathematical problems in one of two conditions: Female identity salient or Asian identity salient. The assumed stereotype about females was that they were not expected to perform well at quantitative problems, whereas Asians were expected to be better than average. The researchers found that performance in the female salient condition was significantly worse than a control group, and performance in the Asian salient condition was significantly better. The authors also report that when the same procedure was repeated in a culture where stereotypes regarding Asians' superior ability at mathematics did not exist, there was no longer a significant difference from a control group. A similar result has also been reported by Steele & Aronson (1995) in African-American performance on intelligence

tests. These studies suggest that identity salience may be manipulated, and that a change in salience level may have either positive or negative behavioural effects.

Pittinsky, Shih & Ambady (1999) investigated the effect of identity success on affect towards that identity. The authors reported that individuals had a more positive affect towards the identity which was most adaptive in that situation. Thus, individuals may view different identities as more important at any one time, along with different affect towards each identity. This ultimately has an impact on their cognition about each identity. The findings of Shih et al (1999), Steele & Aronson (1995) and Pittinsky et al (1999) are suggestive of behavioural consequences attending identity shifts. They also point to the propensity for such shifts to affect individual cognitions and emotions regarding identity. They may also provide some clues as to how multiple identities are selected, in terms of fitting the situation in which the individual finds him/herself.

In summary, the conceptualization of the construction and manipulation of identity has been taken in two very different directions. On the one hand, Reid & Deaux and Turner et al argue that identities are essentially in a state of functional antagonism, with one, complete, identity necessarily being selected at the expense of others. However, Trafimow et al and Brewer see identity in a more constructive manner, whereby individual aspects of identity can be manipulated to satisfy particular needs and situations. However, what is clear from the work of Shih and co-workers is that, however identity is constructed and selected, there is a clear behavioural effect of such changes.

The social components implicated in all level of the process are indicative of why ostracism by a group may affect the individual negatively. In exclusion from the group, a fundamental component of identity has been taken from the individual, thus affecting their entire construction of identity.

Virtual identities

"There is a powerful tension in our relationship to technology. We are excited by egalitarianism and anonymity, but we constantly fight for our identity." David Owens

The theories and studies outlined thus far have been based on face-to-face interactions, and often on pre-existing or well established identities. The next challenge for all of these theories, and to take a broader view, a challenge to traditional SIT, is to apply these concepts to a CMC setting, to see if they account for the new possibilities and flexibility of self-presentation that this new technology offers.

A major model concerning CMC and the effect of social identities is the Social Identity model of Deindividuation Effects, (SIDE) as proposed by Lea & Spears (1991) and Spears & Lea (1992, 1994). Traditional social identity/categorisation theory would suggest that CMC should reduce the group effects seen in face-to-face interaction (such as in-group bias and normative behaviour) due to anonymity and reduced contact. However, the SIDE model predicts *increased* group effects in CMC environments. A lessened ability to individuate group members, due to anonymity, will increase the salience of group membership. In a face-to-face situation, the individual can see the other members of the group and is therefore more aware of their individual differences. This individuation may then draw focus away from the coherence of the group. In a CMC setting, where the individual cannot see and does not know the other members of the group, all that

one has in common with the other members is group membership, and so the individual will emphasise this point to the self. Overall, then, deindividuation increases group identification, and therefore its effects, in small groups.

CMC was originally expected to reduce bias, through what was to become known as the equalisation phenomenon, (Dubrovsky, Kiesler & Sethna, 1991) but research based on the predictions of the SIDE model indicated that this was not the case. Reicher, Spears & Postmes (1995) reported higher levels of in-group favouritism in anonymous CMC than when group membership for each individual was made public. However, under conditions where a fairness norm was primed to the group, in-group favouritism reduced. Spears, Lee & Lea (1990) reported that participants conformed most to group opinion in discussion when in isolation and aware of being in a group. Postmes, Spears, Sakhel & De Groot (1996) primed groups with social norms for either efficiency or pro-social behaviour, then asked them to solve a dilemma through CMC. When the communication was anonymous, the participants complied more with the social norms. It was also demonstrated that group norms were established through interaction, as even those who had not been primed were acting in accordance with the primed norms after a short period of time. Postmes, Spears & Lea (1996) found that when individuals were identifiable, then other co-discussants remembered *which individual* made certain statements better than when individuals were anonymous. In anonymous conditions, co-discussants tended to remember which *group* said what, demonstrating that the focus of attention is on the group, and not the individual. This shows the cognitive component of social identity, as attention and memory are directed by identity salience.

McKenna & Bargh (2000) identified from the extant research four main characteristics of the Internet which differ from off-line life. They argued that these factors lead to the reported differences between interaction on the Internet and face-to-face. The first of these is physical distance: In an on-line situation there is no need for the participants in an interaction to be physically near to each other, which greatly increases the number of potential interaction partners for each individual. Secondly, is appearance. In face-to-face meetings, the physical appearance of an individual is a very important factor in interaction, both in terms of physical attractiveness (Zebrowitz & Montepare, 2005) and stereotypes associated with, for example, race or gender. However, in CMC, without a physical presence there are no such cues. Thirdly, time can also be managed differently in CMC. Although many chat rooms, messaging services and Multi User Dimensions (MUDs) can be used synchronously, conversations can also be conducted over a long period of time, through e-mails or postings to newsgroups, for example. One advantage of this is that the individual can spend as long as he/she wishes over preparing a comment, writing and re-writing it until they are happy. This is in contrast to face-to-face or telephone interactions, where each respondent must reply relatively quickly, on the spot.

The fourth factor highlighted by McKenna & Bargh, anonymity, has emerged frequently in CMC research and theory. However, the definition of anonymity has not always been clear. Scott (1999) argues that there are two different types of anonymity, physical and discursive, and that the effects of the two are not necessarily the same. Scott claims that discursive anonymity has the greater impact of the two in Group Decision Support Systems, (GDSS; a form of CMC) as this allows the individual to feel freer in terms of being unidentifiable, as opposed

to just not physically available. This freedom may affect which identities become salient, with fewer cues on which to base selection. Scott (1999) investigated whether multiple identifications changed in salience when communicating via computer compared with conventional meetings. He found that identification levels with the company the participants worked for were lower in CMC than in conventional meetings. During CMC, the lowest possible level of identification, the immediate group involved in current communication, became the most salient. This is in accordance with the predictions of the SIDE model, in that individuals experienced more identification with the immediate group in an anonymous situation.

Anonymity may also have negative consequences in particular settings: *"Hiding behind the anonymity created by the Internet's trusting technology, he exhibits no social conscience." The Guardian (G2) p3, 5.6.01. Article by Steve Millar, quote from Steve Gibson about a thirteen year old hacker who brought down his company website.* There is little evidence to support the assertion that the anonymity provided by the Internet leads to reduced social conscience. However, it may be the case that users are less concerned about the sensitivities of others not in their group, with hackers being an excellent example. The boy in question was, one could argue, fulfilling his perceived role as a hacker. In so doing, he showed little regard for the effect on the target company and individuals, and perhaps a wider social conscience. He may, however, have been exhibiting social awareness of his own group and behaving accordingly. In this case, the anonymity itself did not cause the behaviour, but a combination of group identification and conformity to norms that may have been aided by anonymity. While this example is anecdotal, empirical studies have also suggested potentially negative effects of anonymity on

the Internet. Dubrovsky, Kiesler & Sethna, (1991; see also Culnan & Markus, 1987) report that people communicate more bluntly when communicating via computer as opposed to in face-to face situations, which can lead to more frequent misunderstandings and hostility. Bocij & McFarlane (2003) also propose that anonymity may enable hate groups of various kinds to encourage violence against others with less or no fear of being caught.

However, it is not the case that anonymity is necessarily negative. An early study which suggested a potentially positive effect of anonymity was reported by Gergen, Gergen & Barton (1973). Pairs of participants sat in either a darkened or normally lighted room during a discussion. Individuals in darkened rooms disclosed more intimate detail about themselves and their lives that those in a lighted room, and also felt more positive about the other person afterwards. The CMC environment could be conceptually construed as similar to the darkened room of this experiment, and it would not be unreasonable to expect similar occurrences on the Internet. Similar results have indeed been reported by McKenna & Bargh (1999) and McKenna (1998) reported that as relationships over the Internet progressed over time, participants begin to reduce their control over the conversation in exchange for increased physical closeness, on occasion resulting in meeting off-line.

One of the other possible advantages to anonymity is the opportunity for identity play. Under the protection of anonymity, it is possible for the individual to experiment with identity in what some researchers have dubbed the "identity laboratory." The way in which the self, both singular and multiple, is created, experimented with and presented in an on-line situation has been discussed by many theorists and researchers. Waskul & Douglass (1997) considered the

construction of self, with specific reference to chat rooms. They believed, along with others such as Turkle (1995) and Stone (1995,) that the self is created through meaningful interaction with others, and that the Internet is a legitimate area in which this interaction may occur. In their discussion of selfhood in a CMC context, they refer to the concept of "social saturation," (the exposure of an individual to a wide range of social possibilities) first termed by Gergen (1991). This is particularly evident in Internet communication, where the individual is exposed to many more divergent views and identities than may occur in offline life. This exposure to different potential identities creates within the individual a series of "hidden potentials" which become possible selves that, given the right circumstances, could be expressed. This gives the individual many more potential identities than could have been possible before Internet communication, making the issue of multiple identities much more common.

However, Waskul and Douglass suggest that there is not the same level of commitment to any of these new identities as may be expected in off-line identities, and so the individual may not experience the same management difficulties, or the potential benefits outlined by Linville (1985). The new identities that people in chat rooms may present to others can easily be very different to how they are perceived in everyday, off-line life. They may also just as easily be as true a representation as that person can make, or become a close representation: *"As one vampire player* [in an online game] *explained 'Lots of people start out playing something totally different from themselves, but most of us can't help bringing our own personalities into the character eventually.'"* (Wallace, 1999, p39.) However, as the selves in an on-line situation are heavily based in the on-line context, then *"cyberselves will always represent some degree of departure from the selves that*

people present in everyday life." (Waskul & Douglass, 1997, p388.) Thus, due to the interaction based nature of the self, then an on-line self, even if similar to an off-line self, may be considered as another legitimate identity.

When an individual joins an online group, it is likely that the other members of the group will not be known in offline life. Thus, the new, online peer group can be kept entirely separate from previously existing offline groups and identities. The new group will also have "*no prior conceptions or expectations about the kinds of identities or roles to which this person should adhere*" (McKenna & Bargh, 2000, p63). The freedom afforded by this lack of prior expectations allows the individual to present him/herself as the person he/she would like to be, often portraying an idealized version of themselves (McKenna & Bargh, 1999). This also allows some scope for the individual's exploration of Markus & Nurius' (1986) possible selves. In a CMC context, the individual may find it easier to experiment with aspects of their possible selves, finding what works and what does not for the individual, and may function in such a way that the individual begins to take on the traits of a self into their off-line life. In so doing, the individual may feel encouraged that they are moving towards a better version of themselves, and eventually perhaps towards what Rogers (1951) termed the "ideal self" – the self that the individual would like to become. Thus, possible selves may have a strong motivational effect on the individual in everyday life, but the opportunity to explore some of those possibilities without risk may provide even stronger motivation to move the person towards becoming more like a particular self. Baumeister (1998) suggested that people need to make any desired traits or attributes a social reality, in other words, to have other people recognise those attributes, before they can be accepted into the persona. The Internet provides the opportunity for this to happen, though there is

still little research on the nature of the relationship between online and offline identities.

Deaux et al (1995) argued that identities within the same cluster, (e.g. personal relationships: mother, sister, wife) were interchangeable. While there may be a need to express identities from the individual's clusters, as long as one from each cluster can be expressed in the current circumstances, then this need can be met. In a CMC context, the opportunity to exchange identities could mean that this concept is more pertinent and easier for the individual to experiment with. In situations where it may be inappropriate for the individual to express an identity from a cluster, then the Internet may provide an opportunity to express an alternative one. This could be of particular importance in the extreme case of stigmatised identities, as McKenna & Bargh (1998) demonstrated. Finally, the self-complexity theory of Linville (1985) is clearly of interest in a CMC context. If, as many of the researchers discussed above suggest, CMC truly increases the number (or potential number) of identities that a person may have, whether these may also provide a buffering effect against negative events in the way that Linville reported in offline identities is of clear importance.

In conclusion, while the extant research into multiple identities and their management in an offline setting has begun to be applied to CMC and Internet contexts, there are still many gaps in our understanding. The effects of repeated identity change have not been fully examined, and although some interest has been taken in the on-line-off-line interaction, the relationship is not well understood. The following chapter covers the first empirical work of the thesis – a descriptive overview of the social identities which people are taking on in chat-rooms and the way (if any) that this mediates their behaviour. As social identities, this is naturally

accompanied by an examination of the social groups that are formed in online communication and how well previous theories of offline group behaviour may explain them. Such a further understanding of CMC in a naturalistic context may aid understanding of the effects of ostracism on social and personal identity, and consequent behaviours, in such a context.

Chapter 3 – Online group behaviour: A qualitative overview

Introduction

While the previous chapters have outlined the research on ostracism and social identity, the application of the theories covered in an online setting allows for a new test of these ideas. Ostracism has been demonstrated to occur in online settings (see chapter 1), albeit with fewer negative consequences (e.g. Williams et al, 2002). In order to fully understand the relationship between on and offline settings for ostracism and their attendant consequences, the more fundamental relationship between on and offline settings for social communication in general must first be addressed. To this end, this chapter represents an overview of the social behaviour evidenced in an online setting, specifically Internet chat rooms, along with consideration of how this relates to previously reported socal behaviour in offline settings.

The existence of virtual groups and communities on the Internet has previously been reported by a number of researchers (e.g. Turkle, 1995; McKenna & Bargh, 2000). However, a definition of "group" has not always been common across research groups, and has been subject to much debate. Prentice, Miller & Lightdale (1994) entered this debate with descriptions of two different types of group: common bond and common identity. Common bond groups were characterised as groups united by a high level of interpersonal attachment, rather than a wider attachment to a group as a separate concept. Common identity groups, on the other hand, were characterised as based on attraction to the purpose and goals of the group as a whole. Prentice, Miller & Lightdale argued that

common identity groups were therefore more stable over time and change, as the departure of prominent members would not necessarily detract from the overall purpose and goals of the group.

Sassenberg (2002) conducted a comparison of such virtual groups in the Internet Relay Chat (IRC) medium, using the definitions set out by Prentice, Miller & Lightdale. Based on this distinction, Sassenberg contacted members of 14 Internet Relay Chat (IRC) groups, seven of which were based around a particular topic (e.g. Linux), argued to correspond to Prentice et al's common identity groups. Members of seven channels with more general chat, not based around a specific topic (e.g. Germany: not a channel mainly discussing Germany, but general chat), representing common identity groups, were also contacted. Respondents to an initial IRC contact were provided with a questionnaire to assess how much they liked the other members of the group (personal attraction), how much they liked the group as a whole (group attraction) and how much they felt a part of the group (social identification).

The results indicated that those respondents in topic-based channels reported higher group identification, while those in non-topic base channels reported higher interpersonal liking. Similarly, social identification in common bond groups was best predicted by group identification, while in common identity groups, interpersonal liking was a better predictor.

The development of and adherence to norms is a key part of group behaviour in offline settings (e.g. Feldman, 1984) and there is evidence that online groups also develop and adhere to norms. For example, Sassenberg's (2002) analysis of discussions recorded in IRC channels, reveals that norms regarding paralinguistic

language developed within the groups studied. However, he also reported that common identity groups adhere more strongly to these norms than common bond groups. Postmes, Spears & Lea (2000) report that norms develop in CMC groups as each group defines its own communication style. They found that communicative behaviour becomes closer to the norm over time (as measured by number of comments) and that different norms of behaviour were observed in communication towards non-group members.

While the identification of groups in CMC by Sassenberg (2002) and others and evidence that norms also developed in CMC (Postmes et al, 2000) suggest that online groups are very similar to offline groups, there are also reported areas of difference between these types of group. Dubrovsky, Kiesler & Sethna (1991) propose an "equalisation phenomenon" in CMC, whereby many of the traditional status biases (e.g. gender, race, age) no longer exist due to a reduction in social-context cues, such as physical appearance or types of non-verbal behaviour to assert authority. They reported that while in face-to-face groups the high-status member dominated discussion, in CMC groups, there was a more equal share of the conversation between high and low status individuals.

However, Herring, (1993, 1994) reported that, while the visual cues to the gender of an individual may no longer be present, differences in communication styles of men and women enable other group members to identify the gender of a particular discussant. While knowing the gender of a co-discussant online may not necessarily lead to bias and prejudice, Matheson (1991) reported evidence consistent with the notion that stereotypes about communicants' respective genders still emerge in CMC. Male and female participants who were led to believe that they were negotiating with a male partner through CMC reported him to be more

difficult to negotiate with and more exploitative than when they believed they were negotiating with a female, even though the text from the alleged partner was identical. Similarly, Postmes & Spears (2002) report that gender stereotypes and inequalities were present in groups where members were anonymous and not individuated.

While much of the empirical work has focused on the amount and type of communication between discussants in CMC, it is also the case that lack of communication is common. Many Internet chat rooms include a function for an individual to ignore other members of the room, such that their messages do not appear on the screen (Pankoke-Babatz & Jeffrey, 2002). Similarly, most have functions for room administrators to gag an individual, remove them from the room temporarily ("kick") or to ban them entirely for infringements of previously set out rules or inappropriate behaviour (Pankoke-Babatz & Jeffrey, 2002). On a more interpersonal note, Rintel & Pittam (1997) report that Internet users perceive that they are being ignored when others do not respond to their comments. The reported reaction to such ostracism over a short (5 minute) period was increased frustration and hostility towards other members of the chat room. This is consistent with the findings reported by Williams et al (2002) in that the aversive impact of ostracism persists in CMC, although at a lesser level than that reported in face-to-face ostracism. It would appear that ostracism is very much a part of both interpersonal interactions and chat room control, to the extent that it is programmed into the very functionality of the system.

Despite the prevalence of previous research on group behaviour, the role of the individual within such groups has not been entirely overlooked. The use of on-screen names as a representation of individual identity in CMC represents a

potentially important component of understanding the way that interactions are managed. Bechar-Israeli (1995) produced a typology of screen names, with 7 different categories, such as those based on a characteristic of the self (e.g. shydude), flora and fauna (e.g. tulip) or celebrities (e.g. elvis). The IRC system does not allow a screen name to be used by two people simultaneously and Bechar-Israeli reported a number of incidents where the taking of an individual's screen name by another discussant caused significant distress until it was returned. There was also evidence of game playing with screen names, whereby participants in a group may joke about others names (e.g. "god" provokes a number of responses, such as "I knew god existed!") or swap names with each other. There were also reported incidences of participants changing their screen names to directly reflect a change in identity which could also be observed in their behaviour.

Despite the limitations and dangers associated with an over-reliance upon such qualitative accounts of individual and group behaviour in CMC, the approach does offer a potentially rich seam of information that may well prove helpful in guiding further quantitative analysis of online behaviours. As this is a relatively new area, a preliminary qualitative overview of the behaviours exhibited may be useful to inform further, quantitative, analysis. While there is no specific hypothesis for the overview, such an approach allows for a low-constraint, exploratory approach to the data to highlight potential areas of interest, before embarking upon a more formal, quantitative analysis of IRC commuication.

Methods

The undernet server for the mIRC chat client (www.mirc.co.uk.) was used as the base to select channels for data acquisition. This client is one of the most popular Internet Relay Chat systems and includes a capability for logging (saving) chat, with date and timestamps.

In order to determine which chat channels to use, and length of sampling periods to produce an appropriately sized data set, an initial survey of the available channels was conducted. Channels with less than 70 users online at the time of the survey were discarded. From the remaining channels, 20 "neutral" channels (i.e. not about specialist subjects, but for general chat) were quasi-randomly selected and logged for 30 minutes each. The data logs were examined and those with any period of 5 minutes or more with no contributions were also discarded. From the remaining channels, six were quasi-randomly selected through blind selection. A total of 6 was felt sufficient to provide a range of topics and potential for group differences. The six chosen rooms were: usa, england, australia, worldchat, chatworld and cyberchat. These channels were logged from a single computer on four separate occasions, all during weekday afternoons. Based upon the amount of chat observed in the selection period of 30 mins, 3 different sampling periods were used: 60 minutes (for a short sample of group behaviour), 240 minutes (for a long sample within each room to allow for any changes in behaviour over time) and two 90 minute periods (representing a medium length sample) resulting in 8 hours for each channel in total. Only the conversations in the public sector of the channel were logged, and the observer did not interact with any of the chatters online.

The design of the investigation was observational and as such, no members of the chat rooms were contacted directly. Rather, transcripts of publicly available chat rooms were read for evidence of five potential attributes of virtual group existence and dynamics.

1. Evidence for the existence of virtual groups, either common identity or common bond in the data was assessed through analysis of the transcripts to establish whether particular discussants in the chat room made frequent exchanges with the same people, indicating that they may constitute a group. The behaviour of any proposed groups' members was also examined for examples of group cohesion and defence, to further examine the evidence for stable and cohesive groups in the data set.

2. Identification of observable norms within the groups studied was similarly sought. Analysis of norms was not restricted to any particular type of behaviour (such as the use of emoticons in Sassenberg's (2002) study), nor to a longitudinal study of a single group (e.g. Postmes et al (2000)). Rather, a more general analysis of discussion that aimed to identify any behavioural norms across groups and behavioural repertoire was conducted. The reaction of group members to norm violation was also investigated.

3. Status differences within the groups, alongside cues to such status differences, were also identified.

4. Interpersonal ostracism (as opposed to removal by administrators) and the circumstances that may have precipitated ostracism was also identified. In light of the findings of Williams et al (2002) that the effects of ostracism are reduced in CMC, the response of the targets of any such ostracism was also recorded.

5. The use of screen names, including what types of names are displayed, whether they are consistent within individuals, and whether name changes were concomitant with behavioural changes was also noted.

Evidence for these behavioural categories is described below, along with a consideration of how these behaviours are consistent with previous research, both in online and face-to-face group behaviour.

Overview and Discussion

Group behaviour and cohesion

In each channel, a main central group was evident, who were familiar with each other and in some cases had been involved in the channel for a long period of time. While the absolute number of group members varied across time, typically the central group consisted of approximately 6 people. Around this main group was a more transient outer group, many of whom were new to the channel, and in some cases new to IRC as a whole.

There were some evident features of group members and their behaviour which helped to identify them within the channel. The members of the central group were often also operators, who have the responsibility of maintaining the channel, removing people temporarily or banning them for rule infringements. Another feature of the members of the central group is that they frequently referred to themselves and other members who were not present, as 'oldies.' This was with reference and in opposition to "newbies" (a name used for people new to the room or IRC), in that they have been a part of that channel over a long period, in some cases years. One further feature of central group members was that these members would often state when they were leaving the computer, and for what reason (i.e. food, phone etc.), before being welcomed back by other members of the group.

The group members also defended themselves against outsiders, such as advertising of other channels, and would not tolerate criticism of the group or members of that group. For instance, after the character Navashvay had been ignored by the in-group since arriving a few minutes earlier, the following exchange ensued:

[14:16] <Navashvay> are american so arrogant that dont talk to a brasilian?
[14:16] <johnCoffe> and i just wanted to put an eye on
[14:16] <Jewelzz> heh :)
[14:17] <kelly_467> lol john, that will do :)
[14:17] <Jewelzz> disinterest is often mistaken for arrogance, Navashvay...
[14:17] <johnCoffe> oops e-mail ??
[14:17] <LdySandra> No one's arrogant here Navashvay
[14:17] * johnCoffe brb
[14:17] <kelly_467> i agree julie :)
[14:17] *** sudheer is now known as sanjay00
[14:18] * kelly_467 looks around.... hmmm, arrogant?

An example of the resentment of outsiders through advertising is shown in Appendix 1a. In this example, there is a flood of advertising from outside the channel, which the regulars are not happy about. F|ash announces that he is "going to that channel to spam our channel." Another member, HuGGyBeaR laughs, but says not to, but once F|ash has actually done it, HuGGyBeaR laughs along, and approves of the act, as a member of the originally offended group. In this exchange, there is a very strong sense of them and us emerging, which is evidenced by their behaviour.

Norms

One behaviour which emerged as a norm was the use of English. In all the chat rooms studied, the only language permitted was English. Discussants who violated this rule were quickly reproached by group members or operators and, if they persisted, were temporarily removed from the room or banned if they returned and continued. It has been suggested that language is a key part of group identity, as can be seen in various nations' defence of their own language, such as Welsh (Bourhis, Giles & Tajfel, 1973) or French (Adamson, 2007). Bourhis & Giles

(1976) found that when the linguistic identity of an in-group was threatened, they tended to broaden their accent or switch language entirely. This is in direct contrast to the findings of Giles & Powesland (1975) who report that linguistic convergence emerges in interpersonal interactions. As language is an important aspect of a group identity, the control of language in chat channels may take on a key role. This could include enforcing the same language for everybody not only to ensure group cohesion through common language, but also to prevent a separation of groups through language. It could be argued that this protection of group cohesion is due to the ease with which discussants may change groups. This may make a sense of cohesion more fragile for the members, who therefore fight to defend it. The central groups in the examples here appeared relatively stable, but these types of group defence activities and protection of language may have become part of IRC etiquette precisely so that these types of group could develop, and have been continued as traditional and normative behaviour. The sense also emerged that there were other chat channels available for these individuals if they wanted to talk in a different language, or about specific topics which members of the central group found inappropriate or dull and so should not be indulged in their particular channel.

Another issue surrounding language was the banning of swearing. Again, this was frowned upon within all the groups studied here, resulting in temporary removal or banning for persistent offenders. However, many of the regulars were not averse to swearing themselves, and often found themselves automatically temporarily removed by accident. Alternatively, discussants used innovative ways to write swear words which would not be picked up by software built in to automatically detect swearing, for example using *s or spelling slightly differently, e.g.

"fugging." This would seem to imply that this norm was not imposed by the inner group of each channel because of their own sensibilities, but perhaps more an attempt to maintain standards of polite exchange within the channel.

While both swearing and the use of English were listed in the guide to etiquette (netiquette) for the channels, the vigour with which these were defended compared with other rule infringements, such as use of capital letters (commonly viewed as representing shouting in CMC) in normal conversation, suggest that these were considered particularly important to these channels and emerge as norms specific to those groups.

Status

In all channels, evidence of status inequalities within the groups was manifest. The initial and most obvious status differences in these groups were those between the central group, and the more transient outer group. The central group was seen as higher status (both by the in-group members and the out-group members), often ignoring the outer group, unless telling them of rules they have inadvertently broken. However, there were also status inequalities within the inner group, the most clear-cut of which was the operators (ops) versus other group members. The channel operators were at a clear advantage over other people in the channel, as they had the power to control who may remain within the channel and who may not. This led to the outcome that an operator could win any disagreement with another person, by removing them from the room. The other discussants respected this, and was shown in comments made to or about the operators, for example in the following exchange:

```
[17:44] <Gorf> Pr0Drive <--- as IF!
[17:44] <Gorf> op me, op me, op me!!!
[17:44] <Op-Vader> Pr0Drive: no u cant have op
[17:44] <Op-Vader> and gord u should know better :P
[17:44] * Gorf looks up to the heavens and sees Op-Vader frowning
upon the mere mortals asking for op.
```

Op-Vader is an operator in this particular channel, and is here seen refusing op status to another member, in a good humoured exchange with Gorf, a non-operator, central group member. This can also be seen in a further example in Appendix 1b, where Chaplain refers to non-ops (including himself) as "little people".

These exchanges show half joking reverence for the operators, due to their higher status. Slightly lower than the operators in the hierarchy of these chat channels were the other members of the central group. These people may have been regulars of the chat channel for some time (the "oldies") but had not achieved or did not want operator status, due to the extra responsibility. These people often assisted the operators to a certain extent in their duties, in a mutually beneficial manner, sometimes pointing out chatters with bad scripts or who were annoying them so that the operator would remove them from the channel. The operators often stood up for these members in the event of a disagreement with another, out-group member. For example, in one incident in the chat room eng, QuinnM (new member) offended Clee-Ohh (operator) with some (possibly joking) sexist remarks. As an operator, she removed him from the channel. He rejoined immediately, apologised, and then became involved in mild insult exchanging with bl|nk. However, bl|nk, though not an operator, was part of the central group, and so even though both bl|nk and QuinnM were involved in the insults, QuinnM was again removed by Clee-Ohh on bl|nk's behalf. The full text of the incident is available in Appendix 1c.

Brown (2000) proposes two themes in status differentiation: the initiation of ideas and activities taken on by the group (also Sherif & Sherif, 1964) and consensual prestige (positive evaluation by other members of the group: Homans, 1950). The first of these was evident in the central group, whereby word games or topics of conversation were frequently taken up by non-central group members. It was also apparent that particular skills were well regarded by the group – specifically, computer knowledge. Individuals who were knowledgeable about computer programming were considered to be higher status than others. While the central, high status, group often ignored outsiders or newbies, (an issue we return to below) there were occasions where relative newbies were included by the group. The new members who were included in the central group's exchanges were discussing computer programming or hardware. For example, in one exchange Toppy and S|rKn|ght spent much of the time exchanging a new mIRC script that S|rKn|ght had written, and were the only central group members in this channel during this discussion. The other people in the channel were ignored as these group members discussed the details, apart from two people: richard99 and |ronsh|ek. Both these individuals were familiar with scripting and programming and joined the conversation by asking what was going on, and offering help with what they could see on the screen. Toppy and S|rKn|ght responded to their questions and also helped |ronSh|ek with a problem that he/she was having with scripting. This was much more inclusive than usual with new members and it seems plausible that this was due to the common interest and knowledge about computer programming.

The computing knowledge of The^Fiend also helped to raise his status, as a member of the central group but not as an operator. In many situations he appeared to be an operator, frequently online, but often slightly removed from the discussion

engaged in other activities, making contributions regularly but not necessarily frequently. The respect he commanded from other members can be seen in the way that he is treated, by both new members and other central group members. This is particularly clear in cyberchat (appendix 1d) where the age of The^Fiend comes to light (19) of which he is slightly embarrassed and the other group members are surprised. This indicates that the behaviour of The^Fiend had led others to believe that he was older than he is, perhaps due to his high status. The impression of higher status and maturity was encouraged by The^Fiend, and although he could be quite playful with other members, particularly eek', he could also appear superior and aloof from the group:

```
[12:25] * The^Fiend sighs, ignores the morons that have infected
the room with the dawn, and goes to his private scripting cave
```

As the usual status indicators employed in off-line life are often harder for other people in the channel to determine, such as race or gender, then the status of the individual is much more dependent on their behaviour within that group. Status could be gained by participating frequently, contributing to the scripting and upkeep of the system or by assisting others with computer based problems. This status maintenance indicates that on-line groups are the same as off-line groups in this particular aspect, as while the means of status gain and the cues to status may be different, fundamentally there are still hierarchies in place (e.g. Sherif & Sherif, 1964).

Ostracism

In all of the channels, as reported above, the central group tended to ignore newcomers and remain wrapped up in their own conversation, refusing to respond to their comments. In what was commonly perceived to be an open and inclusive social environment, many new participants may not have expected this ostracism and, when their attempts to contribute to the conversation failed, responded in one of two ways. In most cases, the new member gave up trying to participate, and either began private messaging to other people (which is not accessible in this data set) or left altogether. In some cases however, the individual commented on the fact that they were being ostracized. An example of an angry response to ostracism from a target is reported in the group behaviour and cohesion section. Consistent with Rintel & Pittam (1995) the ostracised participants became more hostile over the course of a few minutes. This behaviour is also consistent with Williams et al (2002) reports of ostracised participants continuing to make comments, contrary to ostracised participants in face-to-face settings. A further example is cowboybob, as a new member being ignored by the group, despite repeated comments on his part (see Appendix 1e). He began to question whether he was visible at all, and then became slightly more irritable, looking for an answer from outside the central group:

```
[13:57] <cowboybob> anyone else here just reading teh channel care
to chat
[13:57] <citylight> hehe cowboybob
[13:58] <cowboybob> welll
[13:58] <cowboybob> a sign of life
[13:58] <cowboybob> i thouht i was invisible
[13:58] <citylight> ý am alive
[13:58] <libanaise> bonjour
[13:58] <citylight> :)
```

[13:58] <^fairy^> just spending some time together pav
[13:58] <angelo1> hi all
[13:58] <cowboybob> thank you citylight

Another person finally responds, citylight (not a member of the central group) and the two chat with no reference to the other conversation which was still continuing, perhaps having decided that there was no point attempting to join the conversation. This tendency to ignore new members is also illustrated by a comment made by Alchemist, an 'oldie' and operator:

[12:25] <AlchemisT> I don't know any new ppl here... I don't bother really with many people

A further discussion as to the potential reasons for this approach can be seen in Appendix 1f. This example also contains an example of ostracism of the chatter Waitress, who continues to contribute, but gets no direct response, unlike other members. However, this tendency to ignore was not the case in all channels, or at all times, as some members did encourage newcomers to join the conversation, or explain the rules or etiquette in that room to them. It was, however, more unusual in the data collected here.

Types of identity change

Many different types of identity change were evidenced, for a variety of purposes. One such type is the identity change as an indication of availability status. The character johnCoffe frequently used this, changing identity to, for example, JCbrb (johnCoffe be right back) or Jcphone (johnCoffe is on the telephone, i.e. giving specific reason for brief absence from online chat):

[14:35] *** johnCoffe is now known as JCphone

✳ ✳ ✳

[14:40] *** JCphone is now known as johnCoffe
[14:40] * johnCoffe back ... **smile**
[14:40] <Biged^> well see ya all later ...theres some real work to be done ...have a good one and take care ...chat hard ...and sleep well ...HUGS for kelly ,,,,,and flaura ...winks too
[14:41] <kelly_467> try it now sis... i often pinch myself
[14:41] <kelly_467> wb johncof
[14:41] * kelly_467 _4Hugs_9ø,¸¸,ø¤°`° _6 Biged^ _9`°¤ø,¸¸,ø_4Hugs_9ø,¸¸,ø¤°`°_6 Biged^ _9`°¤ø,¸¸,ø¤°`°_4 Kisses _9`°¤ø,¸¸,ø¤°`°_2 Biged^ _9`°¤ø,¸¸,ø¤°`°_6 Biged^ _9`°¤ø,¸¸¸,ø¤°`°_4 Hugs _9`°¤ø,¸¸¸,ø¤°`°_4 Kisses
[14:41] <KindBudz`> laterz B
[14:41] <johnCoffe> thx kelly
[14:41] <LdySandra> wb john:)
[14:41] * kelly_467 sends her angel to bless and guide Biged :)
[14:41] <flaura> lol
[14:41] <johnCoffe> :) sandra :)

Some of the central group members had more than one identity, but changing between them did not appreciably change the way they interacted with others, or the way they were perceived. In one example, a central group member with the identity flaura also has the identity ms^smile. When she presents as ms^smile, other group members persist in calling her flaura, and the style interaction is no different to when she presents as flaura at the beginning. Similar behaviour can also be seen in the character eek', who also has the identity crashd. This indicates that although the identity has changed, the role of the individual has not, and other members of the group understand this.

However, there are examples where identity change indicates a change of role which is reflected in behaviour. For example, S|rKn|ght, changes his identity to

|Bladez| when he mimics changing the music and headbanging. This identity and behaviour is a better match than the S|rKn|ght identity, and is the only apparent reason for the change, as it is changed back very soon after (Appendix 1g). Another character to change their identity for a reason is Asha'man, who is also known as DReaDLoRD. This identity is used when this individual is removing a number of people from the channel for rule infringements (Appendix 1h). It would appear that this identity reflects the more authoritarian side of the individual or of the tasks of an operator.

Identity importance

The importance of screen identities to the individual is shown on a number of occasions. For example, a character named pipes' becomes upset when it appears that somebody has stolen his identity. Another, similar identity is suggested, pipez, but is rejected on the grounds that it "sounds like some queer French guy." (see appendix 1i). This identity is only one letter different, but pipes' obviously feels that it does not represent him/her as well as his/her own, current, identity. Another example of the negative reaction to an identity being stolen, even in play, is shown in Appendix 1j. The use of screen identites can be of particular use to individuals who may wish to disguise certain aspects of their character:

```
[14:16] <GAYLORD> i think ur cute Asha'man
[14:16] <GAYLORD> how come u have a males nick?
[14:16] <Gun_Man> kom  til kanalen keaz
[14:16] <Rose_2> Makavelli and i should answer that question.....
why?
[14:17] <giftpack> hey asha'man or what ever i am used to aol so if
u do'nt like it deal with it
[14:17] <Rose_2> @@
[14:17] <GAYLORD> y?
[14:18] <Asha'man> Heh.. want me to deal wif it huh?
```

[14:18] <Rose_2> cause its better to use a males nick than be bothered with a female one

Asha'man says she is a female, and another in the group asks why she has a male nick. Another female member of the group, Rose_2 replies that "its better to use a males nick than be bothered with a female one." This implies that females in these environments may get more attention than they would like from males, which has been previously indicated (e.g. Kendall, 1996; Rintel & Pittam, 1997; Morahan-Martin, 2000).

The identities used in the present study do not exactly follow the findings of Bechar-Israeli (1995), as outlined in the Introduction, but the most common choice of identity was again based on some aspect of the self, e.g. occupation, musical preferences. The findings in relation to identity stealing here are very similar to those reported by Bechar-Israeli. One slight point of difference between the results reported here and those of Bechar-Israeli is that while Bechar-Israeli reported infrequent identity change from the central group members (other than in consensual games), in these data there are examples of central participants using different identities for different rooms or personality characteristics.

The concept of self-presentation has a long tradition in offline research, most notably by Goffman (1959). His arguments that the presentation of self is dramaturgically based, with a front and back stage are of particular importance here. The individuals in these chat rooms are, in some cases, changing their identities to represent a different role being played. This is something that rarely occurs in off-line settings, as different roles are played out to different groups of people. Critically, as Goffman states, the separate groups should never see that the same role is carried out with other people, nor how different the actor is in different

situations. In this on-line situation, this is not the case, as the members of the group see the actor in many different roles with many different people, and so perhaps through a change in visible identity, the actor warns others of the imminent change in identity role.

Conclusions

Cohesive groups were evident in all of these channels, often based around the operators of the channels. These groups were defended against intruders and protective of the group and each other. The members had often known each other for a long period of time and referred to themselves as 'oldies.'

Two norms emerged in the analysis of these rooms: the use of English and banning of swearing. While these are in the rules for the rooms, there are many other etiquette rules which are not enforced as fervently as these, which indicate how strongly these expected behaviours are respected by the group and hence may also be considered as norms. The fact that both of these norms are language based is perhaps understandable, given the entirely text based nature of the environment. Individuals who violated either of these norms were very swiftly removed from the channel by operators and repeat offenders risked a total ban.

A status hierarchy was observed in each of the rooms studied, with the operators as high status, other central group members medium status and outer group and new members low status. Methods of gaining status were mainly based around technical computing knowledge, but simply being a high contributor over a period of time was another route to higher status.

There were also examples of ostracism in the chat rooms recorded here. The central groups were insulated against newcomers, often ignoring them entirely

unless they broke one of the rules of the channel. The response to ostracism was most usually to leave the room, but on occasion, targets of ostracism would become angry with the central group, or continue to contribute until somebody, central group or not, responded.

Finally, the types of identity chosen are in agreement with those reported by Bechar-Israeli (1995). In addition to this, it is also clear that, while an individual's screen identity is important to them, many members of the chat room maintained more than one identity, either for different rooms or for different roles.

These findings indicate that many of the characteristics present in offline groups were also visible online, although the methods of organisation and maintenance may have been modified to fit the specific demands of the CMC context. It is clear that each channel studied contained a cohesive group, which had developed norms that were maintained and shared by the group members, set out formally in the rules available to all members at all times. This group then defended itself against out-group individuals, either ignoring them or removing them from the room for repeated infringements of the norms and rules. However, these groups, though similar to offline groups, appeared far more fluid, with no set leaders or roles, but rather a group of people who fulfilled these roles at different times, depending on who was present in the room.

In summary, a picture begins to emerge from this description, whereby the nature of group behaviour and interaction in CMC is in many ways very similar to face-to-face interaction. The qualitative approach described here carries many advantages, not least of which being the ability to explore the data with a non-constrained, bottom-up approach. Such an approach allows potential issues and

areas for further consideration to emerge, without the danger of a more theory-driven approach clouding the raw data itself. In such a way, group behaviours have been identified, which are consistent with those described elsewhere. Additionally, differences have emerged between the online groups reported here and face-to-face groups in the way that behaviours are expressed. Such differences in expression must be considered in any further analysis of group behaviour, as while behaviours may not appear similar at first glance, they may represent alternate expressions of more familiar group behaviours. For example, technical discussions between individuals may be indicative of not only shared interest, but also an expression of status which holds particular importance in CMC.

However, the descriptive approach taken here also leaves many issues open to interpretation, both in terms of their relationship with previous research and in their relative frequency and importance. The current description simply states that certain behaviours occur, but with no indication as to whether this may happen once in a room or much more frequently. Consequently, a more precise formulation of these attributes of CMC behaviour may be gleaned from a quantitative analysis of the data, partly based upon the categories of behaviour reported here. Such an analysis allows for the frequency of different behaviours to be analysed, along with any potential relationships between them, which is the subject of the following chapter.

Chapter 4 - Internet chat rooms: Periodic & Temporal characteristics

Introduction

A preliminary qualitative overview (see chapter 3) identified a number of attributes of CMC that are similar to those reported in face-to-face groups, along with some differences in how these may be expressed. However, the qualitative approach is limited with respect to characterizing the relationship between the various facets of communicative action and any underlying structure of CMC. Such a characterization of CMC, especially with respect to the dynamics of identity change and ostracism, are not only of intrinsic interest but may also serve to inform previous speculation regarding the structure and dynamics of face-to-face communication (e.g. Chapple, 1970). Moreover, an understanding of the gross dynamics of CMC may also place its use in investigations of ostracism (c.f. Williams et al, 2002) on a surer footing. In particular, further investigation of the nature of CMC, where it differs from, and is similar to, face-to-face communication may enable a better understanding of the media in which both naturally occurring (Rintel & Pittam, 1997) and experimentally induced ostracism (Williams et al, 2002) have been studied.

The chat room data presented in chapter 3 comprise over 8 hours of minute-by-minute, time stamped comments for each of 6 chat rooms and, as such, constitute a potentially rich source for probing the regularities of, and relationships between, attributes of on-line communication. The structure of online communication can be considered both in terms of a structured relationship between event types, and in terms of underlying temporal structure (such as patterns in the frequency of certain

events over time). The amenability of these data to a quantitative analysis with respect to the relationship between event types and to temporal structure renders it promising both in terms of comparison to face-to-face communication and in terms of analysis of the relationship between social events within CMC.

The analysis of verbal patterns of on/off activity in dyadic, face-to-face, conversation has previously been addressed using Fourier analysis, most notably by Warner (e.g. 1979, 1992; McGarva & Warner, 2003). Cyclic patterns of between 2 and 6 minutes in dyadic conversation have been reported in a number of studies using this approach (e.g. Kimberley, 1970; Warner, 1979; Warner, Waggener & Kronauer, 1983; Warner & Mooney, 1988), suggesting that there is a reliable underlying temporal structure in face-to-face communication. Moreover, Chapple (1970) argued that while each individual has a cyclic pattern to their verbal behaviour, people in conversation with each other attempt to adjust their own cycle to create a conversation with matched alternate periods of activity and non-activity. Indeed, Warner (1992) and McGarva & Warner (2003) demonstrated that the periodicity of individual discussants on/off vocal activity became more closely linked with that of their conversational partner over a 40 minute conversation period.

Chapple (1970) proposed that the underlying mechanisms for the observed cyclicity within an individual's vocal behaviour is related to the underlying physiological rhythms in respiration and heart rate and their potential consequences for the ability to produce speech (e.g. Lenneberg, 1967). Evidence for the proposed biological bases for this reported cyclicity in vocal activity has been provided by both Warner, Waggener & Kronaouer (1983; respiration) and Warner, Malloy, Schneider, Knoth & Wilder (1987; heart rate), though each with the caveat

that not all participants exhibited the same links between physiological mechanism and vocal cyclicity, suggesting that these potential links are still far from clear.

While there is evidence for temporal periodicity in face-to-face verbal communication, the existence or otherwise of temporal structure in CMC is currently unknown. Additionally, the proposed mechanisms underlying the periodicity of verbal communication are not straightforwardly related to CMC. For instance, the potential effects of physiological patterns on physical ability to speak may have little or no role in patterns of typing in CMC but it cannot be ruled out that other physiological process may impose different constraints on the temporal structure of CMC. Moreover, the CMC data considered is derived from conversations amongst relatively large groups, which may also have a bearing on temporal structure. Wade, Ellis & Bohrer (1973) report that heart rates of children were closest in rhythm in dyadic, rather than tetradic groups, which the authors suggested was due to the varying individual rhythms cancelling each other out rather than falling into phase, as with dyadic interaction. Similarly, in large group CMC the rhythm of individual conversations may overlap and prevent the development of a harmonized pattern of communication across the whole group.

In summary, a quantitative approach to the data allows for consideration of two types of potential structure in computer-mediated communication. Firstly, analysis of the frequency of event types identified in chapter 3 allows for comparison between groups in the relative frequency of events. We hypothesise that there will be differences between groups in the frequency of behaviours that they exhibit. If no differences exist, the behaviours exhibited may be related to the medium of CMC rather than any normative communication differences between groups.

Secondly, while previous research has demonstrated periodicity in verbal communication, it is not known whether CMC may be similarly characterized. Moreover, previous findings of verbal periodicity did not analyse periodicity with respect to event type within communication but simply gross number of utterances. In order to investigate whether CMC reveals temporal periodicity, the temporal structure of the chat room data was evaluated quantitatively. Given that the putative mechanisms underlying periodicity in verbal communication may not yield similar temporal structure in CMC, the analysis was conducted both at the level of number of comments (akin to the utternances employed in previous studies of verbal periodicity) and event type. The second hypothesis for the study is that there will be evidence of periodicity in the number of comments made in each chat room.

Methods

The data were collected as described in chapter 3. Each comment and event type had a minute-precise time stamp, (e.g. 14:45), associated with it. The data were re-coded in relative time, whereby the first minute of sampling was labeled as minute 0, then increasing to minute 1, 2, 3 and so on with each change in the time stamp. Several comments or events could be recorded within a single minute of time stamping.

Based upon the behaviours recorded in the qualitative analysis and observation of further frequent event types in the data, nine categories of events were identified (see Table 1 for descriptions) which were commonly occurring and evident across all chat rooms. The number of comments made per minute (excluding comments displayed by the software, e.g. identity changes, and those potentially involving more than one discussant, e.g. physical mimicking) were also recorded. Exclusion criteria were applied to the coding of identity change: Those where the name changed only by a single character were not counted, as these were the alternative names which each chatter must have in case of others having the same name. These characteristically changed very little and did not reflect a change in identity. Additionally, instances where identity changed and then changed back immediately were recorded as one change, rather than two. This type of change indicated that the system had intervened to remove identical screen names, but the individual had changed back to the original (asserting identity) immediately. An independent rater, trained in the descriptions of the categories, coded one hour of one chat room for the categories which were not strictly defined by on-screen presentation (number of comments, physical mimicing and identity changes) and the codes were

correlated with the author's coding. These correlations yielded significant r values in all categories, ranging from r = .45 (real life references) to r = .97 (ostracism).

Event type	**Description**
Identity change	Highlighted in text as: `[14:40] *** JCphone is now known as johnCoffe`
Ostracism	A comment made by an individual which is not responded to by any other member of the group within three minutes.
Technical chat	A period of conversation between two or more members which centres on either programming or computing in general.
Physical mimicking	The use of the third person to describe a physical action, highlighted within the text as: `* Gorf looks up to the heavens and sees Op-Vader frowning upon the mere mortals asking for op.`
Real life	Conversations about offline life, which may or may not indicate the co-discussants know each other in offline life
ASL	Common question in CMC, referring to asking somebody's age, sex and location. Related to real life, but only exchanged between strangers
Flirting (playful)	Romantic conversations between co-discussants, without any sense of actual relationship – for example joking about being somebody's boyfriend/girlfriend, or discussing physical attractiveness.
Online relationships	Conversations which refer to either knowledge of previous members of the group or knowledge of online chatters in other groups
Protecting the group	Comments where group members either remove offensive/annoying chatters from the room, or planned attacks on other groups in response to perceived intrusion in their chat room

Table 1: Names and descriptions of categories used for coding.

Results: Gross characteristics

Number of comments

There was a high amount of variability in the average number of comments made between the chat rooms, with cyberchat and england making the most and australia and chatworld making the fewest (Fig 1a). A Kolmogorov-Smirnov test of normality indicated that the data for australia were not normally distributed. A Kruskal-Wallis test revealed a significant difference between groups in the number of comments made (χ^2 = 71.99, N = 6, $p<0.001$). Dunn's multiple comparisons test indicated that cyberchat made significantly more comments on average in each time bin, than all rooms other than england (australia, chatworld and usa, $p<0.001$: worldchat, $p<0.05$.)

Number of identity changes

The pattern of identity change data indicated that there were more identity changes, on average, in the usa than the other rooms, who all appeared relatively equal. A Kolmogorov-Smirnov test indicated that none of the groups were normally distributed (all at $p<0.05$). A Kruskal-Wallis test revealed a significant difference between groups in the number of identity changes (χ^2 = 109.7, N = 6, $p<0.0001$). Dunn's multiple comparison test revealed that usa made significantly more changes than every other group (all at $p<0.001$), with further differences between england and chatworld ($p<0.05$), worldchat and cyberchat ($p<0.01$) and worldchat and england ($p<0.01$) (Fig 1b).

Ostracism events

Fig 1c shows that australia had the lowest number of ostracism events, followed by chatworld. The other groups all had a higher frequency of ostracism. A Kolmogorov-Smirnov test indicated that none of the groups was normally distributed (all at $p<0.05$). A Kruskal-Wallis test revealed a significant difference between groups in the number of ostracism events ($\chi^2 = 38.11$, N=6, $p<0.001$). Dunn's multiple comparisons test revealed that australia showed significantly (all at $p<0.01$) fewer ostracism events than all chat rooms, apart from chatworld. There were no significant differences between any of the other groups.

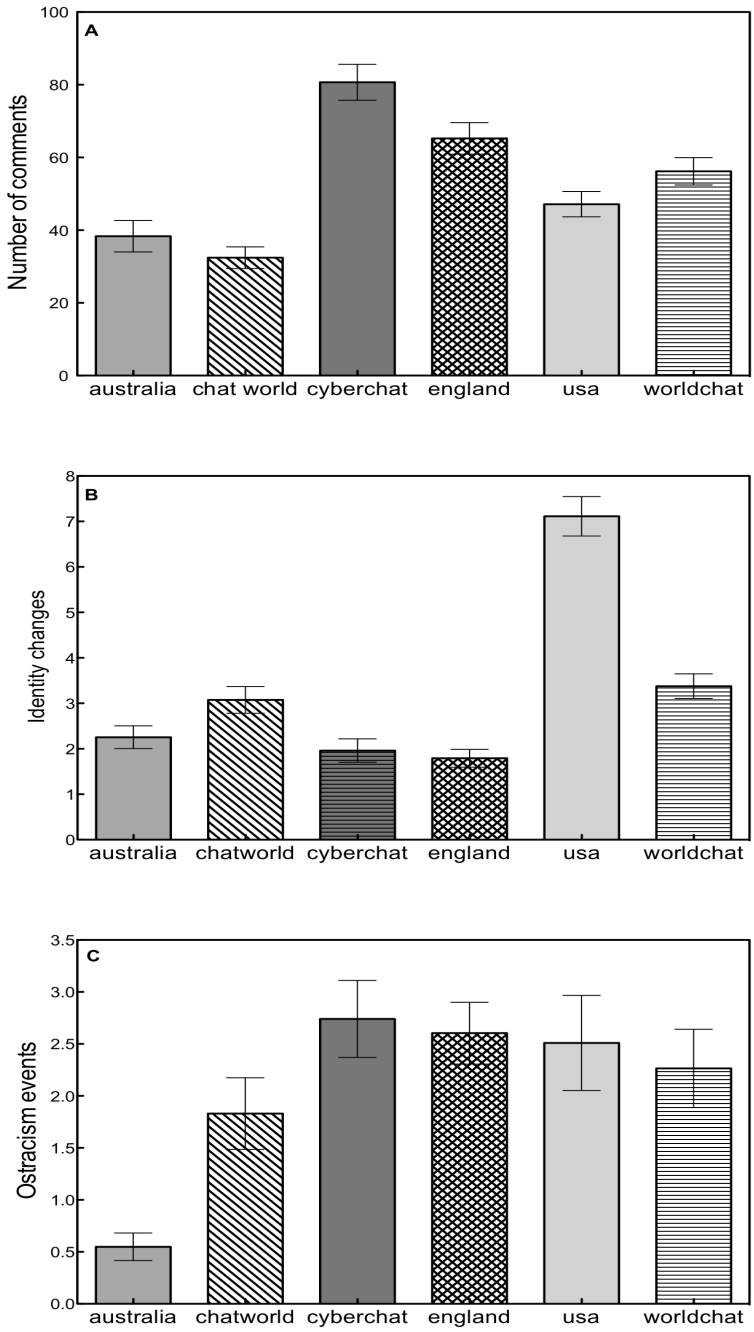


Figure 1: The number of comments, identity changes and ostracism events recorded on average per 10 minute bin. Error bars indicate standard deviation. Panel A shows number of comments, panel B identity changes and panel C ostracism events.

Group size

To assess the possibility that differences in group size may affect the frequency of events, the number of discussants in a 30 minute sample of each chat room was recorded and compared. A chi-square analysis indicated that there was no significant difference in the number of discussants across the six rooms (χ^2 =7.32, df=5, p>0.05).

Event frequency

Total number of comments were converted to z-scores for each group in 30 minute time bins to assess the consistency of rate of comments for each group across and within sessions. The results (Fig. 2) indicate that sessions were relatively equal within each group, with most scores falling between ±1.5 and no scores over ± 2.5.

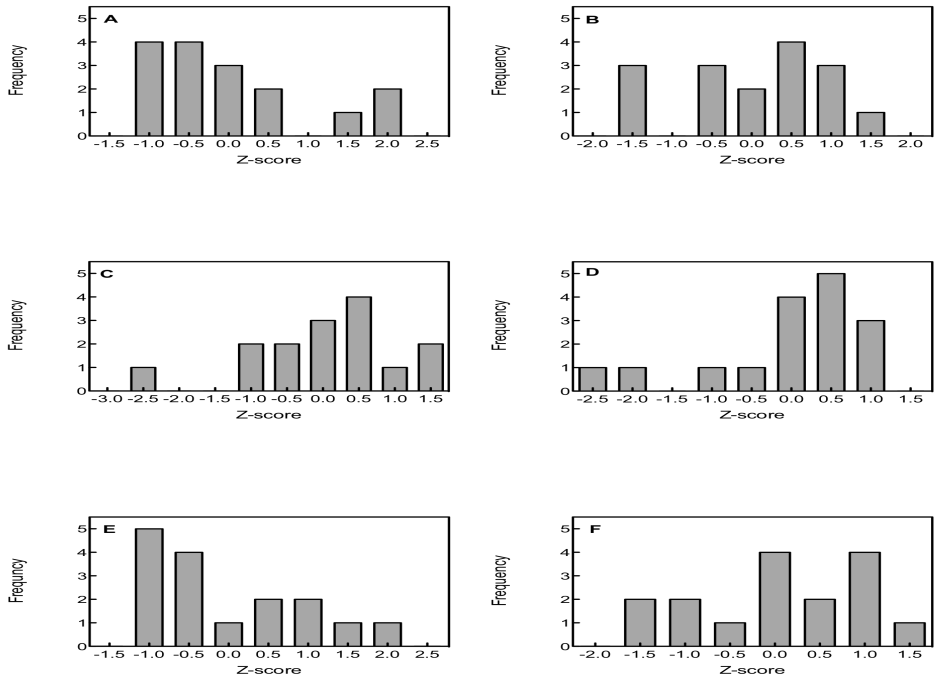


Figure 2: Number of comments per 30 minute time bin for each group. X-axes represent the z-score, Y-axes the frequency. Panel A represents australia, panel B, chatworld and panel C, cyberchat. Panel D represents england, panel E, usa and panel F, worldchat.

Event frequency by type

The number of each event type was firstly concatenated across sessions to produce a total number of each event for each chat room (Fig. 3). The results indicated that there was disparity between the groups, whereby certain events were more common in one chat room than another. Chi-square goodness of fit tests revealed significant differences between the groups on all event types (ASL: $p<0.01$, all other events, $p<0.001$).

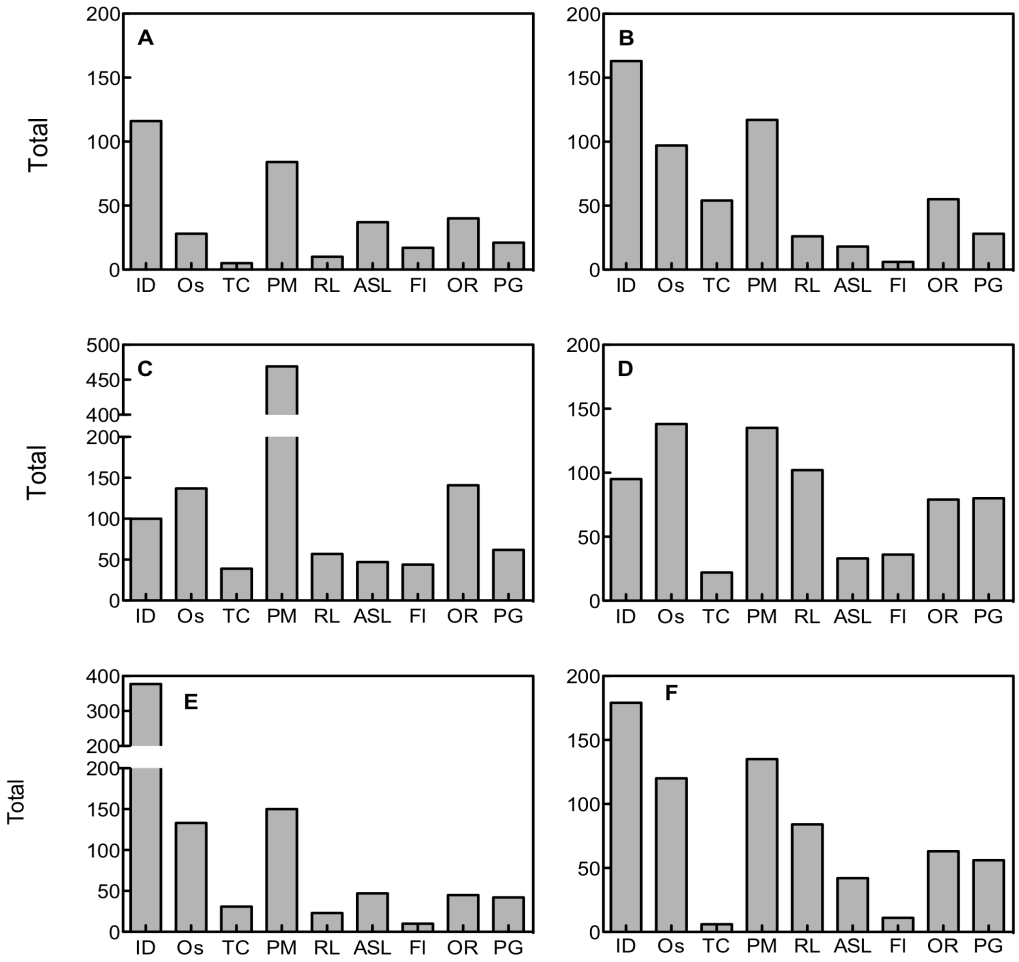


Figure 3: Total number of events for each category, organized by chat room. X-axes represent event type, where ID = identity changes, Os = Ostracism, TC = technical chat, PM = physical mimicking, RL = real life, ASL = Age, Sex, Location, Fl = Flirting, OR = online relationships and PG = protecting the group. Y-axes represent total number of

events. Panel A shows events for Australia, panel B, chatworld and panel C, cyberchat. Panel D represents England, panel E, usa and panel F, worldchat.

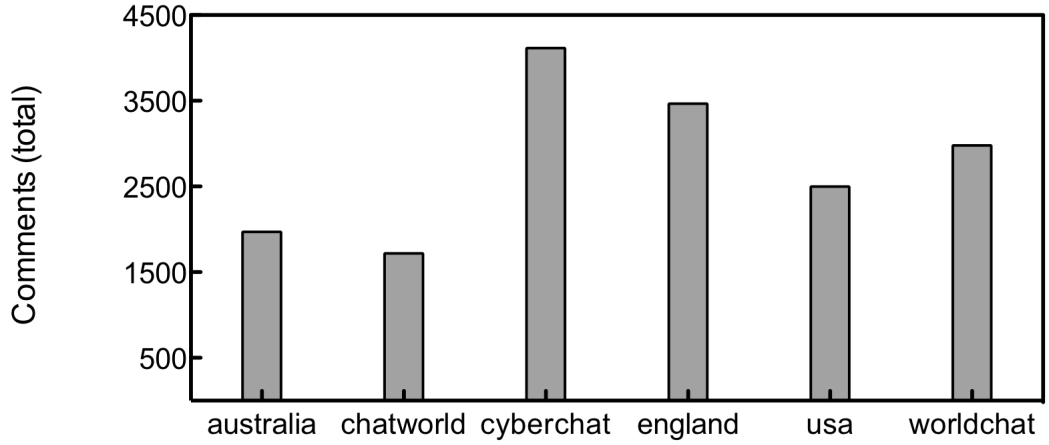


Figure 4: Total number of comments in each chat room. X-axis represents the chat rooms, Y-axis represents total comments.

Fig 4 plots the total number of comments for each group ($\mu = 2791$; $\sigma = 911.6$). A chi-square test of goodness of fit revealed a non-equal distribution (χ^2 (N = 9085) = 1081.82, $p<0.001$), with cyberchat making most comments and chatworld making fewest.

These comparisons at a gross level of total number of events or comments indicate that there are significant differences between the groups in the frequency of all event types.

While differences were found for all event types, number of comments, identity changes and ostracism events were of the most interest and were therefore analysed at a finer level of detail. The data were grouped into 10 minute bins and the average events per bin compared across groups.

Identity change and number of comments

The average number of identity changes and number of comments per minute was calculated for each of the four sampling periods (i.e. different sessions) acquired. A Kolmogorov-Smirnov test of normality revealed that the number of identity changes was not normally distributed ($p<0.01$). A Spearman correlation revealed a significant negative correlation between average number of identity changes and average number of comments ($r_s = -0.43$, $n = 24$, $p<0.05$, two-tailed)(Fig 5).

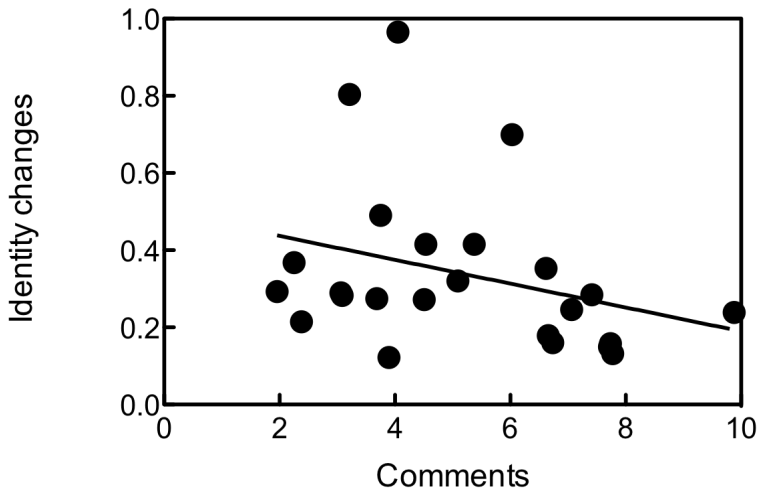


Figure 5: Average number of identity changes per minute as a function of average number of comments per minute. All groups are included and each symbol represents one sampling period, r= -0.43.

In order to obtain a clearer picture of this relationship, the number of contributions was normalized with respect to the number of identity changes in each session, yielding a ratio of changes per contribution. These data are shown in Figs 6 (all channels) and 7 (each channel individually):

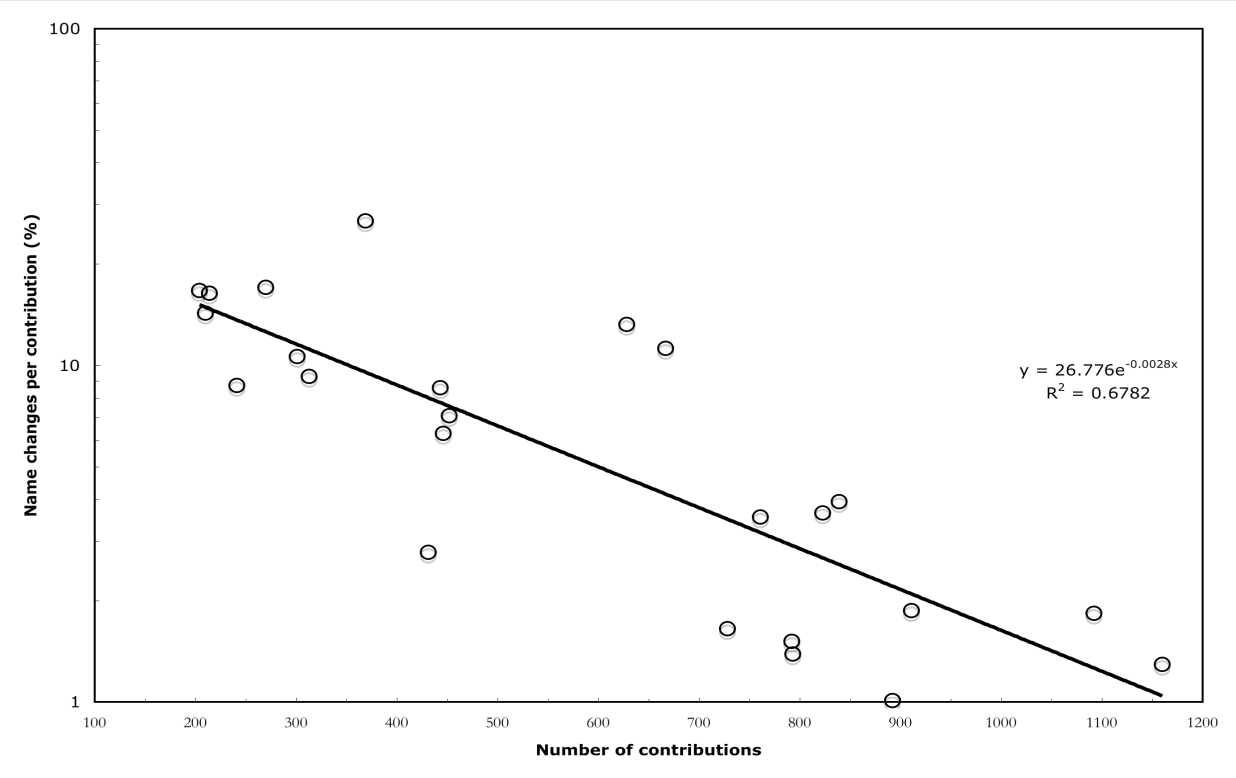


Figure 6: The proportion of name changes per contribution as a function of number of contributions. A least squares fit to an exponential function yielded an r^2 value of .678. The fit is adequate and suggests that the rate of decay of name changes per contribution is proportional to the total number of contributions made. Note that the data are plotted on log lin axes.

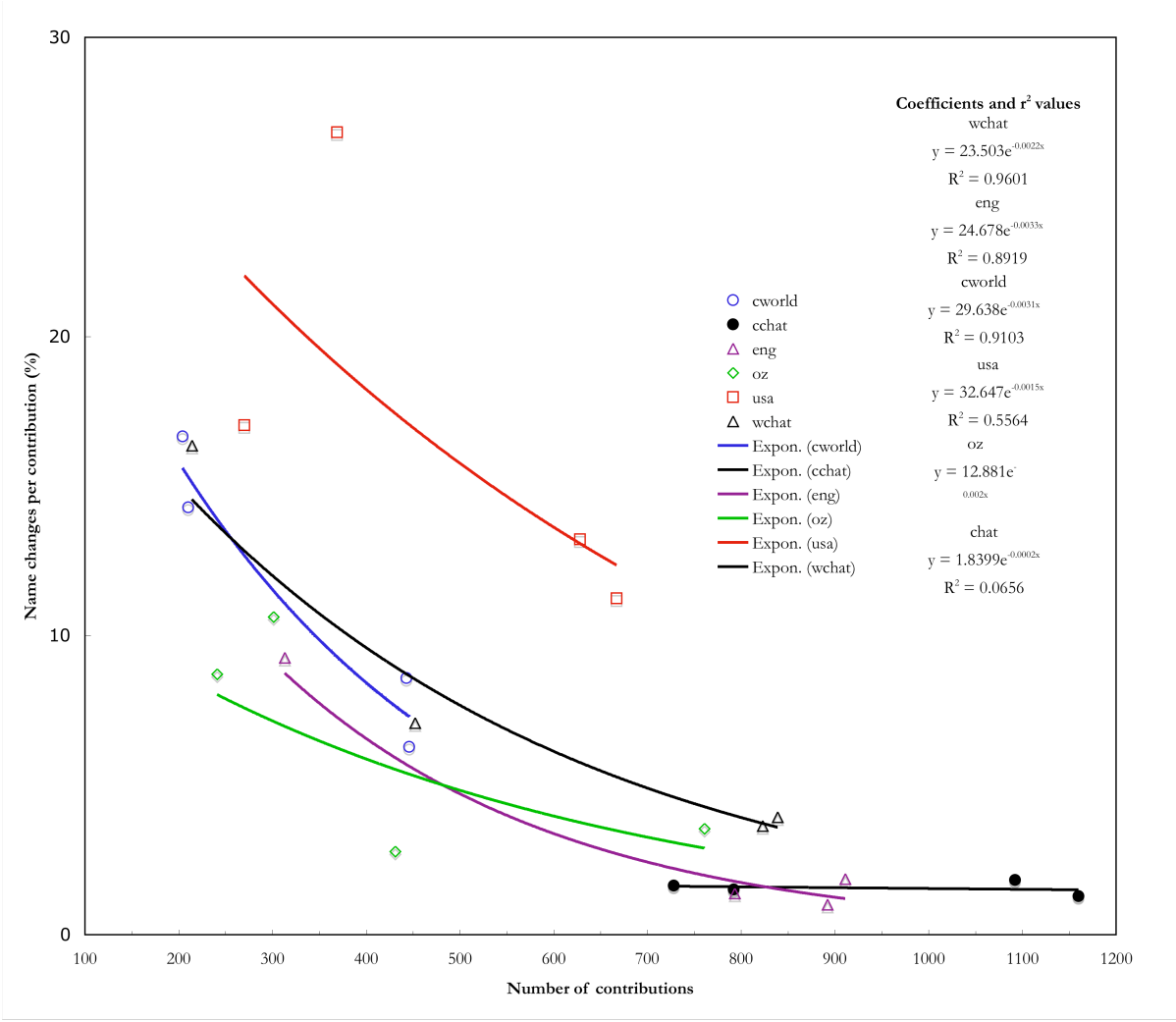


Figure 7: The data from fig 6 are re-plotted by group with respective least squares fits for each group. The r^2 values range from 0.96 for 'wchat' to 0.06 for 'chat'. Note that the group 'chat' has a very high number of contributions at all times and as such appears to represent the asymptotic part of the exponential function. This may indeed explain the low r^2 value for this fit in that, in essence, it represented an attempt to fit an exponential function to data tending to a straight line. The overlap of all groups on a quasi-exponential curve is evident save for the group 'usa' whose baseline name change rate appears somewhat higher. These individual results are suggestive that not only do name changes obey a lawful exponential decay as a function of total group contributions but that this decay is quantitatively very similar for different groups in terms of its decay coefficient.

Fig 6 shows that across all chat rooms, the number of identity changes decreased as the number of contributions increased, and that this relationship is adequately described by an exponential function (r^2=0.678). Such an exponential relationship could be explained by a constant rate of name change (i.e. y = C/x, where C is a

constant) which would produce an exponential function similar to that in fig 6. However, the negative correlation between the two variables (name change and number of comments) shown in fig 5 vies against such an explanation. Fig 7 splits the data into the constituent chat rooms, showing a good degree of similarity across them. The channels all show the same relationship, that of decreasing identity changes with increasing contributions, apart from cyberchat. This may best be explained by the observation that this channel has a very high number of contributions, and consequently a low rate of identity change. This, then, may represent a floor effect, whereby the relationship cannot be discerned as the number of contributions never falls sufficiently to observe the expected rise in identity changes. Overall, this relationship appears to hold well in all groups, and fits the proposed function adequately to very well (in the case of worldchat). The fact that not only do the groups show the same relationship, but show similar functions in terms of the number of contributions at which identity changes alter dramatically, suggest a wider rule that holds for this relationship. The reason for this relationship is difficult to ascertain from these data, and is open to interpretation. One possible explanation for this finding is that as the number of contributions increases, the group (and its communication patterns) becomes more stable and established, and the identity of the group members becomes similarly stable for this period. Once the contributions decrease, perhaps the group becomes less stable, and the opportunity to experiment with identity becomes more attractive to the remaining people in the group. The nature of the analyses conducted thus far render such an interpretation highly speculative, but the possibility of a temporal component to this relationship will be further examined below.

Ostracism events and number of comments

The average number of ostracism events per minute for each recorded session was correlated with the average number of comments. A Pearson correlation revealed a significant positive correlation between these two variables ($r = 0.72$, $n = 24$, $p<0.001$, two tailed). Thus, it would appear that as the number of comments made per minute increased, so did the number of ostracism events. A linear regression of the relationship revealed an r^2 value of 0.52, indicating an adequate fit of the model to the data (Fig 8). Again, a full interpretation of this result in terms of whether either of these variables is causing a change in the other is problematic, but the possibility of a temporal component to the relationship is examined below.

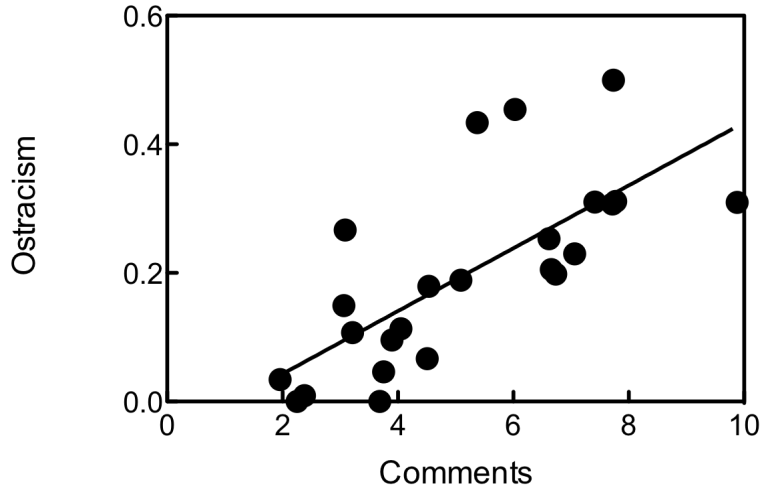


Figure 8: The average number of ostracism events per minute as a function of number of comments per minute. All groups are included and each symbol represents one data sampling period. Line of best fit produced by least squares fit linear regression with an r^2 value of 0.52.

Identity change and ostracism events

The average number of identity changes per minute was correlated with the average number of ostracism events per minute. A Spearman correlation revealed no significant relationship between the two variables (r_s = -0.18, n = 24, p>0.05, two tailed) (Fig 9).

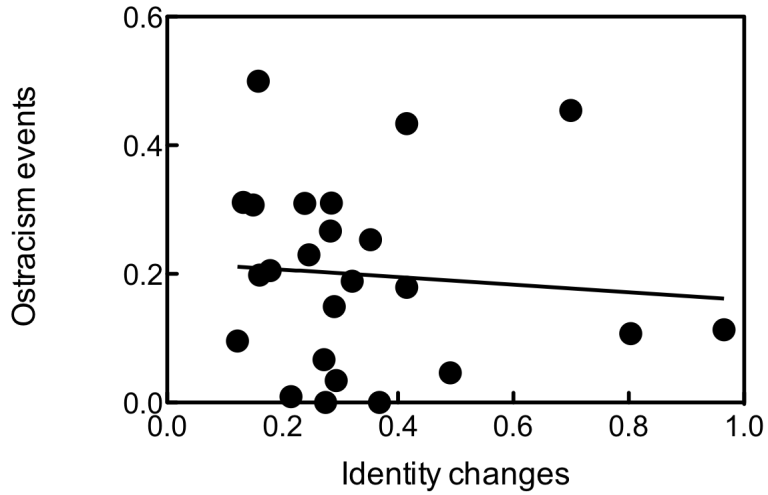


Figure 9: Average number of identity changes as a function of average number of ostracism events. All groups are included and each symbol represents one sampling period. Line of best fit produced by least squares fit linear regression, with an r^2 value of 0.007.

Gross characteristics: Summary

The results indicate that the different groups demonstrated differing frequencies of event types, suggesting that each displays a different profile of normative levels of behaviour type. Across all groups there appear to be complex relationships between identity change, ostracism and number of comments made. While these relationships are interesting, the correlational nature of the analyses can reveal

nothing of causality, rendering an interpretation of the findings somewhat speculative.

It was evident within the raw data that there were changes in the frequency of events or comments over time, such that there were periods with many comments, and other periods with far fewer. These events in time, therefore, may be considered as a signal, where the strength (number of comments) increases and decreases over a period of time. Such a reconceptualisation of the data allows for further analysis to determine whether the observed increases and decreases in frequency of number of comments, identity changes and ostracism events form a periodic pattern. Additionally, these signals can be temporally cross-correlated, to address to some extent the inherent issues with establishing causality in a correlational analysis. In order to further examine these relationships, and to gain a better understanding of the underlying structure of these communication exchanges, further analysis in both the temporal and frequency domain was conducted. In order to characterize the potential periodicity of CMC events, the one-minute binned data for the events comments made, ostracism and ID change were treated as discrete time series, *x(t),* and were analysed in both the temporal and frequency domains using cross-correlation and Fourier techniques respectively. The techniques and methods used for these further analyses are firstly described, before the results are presented.

Methods: Periodicity and temporal characteristics

Fourier analysis

The time course of number of comments, identity changes and ostracism within the chat room data may be considered as a time-varying input signal which can be transformed into the frequency domain using Fourier techniques in order to evaluate any underlying periodicity of these three variables. Determining whether any such periodicity exists will contribute not only to our understanding of the fundamental structure of CMC in this context, but any emergent structure can be compared with the known Fourier characteristics of face-to-face communication (such as Warner (1979; 1992)) thus providing more information on the differences and similarities between the two communication media.

Frequency domain analysis

Fourier analysis is a mathematical transform that completely describes the time series signal in the frequency domain as the sum of component sinusoids whose amplitude, phase and frequency vary. Thus the power associated with any particular frequency reflects the degree to which any particular event (comments made, ostracism, identity change) occurs within the chat room at that periodicity. Should there be no particular frequency at which such events occur, the Power Spectral Density (PSD) would be flat as a function of frequency. Conversely, periodic fluctuations in the occurrence of such events would yield spikes in the power spectrum as a function of frequency, as has been reported in face-to-face communication (Warner, 1992).

The Fourier power spectrum has the advantage of representing the power at any particular frequency in a phase-independent manner and thus allows for an evaluation of periodicity that is not compromised by the arbitrary start times of the original time series acquisitions, nor of any other phase-dependent characteristics that may otherwise mask an underlying periodic structure, such as individual members' events being de-synchronised. Thus we can represent the overall power at any frequency, in a manner that is not possible within the time domain.

The Fourier transform of the time series signal, *x(t),* is formally given by:

$$X(f) = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$$

where $\omega = 2\pi f$

Since the data are sampled (in one minute time bins), the appropriate discrete form of the transform is given by the discrete transform formula:

$$X_k = 1/N \sum_{i=0}^{N-1} x_i e^{-j2\pi i \frac{k}{N}}$$

where *k/N* may be considered as the frequency in cycles per sampling interval.

The Power Spectral Density, P_k, is simply the square of the windowed signal:

$$P_k = 1/N \left| \sum_{i=0}^{N-1} x_i w_i e^{-j2\pi k i} \right|^2$$

where w_i is a window function.

PSDs were estimated using the periodogram method and a rectangular window. Analysis was implemented using a bespoke function within the Matlab

environment (Release 2007b; Mathworks inc: Mass.). The code may be found in Appendix 2.

Time domain analysis

Whilst Fourier techniques provide the ability to identify periodicity in single events, phase-unwrapping also discards information about the temporal structure of events since it discards information about their relative timing. In order to evaluate the temporal relationship between two time series, x_i and y_i, (e.g. comments and ostracism), it is necessary to derive a single function that is the average product values of x_i, y_i for differing values of their relative time delay. Formally, this cross-correlation function is given by:

$$R_{xy}(\tau) = 1/(N-\tau)\sum_{i=1}^{N-1} x_i y_{i+\tau}$$

where τ is the correlation time lag and N is the number of points in the time series. Cross-correlation functions for the three event types of interest – number of comments, ostracism and ID change – were calculated for each chat room for $-11 < \tau < 11$ in order to characterize the relationship between event categories. Cross-correlations were calculated using the timeseries toolbox in Matlab (R2007b, Mathworks Inc., Mass.)

Filtering

While a Fourier transform is able to extract individual signals from within a noisy signal, it is often helpful to first filter the data in order to remove artefactual high frequency noise. This noise is introduced in any digital transform by virtue of the quantization of the signal into time bins and the hard edges of the windowing

function. In order to attenuate these artefacts, that are not an intrinsic attribute of the time series, all signals were filtered using the in-built Matlab (2007b) first order continuous low pass filter and zero-padded. The same filter was applied to the data for both Fourier analysis and cross-correlation.

Preprocessing

The raw, minute-by-minute, data for the longest sampling period (240 minutes) was evaluated for each chat room and three event types: number of comments, number of identity changes and number of ostracism events. In all analyses, the data were normalized with respect to the average event occurrence for that chat room, in order to remove differences in baseline average frequency of each event (an underlying DC shift) in the data.

Results: Periodicity and temporal characteristics

Number of comments

The time course of the raw number of comments is plotted for the room england over the 240 minute sample in Fig 10. The data for the remaining groups is very similar in pattern and is included in Appendix 3. These plots indicate that high frequency noise, an inevitable artefact of quantization of the time series due to one minute sampling, is evident within the data. This highlights the need for filtering, as described above.

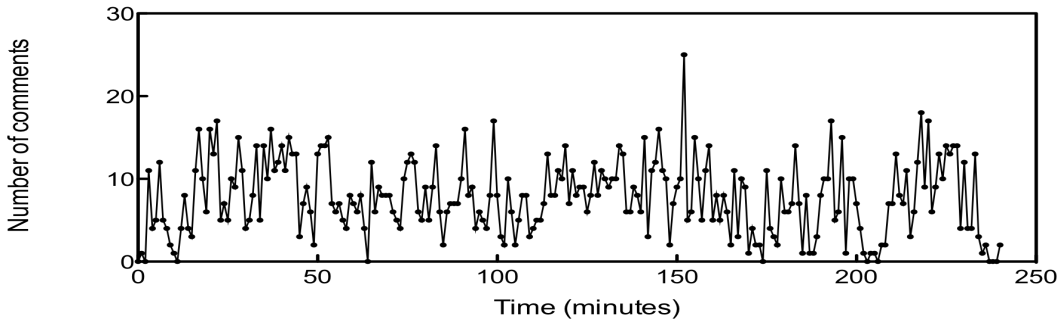
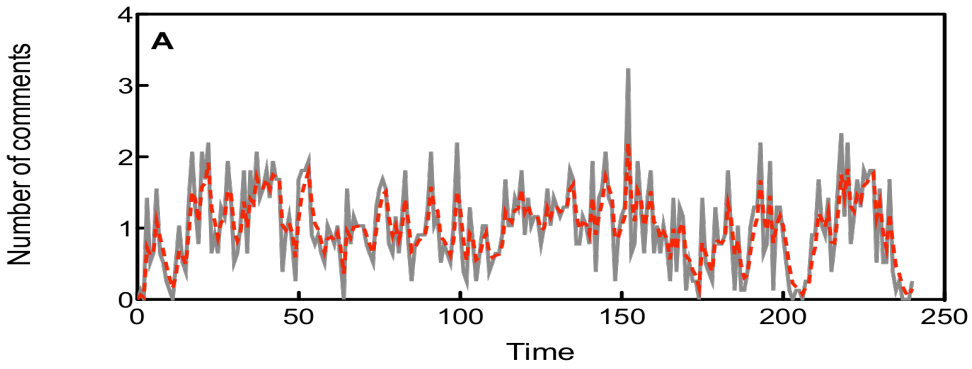


Figure 10: Time course for number of comments made in the chat room england. X-axis represent time (minutes) and Y-axis represents number of comments.

In order to establish an appropriate filter temporal coefficient, time constants of 1, 2, 3, 4 and 5 minutes were initially applied to the data. These constants smooth the data at their respective frequency – in other words, data which showed high frequency at a time of 1 minute (e.g. changes in number of comments) would be smoothed by using a time constant of 1, leaving all other frequencies unaffected. Setting a time constant too low could result in not removing sufficient high-frequency noise from the signal to be render it meaningful, whereas setting this point too high could lead to a loss of genuine variation in the data. Fig 11 shows the effect of the filter for these time constants for England. The results of the remaining groups may be found in Appendix 4.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Number of comments
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1
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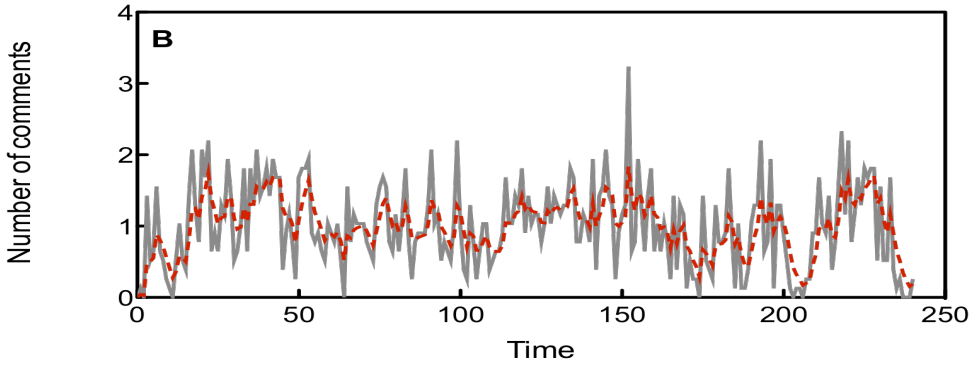
B
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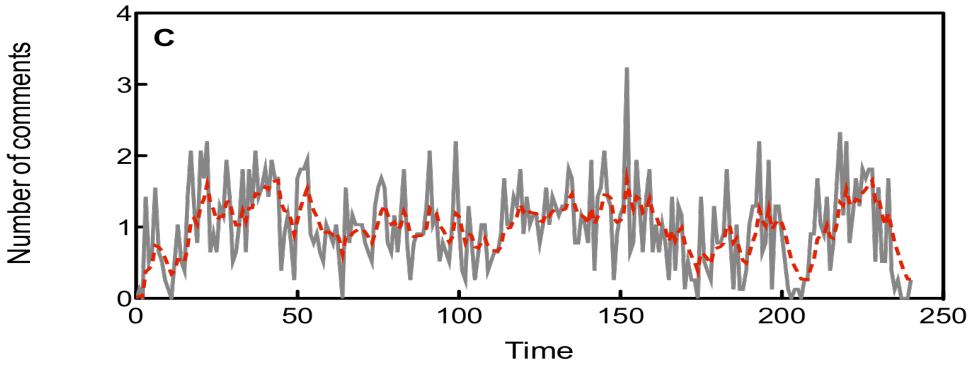
C
Number of comments
Time
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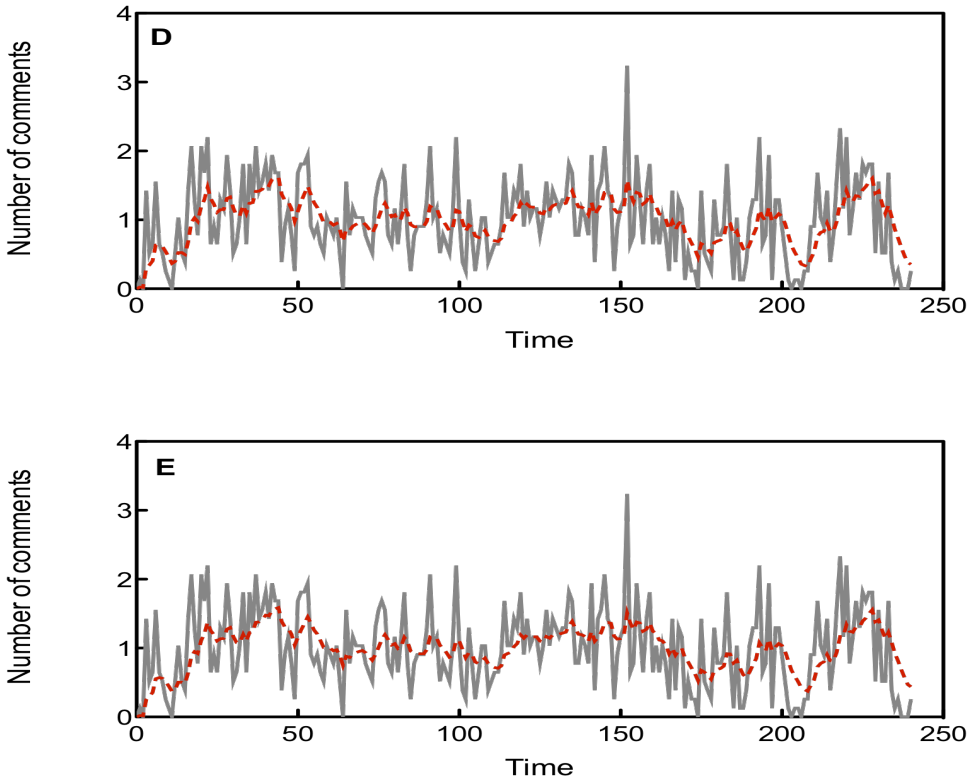


Figure 11: Comparison of raw time course and filtered data for filters at 1 (panel A), 2 (panel B), 3 (panel C), 4 (panel D) and 5 (panel E) minutes. Solid grey line represent raw data, dashed red line represents filtered data.

The results indicated that a filter of 2 minutes provided a reasonable balance between preserving the raw signal and removing particularly high frequency noise. Fig 11, panel shows the filtered signal still contains much of the high frequency noise, but panel E indicates that the filtered signal has been smoothed to the point where it is too distant from the raw signal in many places. The power spectra of the filtered signals for each group are plotted in Fig 12.

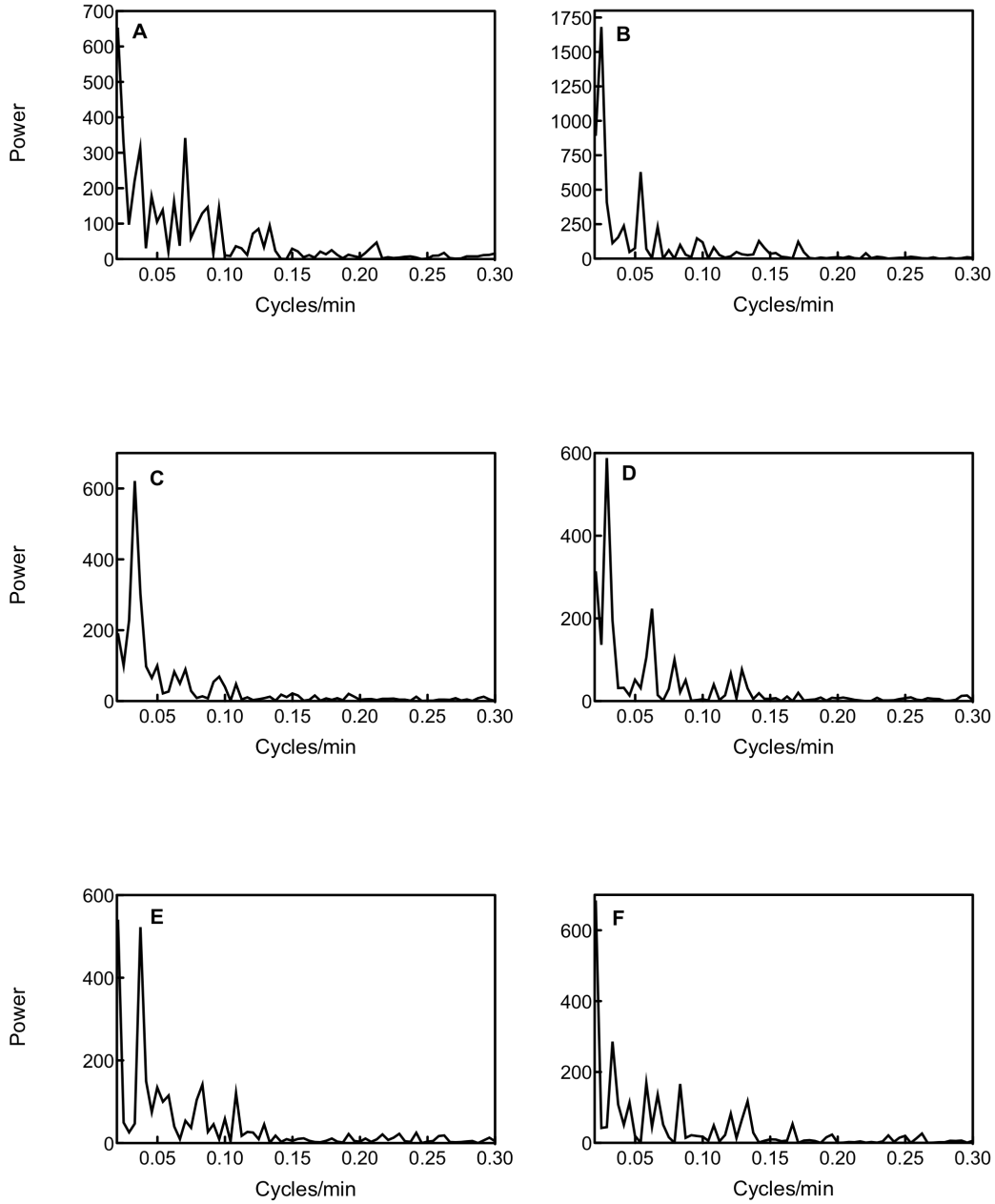


Figure 12: The power spectra produced by Fourier analysis for each chat group. Panel A represents Australia, panel B, chatworld, and panel C, cyberchat. Panel D represents eng, panel E, usa and panel F, worldchat. The X axes represent frequency (cycles minute^{-1}), Y axes represent power.

The power spectra revealed points of similarity between the groups, with all rooms producing a high peak at between 0.02 and 0.04 (30-50 minutes), indicating a relatively low frequency cycle. All groups also produced a peak of power at around 0.06-0.07 cycles per minute, corresponding to a higher frequency cycle of

approximately 15 minutes. These two cycles could possibly reflect different types of rhythm within all rooms, with a longer cycle perhaps indicating a more fundamental rhythm to online chatting, and the shorter cycle possibly indicating typical individual conversation length.

Between group differences in cyclicity are also discernible. Australia, england, usa and worldchat yield local minima in power at around 0.13-4 cycles per minute (a period of approximately 7 minutes) that are not present in chatworld or cyberchat. Finally, worldchat and chatworld indicated a low peak in power at approximately 0.17 cycles per minute (ca 6 minutes per cycle).

However, an average of the power spectra, each normalized with respect to its maximum, for all six groups (Fig 13) confirmed the largely shared cyclic pattern between groups, with peaks at 0.02 (50 mins), 0.05 (20 mins) and around 0.1 (10 mins) per cycle.

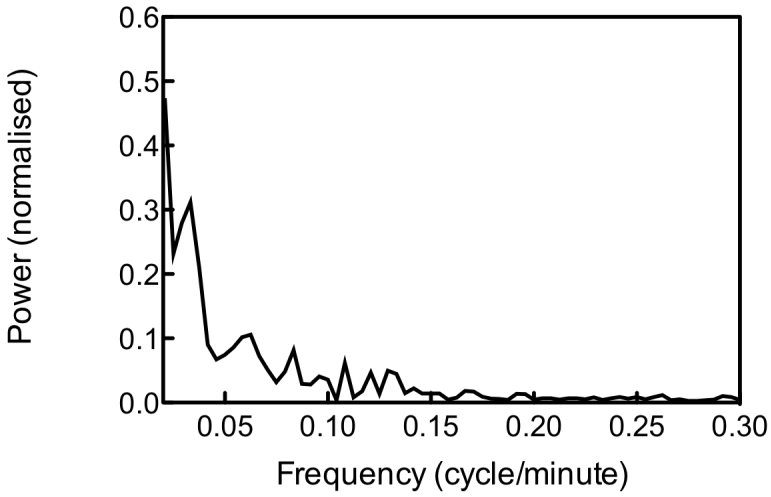


Figure 13: Averaged power spectra across all six chat rooms. X-axis represents frequency (cycles/minute), y-axis represents power.

The apparent cyclicity of chat in Internet communication reported here is consonant with the periodic patterns found in face-to-face communication (Warner, 1979; Warner & Mooney, 1988). The length of the reported cycles does differ between communication media, with Warner (1979) and Warner & Mooney (1988) reporting cycles of approximately 6 minutes in face to face communication, with longer cycles of 50, 20 and 10 minutes reported here. However, estimates of face-to-face periodicity were based upon far shorter time signals than those employed here, for example, Warner (1979) used 40 minute long conversations. This limited the period of cycle that could have been detected to under 20 minutes. The length of the present data allows examination of far longer periods.

Pink noise

The power spectra in Figs 12 and 13 bear a striking resemblance to 1/f or pink noise which has been reported in a wide range of naturally occurring phenomena. Different noise types with specific characteristics have been identified in a range of signals, such as sound and images. White noise indicates a random signal, whose power spectrum (on log-log axes) yields a flat line (slope = 0). Brownian noise contains more power at lower frequencies and yields a slope of -2. Pink noise falls between these two, and is characterized by a 1/f slope (slope = -1) in power spectra plotted on log-log axes such that there is equal energy in each log interval or octave. As such, the energy between, for instance, 0.01 cycles/minute and 0.02 cycles/minute will be the same as that between 0.02 and 0.04 cycles/minute. Thus, as the frequency of comments increases within a log band, the energy associated with it remains constant. Essentially, the amount of activity, in frequency terms, remains the same proportionally whether the system is observed over 3, 10 or 30 minutes – it is scale invariant. Such characteristic spectra are widespread and have

been reported in a diverse variety of phenomena including natural images (Field, 1987), resting neuronal activity derived from both MEG (Novikov, Novikov, Shannahoff-Khalsa, Schwartz & Wright, 1997) and EEG (Ward, 2002) protocols, cerebral blood volume dynamics (Eke, Herman & Hajnal, 2006) and music and human voices (Voss & Clark, 1975).

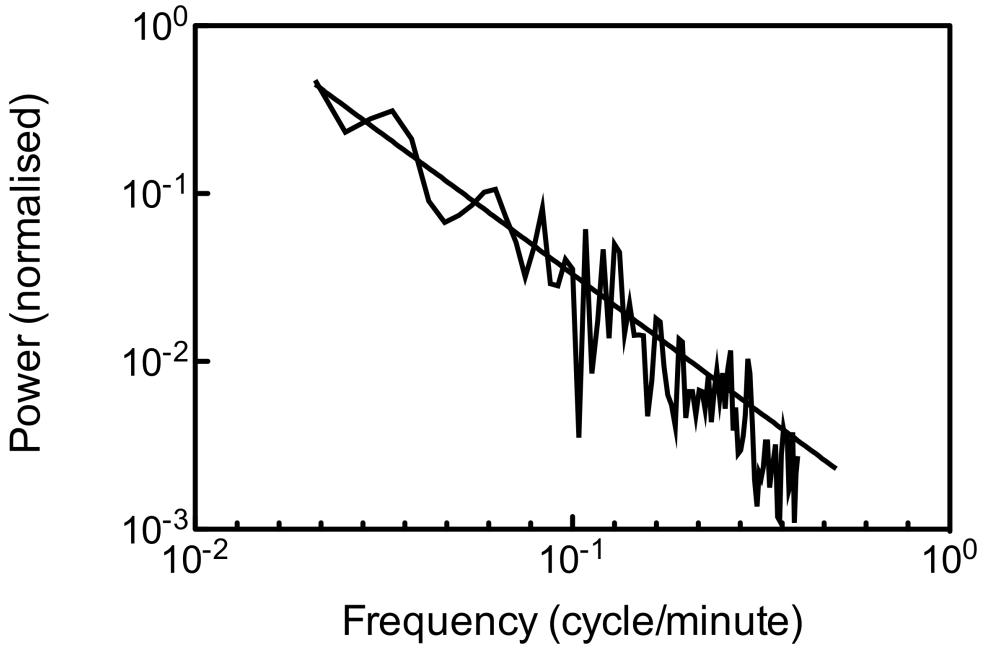


Figure 14: Averaged power spectra plotted on log-log axes. The best least squares fit has an r^2 of 0.92.

The averaged power spectrum of Fig 12 is re-plotted on log-log axes alongside the best least squares fit whose slope is -1.6 and r^2 is 0.92 in fig 14. Thus, the slope of the average spectrum is $1/f^{1.6}$. Similar slopes are evident in each individual chat room, with values ranging between 1/f (worldchat) to $1/f^{2.1}$ (chatworld) (Fig 15).

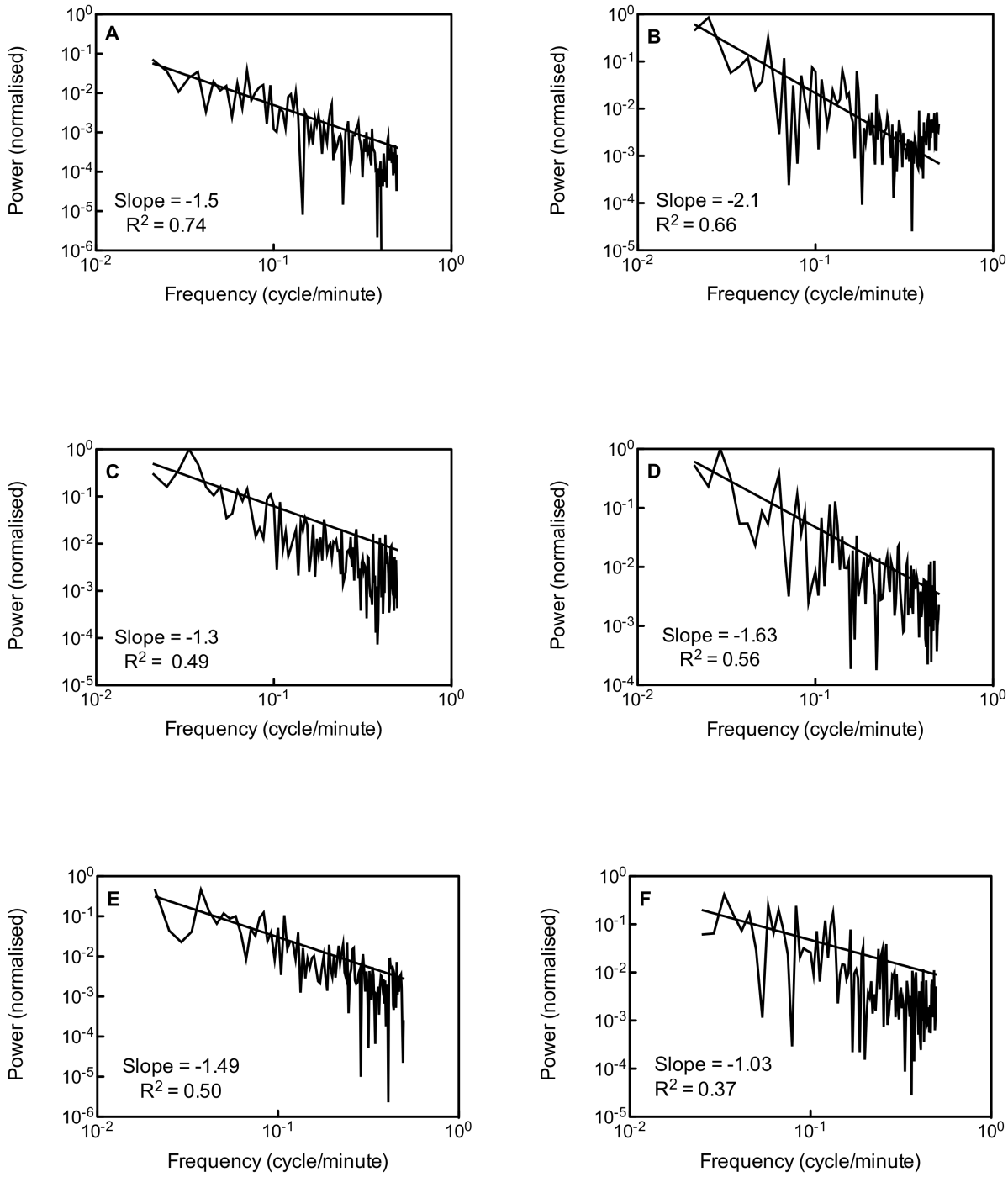


Figure 15: Power spectra for each chat room on log-log axes. X-axes represent frequency (cycles/minute), y-axes represent normalized power. Panel A shows the group australia, panel B, chatworld and panel C, cyberchat. Panel D represents england, panel E, usa and panel F, worldchat.

In order to evaluate whether the slopes found reflect an intrinsic property of CMC, rather than a more generic property of the quantized signal the temporal order of the time series for one chat room (usa), was randomized, and the resulting power spectrum was estimated. This process should yield a PSD slope of zero if there is no generic artefact contributing to the slopes reported in Fig 15. Fig 16 plots the resultant PSD, whose slope is -0.16.

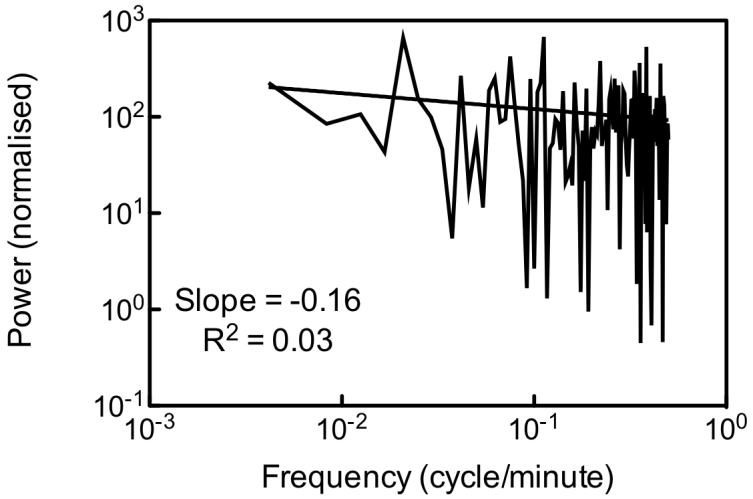


Figure 16: Power spectrum for the randomized number of comments data from the chat room usa. X-axis represents frequency (cycles/minute) and y-axis represents power.

Individual vs group time series in number of comments

While the cause of 1/f noise in such a wide variety of fields is far from clear, one possible way of considering this in population samples emerges from the work of Petrovskii, Mashanova & Jansen (2010). The authors examined the movement patterns of aphids, and discovered that the distance moved by a population of aphids followed a power law with a cut off, not dissimilar to the 1/f distributions reported here and elsewhere. However, Petrovskii et al (2010) revealed that this pattern was produced by a combination of aphids who did not move very far and

those that tended to move longer distances, neither of which produced the power law distribution observed at a population level. One possible explanation, then, for the 1/f pattern observed in the number of comments power distribution reported here could be that while the population of the chat room displays this pattern, individuals within the group may exhibit different patterns which, when combined, produce a 1/f distribution. A one hour subset of the original data (group: worldchat) was selected and in-group members (who contributed throughout the sample period) were identified. The number of comments made by each of these individuals to the discussion during this period were analysed using the same methods used for the whole group data set. All other comments made during this period were concatenated into a single time series for comparison with the individual time series. As shown in fig 17, each individual member displayed a 1/f distribution in power, along with the combined other comments. This indicates that, at least in this data set, the possibility of 1/f emerging from a combination of different individual frequencies, rather than 1/f in communicative patterns, has not been supported.

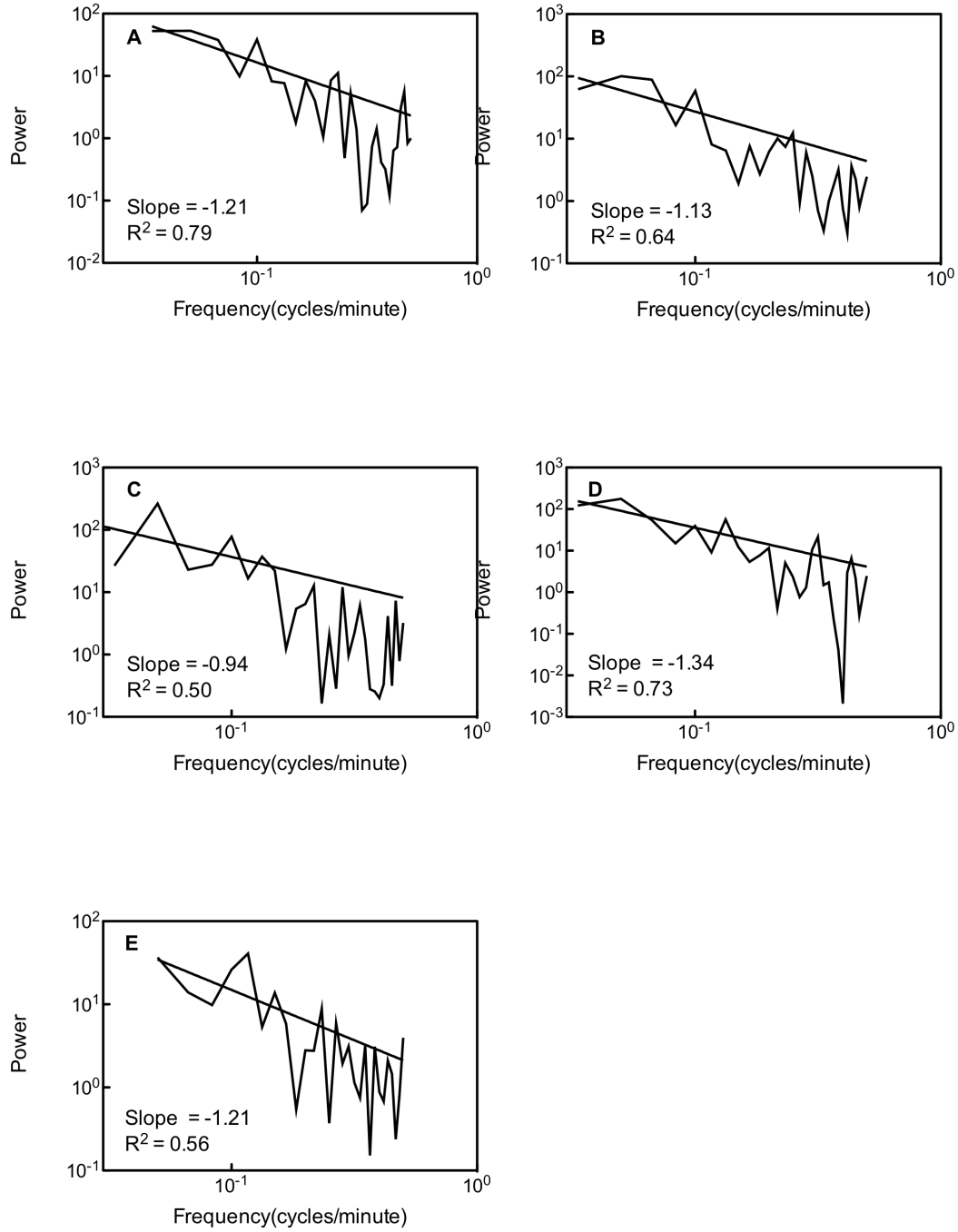


Figure 17: Power spectra for each individual on log-log axes. X-axes represent frequency (cycles/minute), Y-axes represent normalized power. Panels A-D represent individual group members, panel E represents the concatenated comments of all other contributors.

Identity changes

Fourier transforms of the identity change time series (for the same 240 minute period) were also derived using the same methods and 2 minute filter described above.

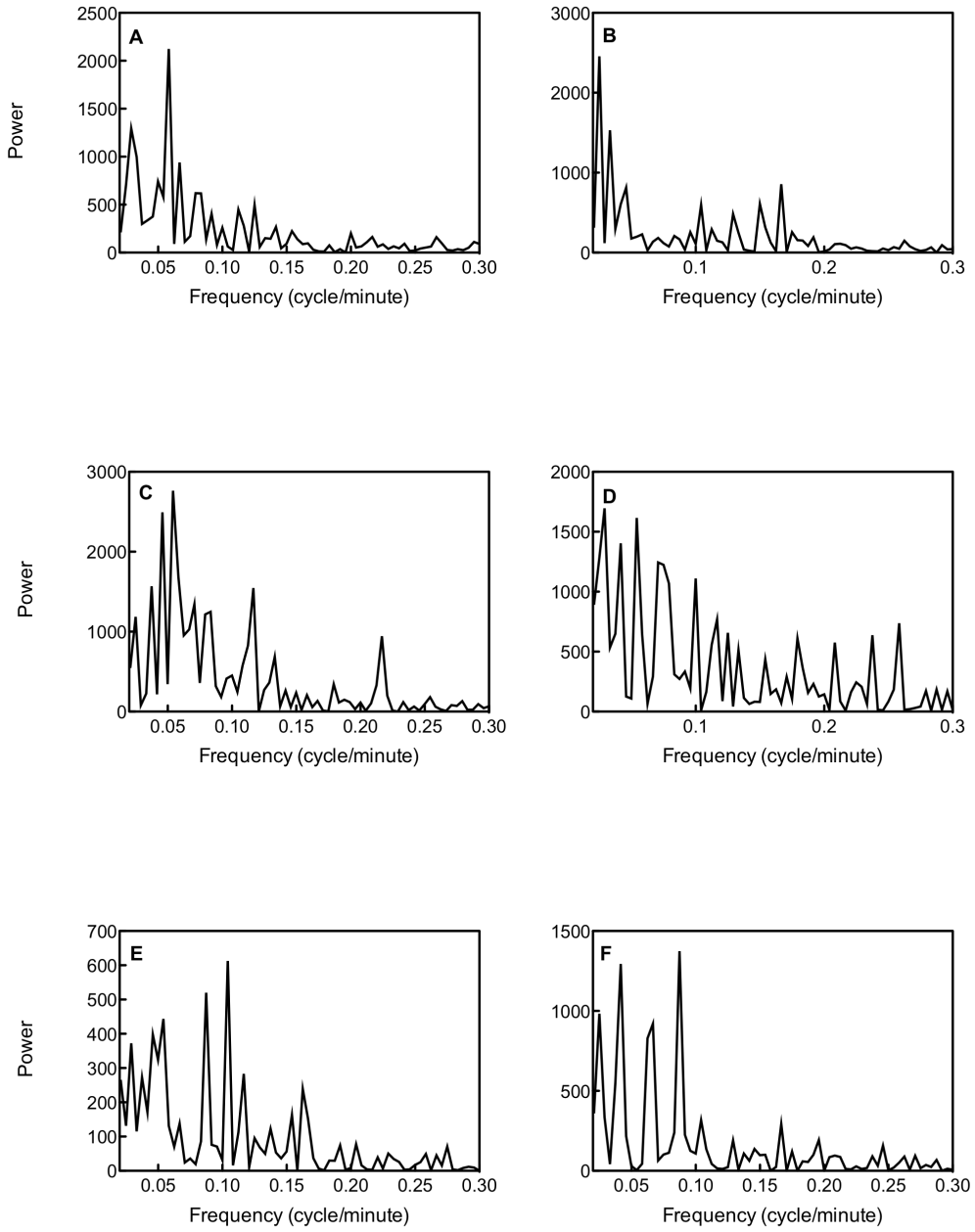


Figure 18: Power spectra for identity change in each group. Panel A represents australia, panel B, chatworld and panel C, cyberchat. Panel D represents eng, panel E, usa and panel F, worldchat. X-axes represent 0.02-0.3 cycles per minute, y-axes represent power.

The power spectra of each of the groups (Fig 18) are, as with number of comments, similar to each other. All groups show a high peak at approximately 0.02-0.03 cycles per minute (50 minutes) and all apart from chatworld, a further peak at approximately 0.07 (14 minutes). There are also peaks for all groups apart from cyberchat around 0.1 (10 minutes) and 0.15 (7 minutes).

These peaks are very similar to those found for number of comments, suggesting that perhaps the two variables share a common cyclic pattern, an issue returned to below.

Fig 19 shows the averaged power spectra of all six rooms, indicating peaks at approximately 0.02 (50 minutes) and 0.01 (10 minutes) cycles per minute.

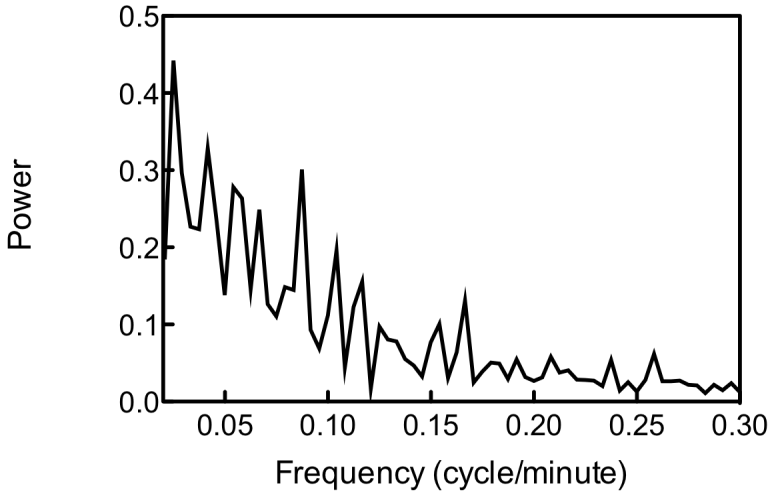


Figure 19: Averaged power spectrum for all six groups. X-axis represents frequency (cycles/minute), Y-axis represents power.

PSD slope

The averaged power spectrum of all six chat rooms are plotted on log-log axes in Fig 20.

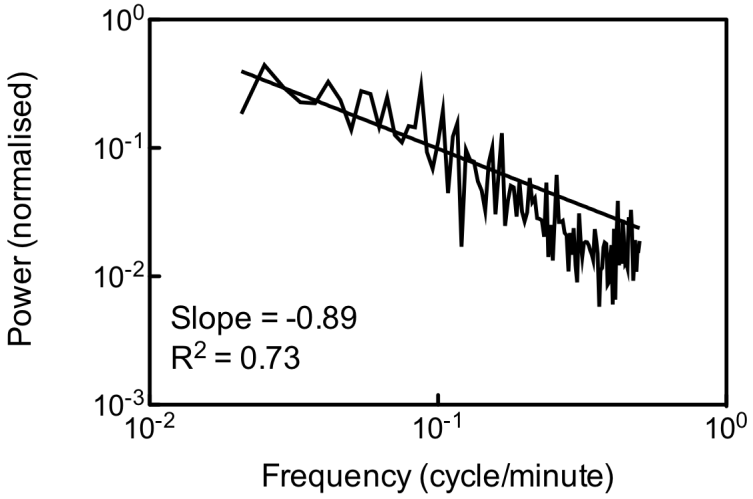


Figure 20: Averaged normalized power spectra across all six chat rooms. X-axis represents frequency (cycles/minute) and the y-axis represents normalized power.

The slope of -0.89 represents a $1/f^{0.89}$ slope, close to a 1/f slope. The slopes for individual rooms (Fig 21) range between -0.88 and -1.11. A one-tailed t-test reveals that the slopes are not significantly different from 1 ($t(5) = 2.34$, $p>0.05$).

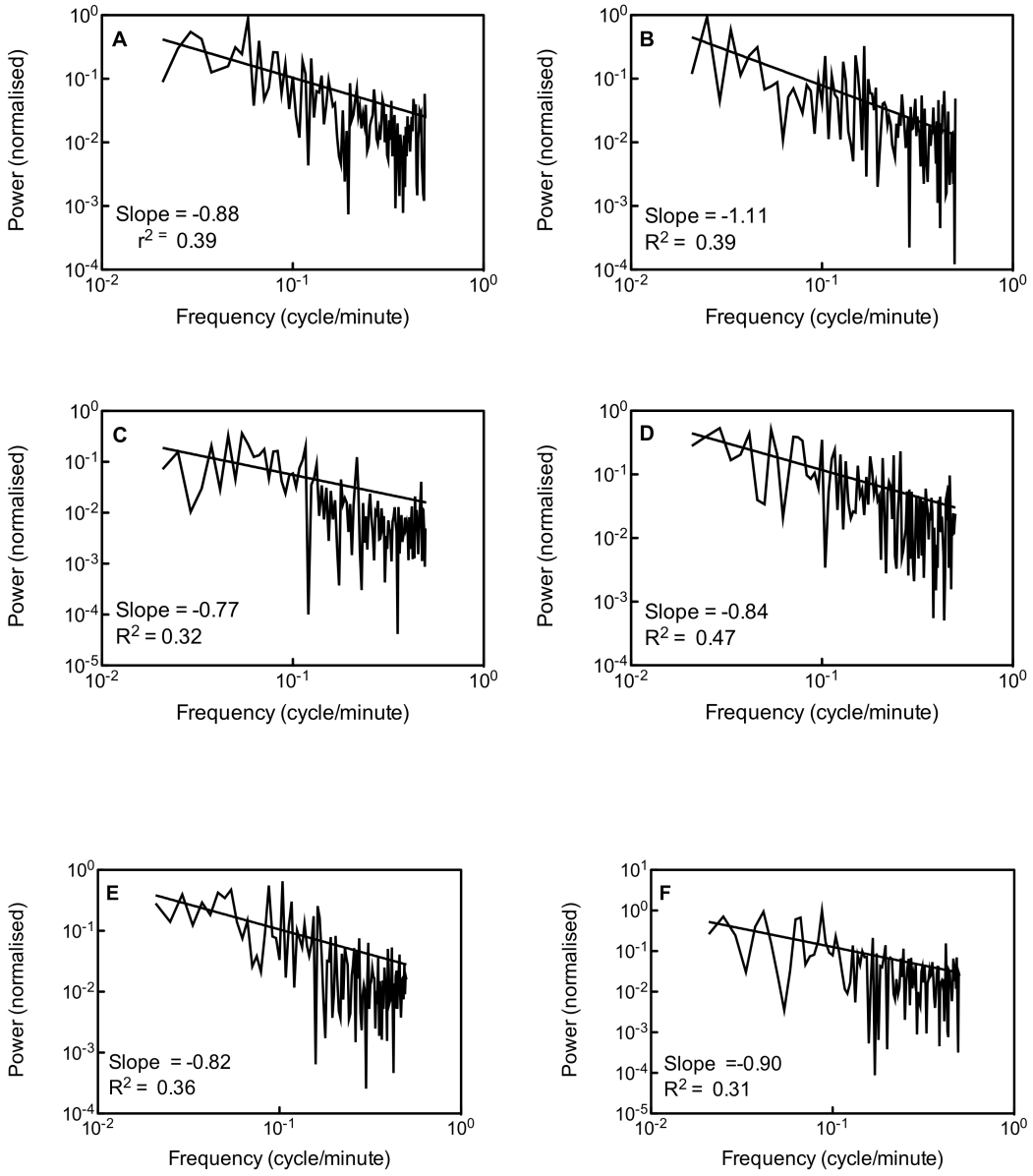


Figure 21: Power spectra for each group plotted on log-log axes. Panel A represents australia, panel B, chatworld and panel C, cyberchat. Panel D represents eng, panel E, usa and panel F, worldchat. X-axes represent frequency (cycles/minute) and y-axes represent power.

Ostracism events

The Fourier transform of the ostracism time signal was calculated using the method as previously described. Fig 22 shows the power spectra for each room separately.

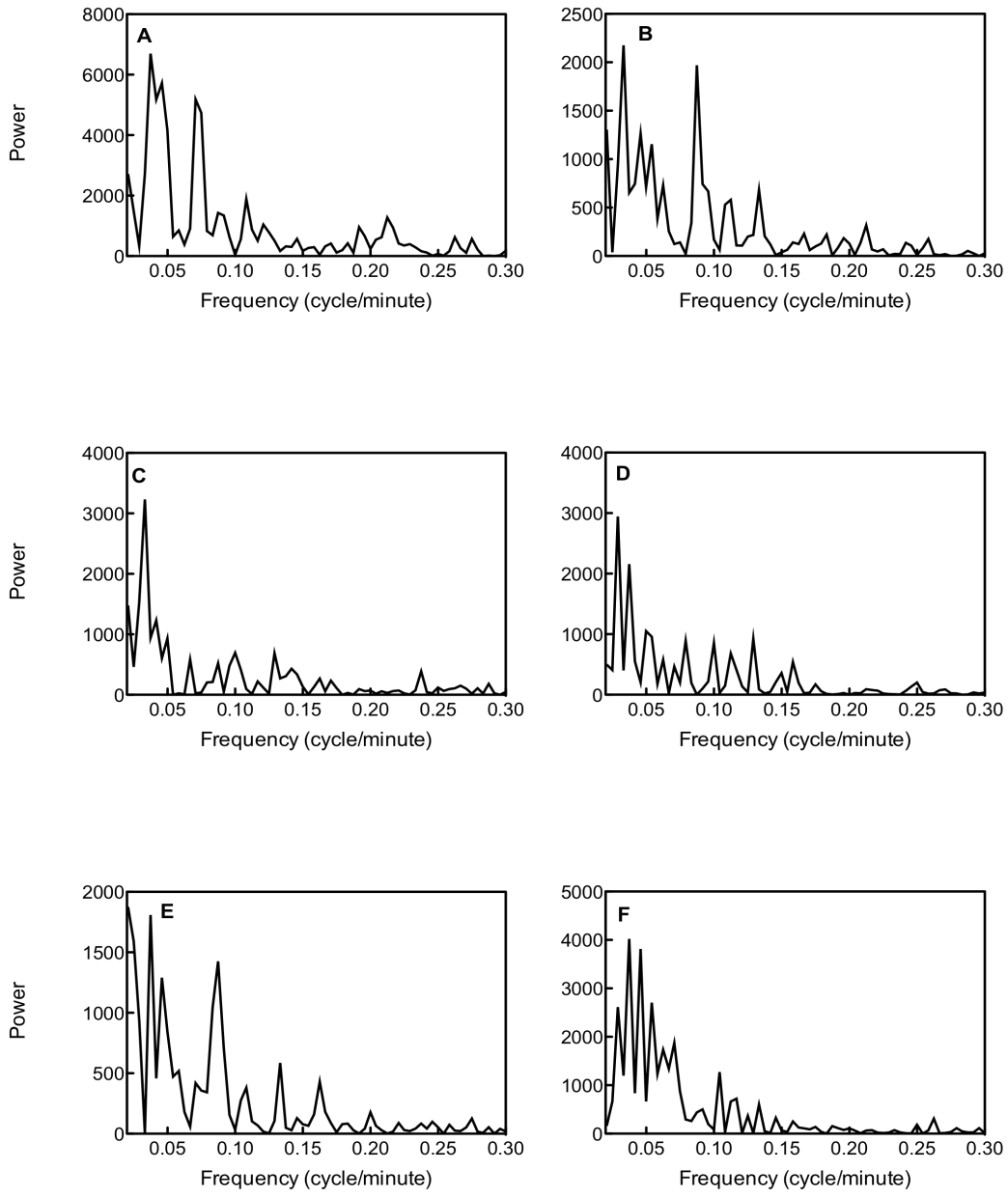


Figure 22: Power spectra of ostracism time series for each group. Panel A represent Australia, panel B, chatworld and panel C, cyberchat. Panel D represents eng, panel E, usa and panel F, worldchat. X-axes represent frequency (cycles/minute) and y-axes represent power.

The power spectra of ostracism events reveal common power peaks at 0.03-0.04 cycles per minute (25-30 minutes). The sparsity of data in the ostracism time series (relative to the number of comments and identity changes series) has led to a decrease in power, but nonetheless, peaks are still visible in a similar pattern to those revealed in the number of comments and identity changes signals. Again, there are some differences between groups, for example, usa (Fig 22e) has fewer peaks and cyberchat (Fig 22c) a very pronounced peak at approximately 0.04 cycles per minute, but the overall shapes of these power spectra appear very similar. Again, the power spectra averaged across all six groups (Fig 23) indicates peaks at the shared frequency of 0.04 indicated by the individual groups. However, the power flattens out at higher frequencies, possibly indicative of less structure than in the number of comments or identity changes, or simply the sparsity of the data points.

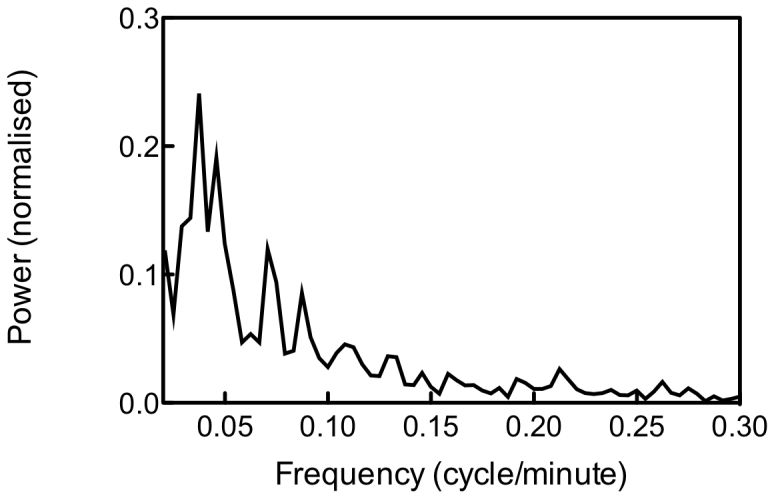


Figure 23: Averaged power spectra for ostracism events. X-axis represents frequency, y-axis represents power.

PSD slope

The power spectrum for each group was normalized and averaged across all groups (Fig 24). The best least squares fit yielded a slope of -0.99, ($r^2 = 0.68$). The power spectra of each group are plotted in Fig 25. The slopes range from -0.9 to -1.23.

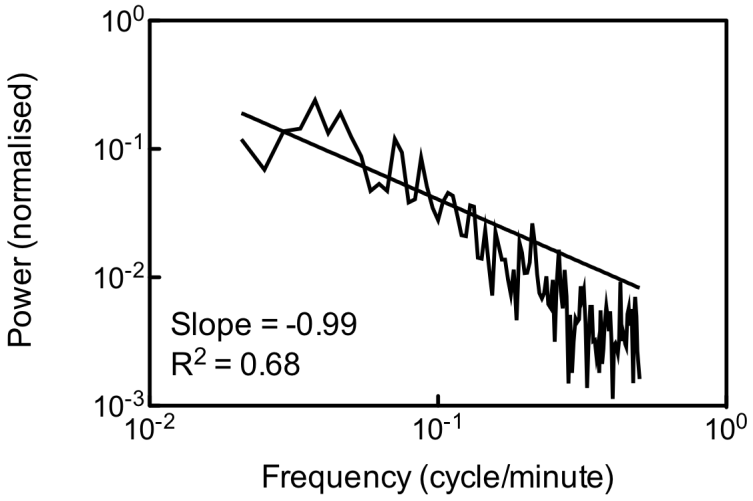


Figure 24: Averaged normalized power spectra across all six chat rooms. X-axis represents frequency (cycles/minute) and the y-axis represents normalized power.

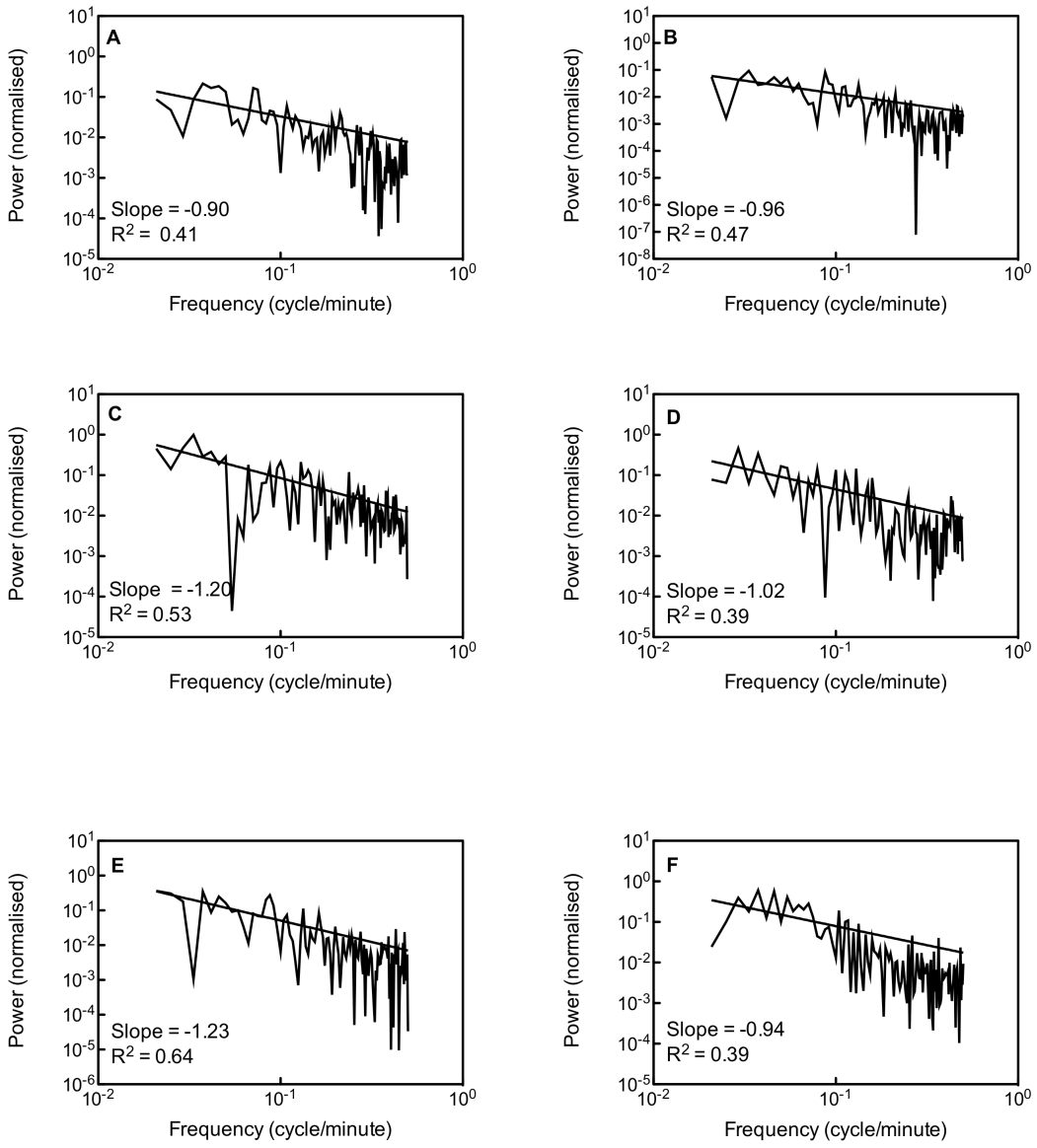
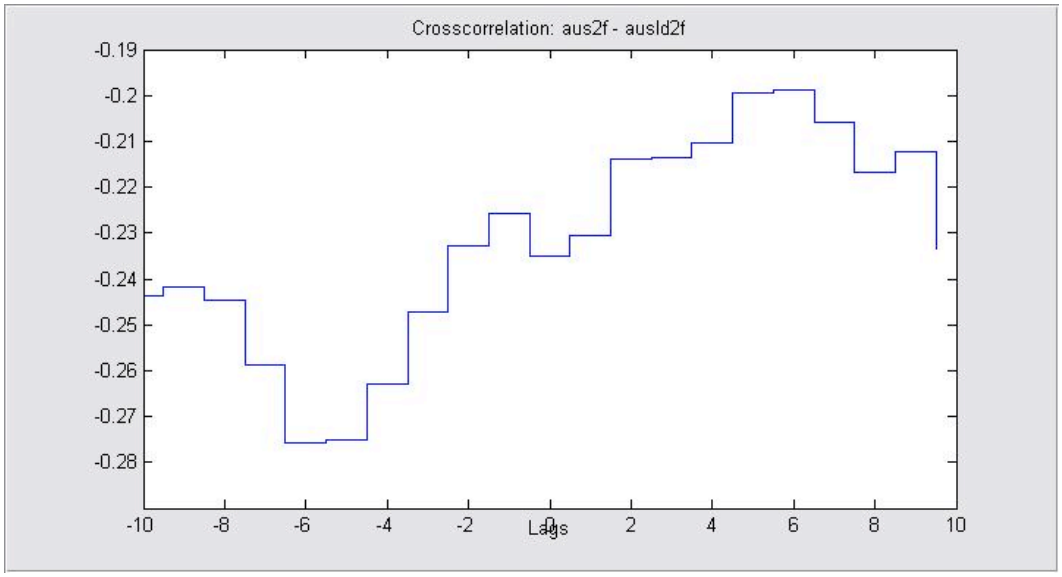
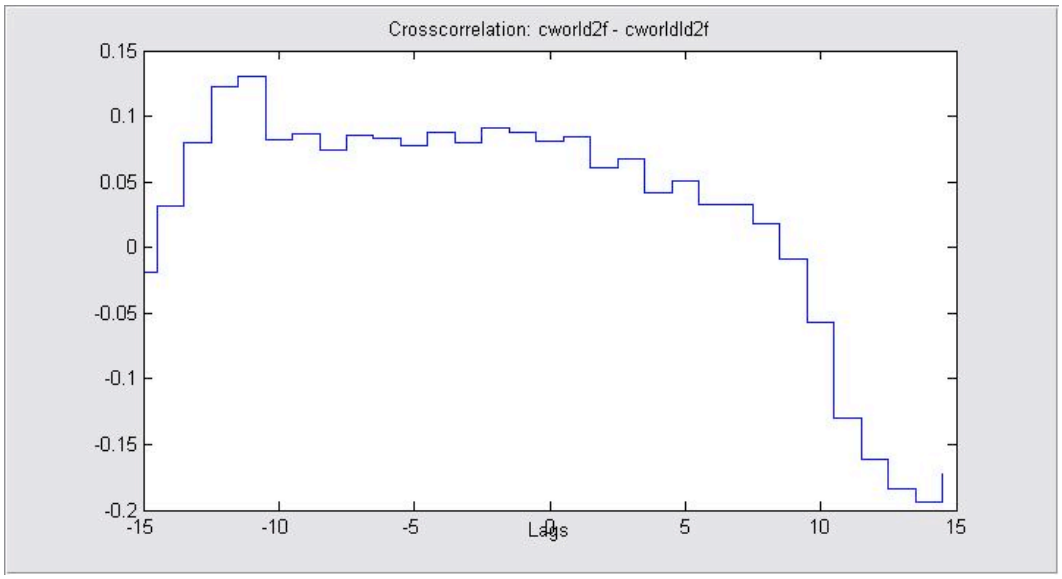


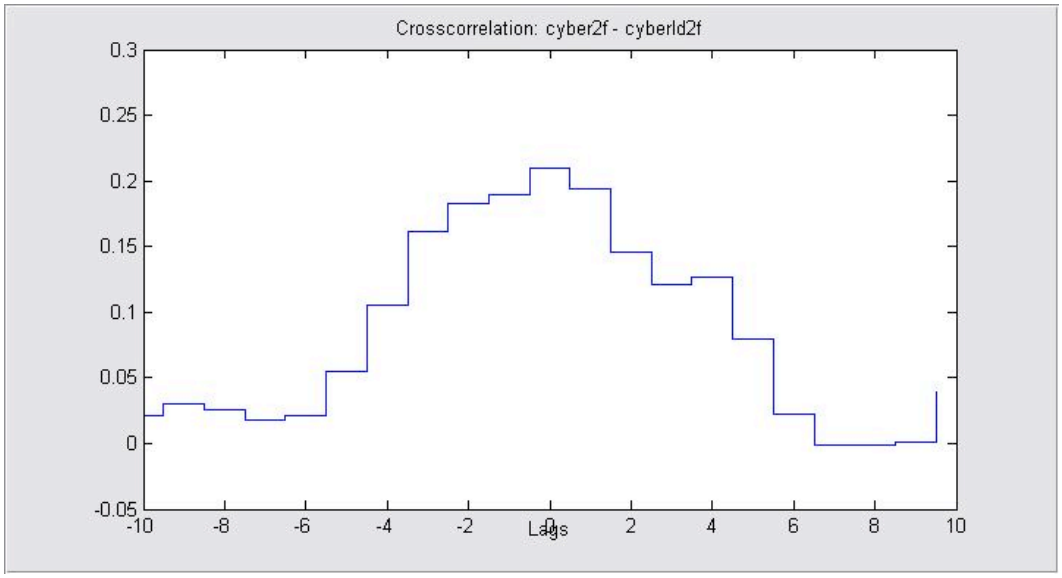
Figure 25: Power spectra for each group plotted on log-log axes. Panel A represents Australia, panel B, chatworld and panel C, cyberchat. Panel D represents eng, panel E, usa and panel F, worldchat. X-axes represent frequency (cycles/minute) and y-axes represent power.

Identity change and number of comments

To explore the relationship between identity change and number of comments in the temporal domain, cross-correlation analyses were performed for each group individually, using the raw minute-by-minute time series signals of the longest single sampling period (240 minutes) acquired. The data were normalized with respect to the average number of event type (i.e. number of comments normalized with respect to average number of comments) and filtered using Matlab's continuous first order low-pass function 'filter' with an elbow frequency of 0.5 cycles/min, as per the pre-Fourier analysis signal treatment. The results for each group are plotted in Fig 26. Differences between the groups are evident. Cyberchat and england show a near symmetrical distribution around 0, indicating little or no temporal relationship between the two variables. The asymmetry evident in australia indicates a temporal relationship between the variables, whereby the highest correlation co-efficient is achieved at a lag of -6. This suggests that a decrease in comments made is followed 6 minutes later by an increase in identity changes, consistent with the negative correlation found at the session average level (Figs 6 & 7). However, no other group shows the same directional relationship, and indeed, many of the co-efficients are positive, and thus entirely inconsistent with the negative correlations found in the averaged data.


Crosscorrelation: aus2f - ausld2f
-0.19
-0.2
-0.21
-0.22
-0.23
-0.24
-0.25
-0.26
-0.27
-0.28
-10
-8
-6
-4
-2
0
2
4
6
8
10
Lags


Crosscorrelation: cworld2f - cworldld2f
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-15
-10
-5
0
5
10
15
Lags


Crosscorrelation: cyber2f - cyberld2f
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-10
-8
-6
-4
-2
0
2
4
6
8
10
Lags

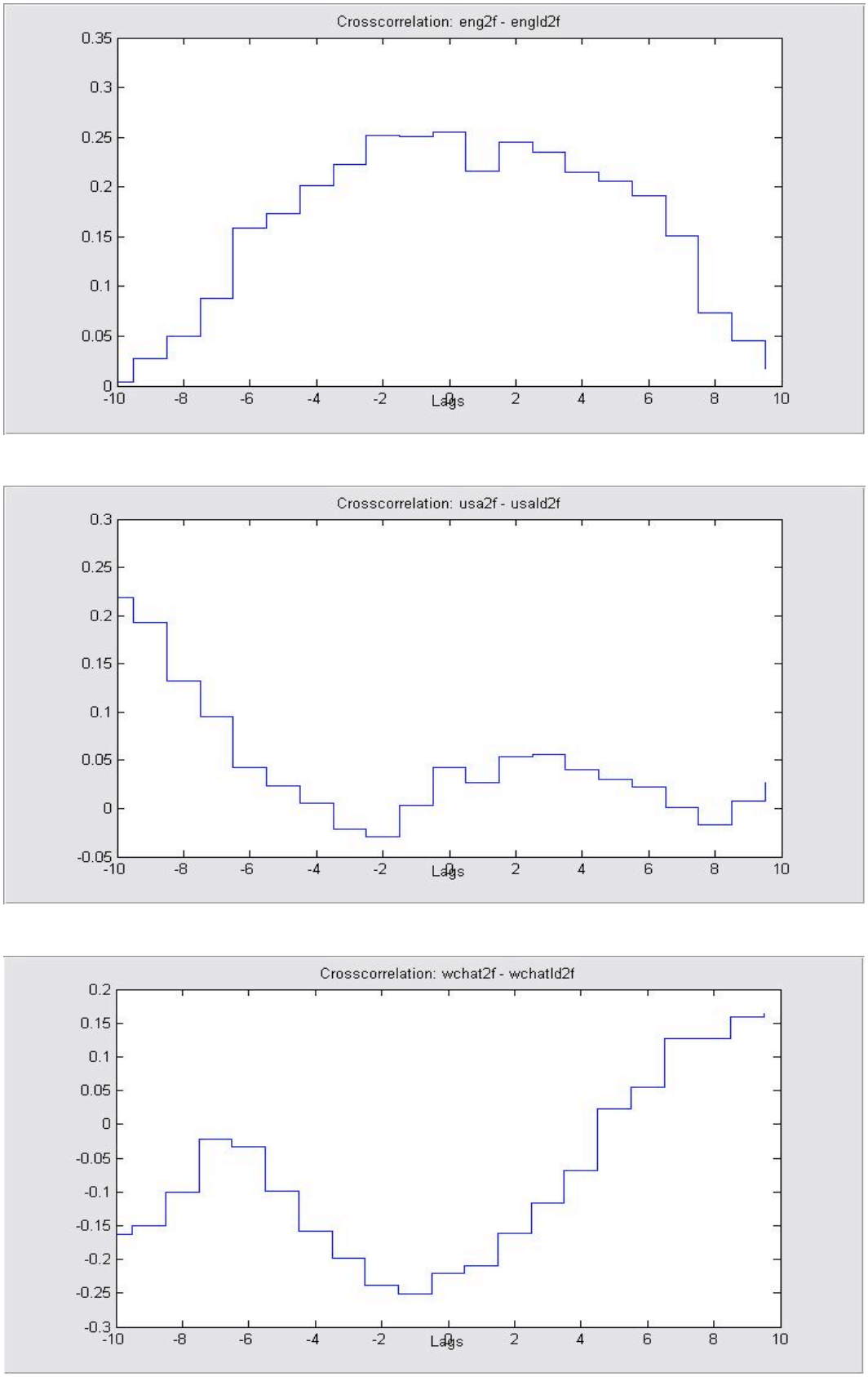
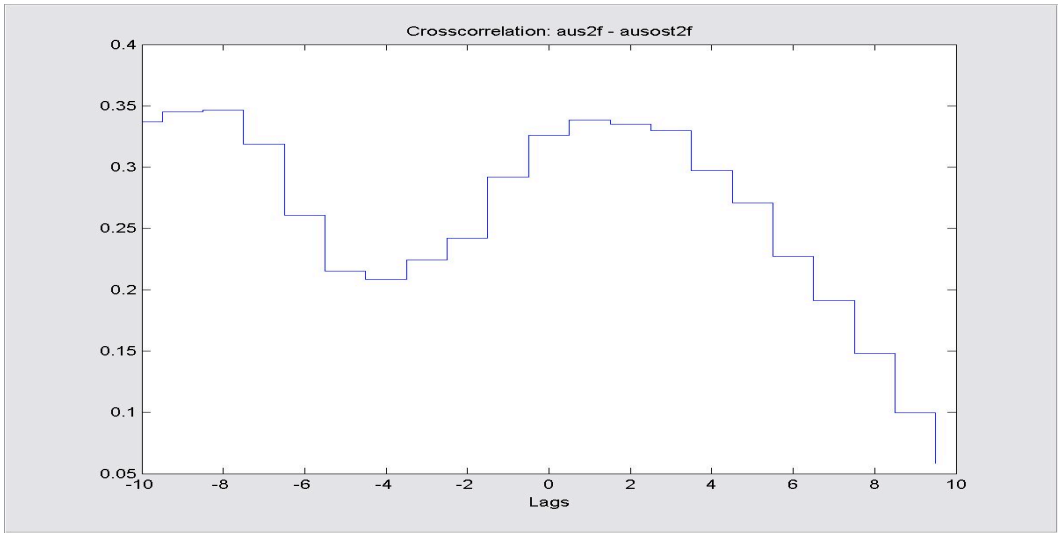


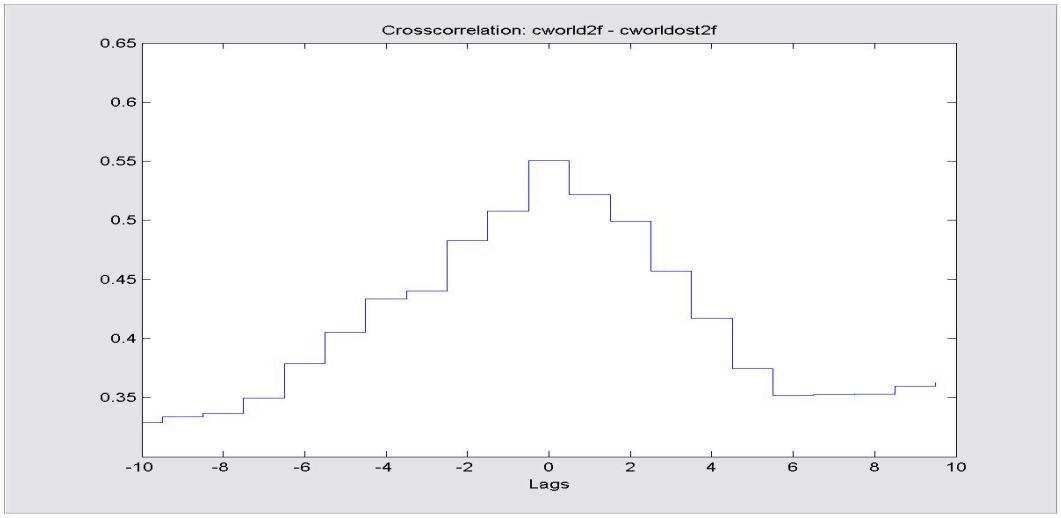
Figure 26: Cross-correlations of identity change and number of comments for each chat room. X-axes represent lag (minutes), y-axes represent correlation co-efficients.

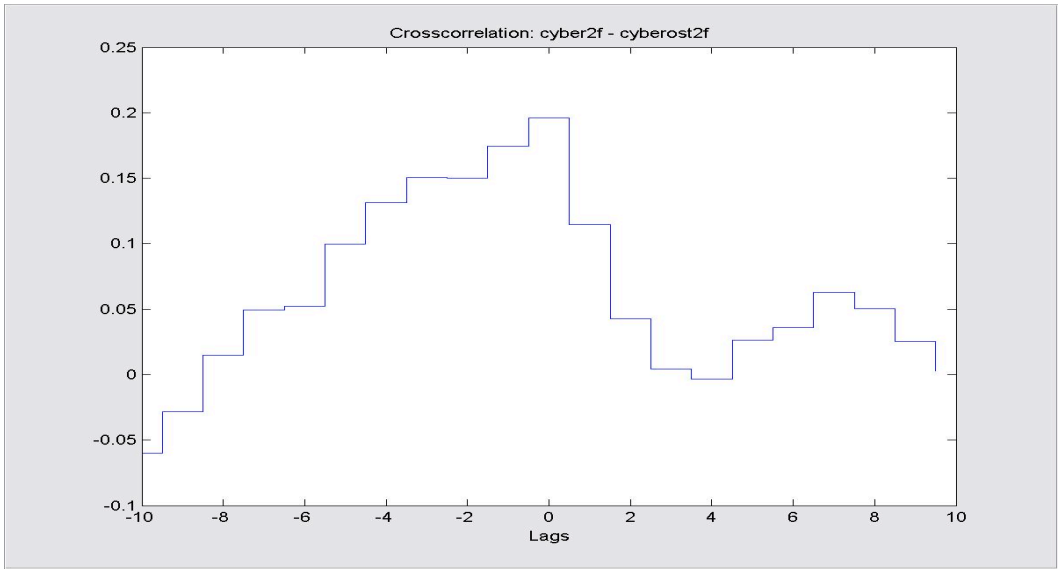
Thus, it would appear to be the case that, while a negative correlation can be observed to exist at large scales (such as entire sessions) the relationship is not evident on a minute-by-minute analysis of the data, even with the lagging of the data provided by cross-correlation. It would, therefore, appear that any relationship between these variables is far from straightforward, and may instead be a case where both variables are being influenced by a third or fourth variable. The nature of such a variable is unclear, but could range from number of people in the room at any one time to technological or typing factors which restrict or encourage contributions at differing moments. Further inspection of cross-correlations at longer time lags may reveal the negative correlation found in the averaged data, but would also lose the potential to infer causality. Consequently, such an analysis has not been conducted. While these analyses may hint at some clues as to what, if any, relationship exists between these two variables, no straightforward or consistent picture emerges at high temporal resolution.

Ostracism events and number of comments

The cross-correlation of ostracism events and number of comments was conducted using the identical pre-processing and methods described above. The results for each group are plotted in Fig 27.


Crosscorrelation: aus2f - ausost2f
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
-10
-8
-6
-4
-2
0
2
4
6
8
10
Lags


Crosscorrelation: cworld2f - cworldost2f
0.65
0.6
0.55
0.5
0.45
0.4
0.35
-10
-8
-6
-4
-2
0
2
4
6
8
10
Lags


Crosscorrelation: cyber2f - cyberost2f
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-10
-8
-6
-4
-2
0
2
4
6
8
10
Lags

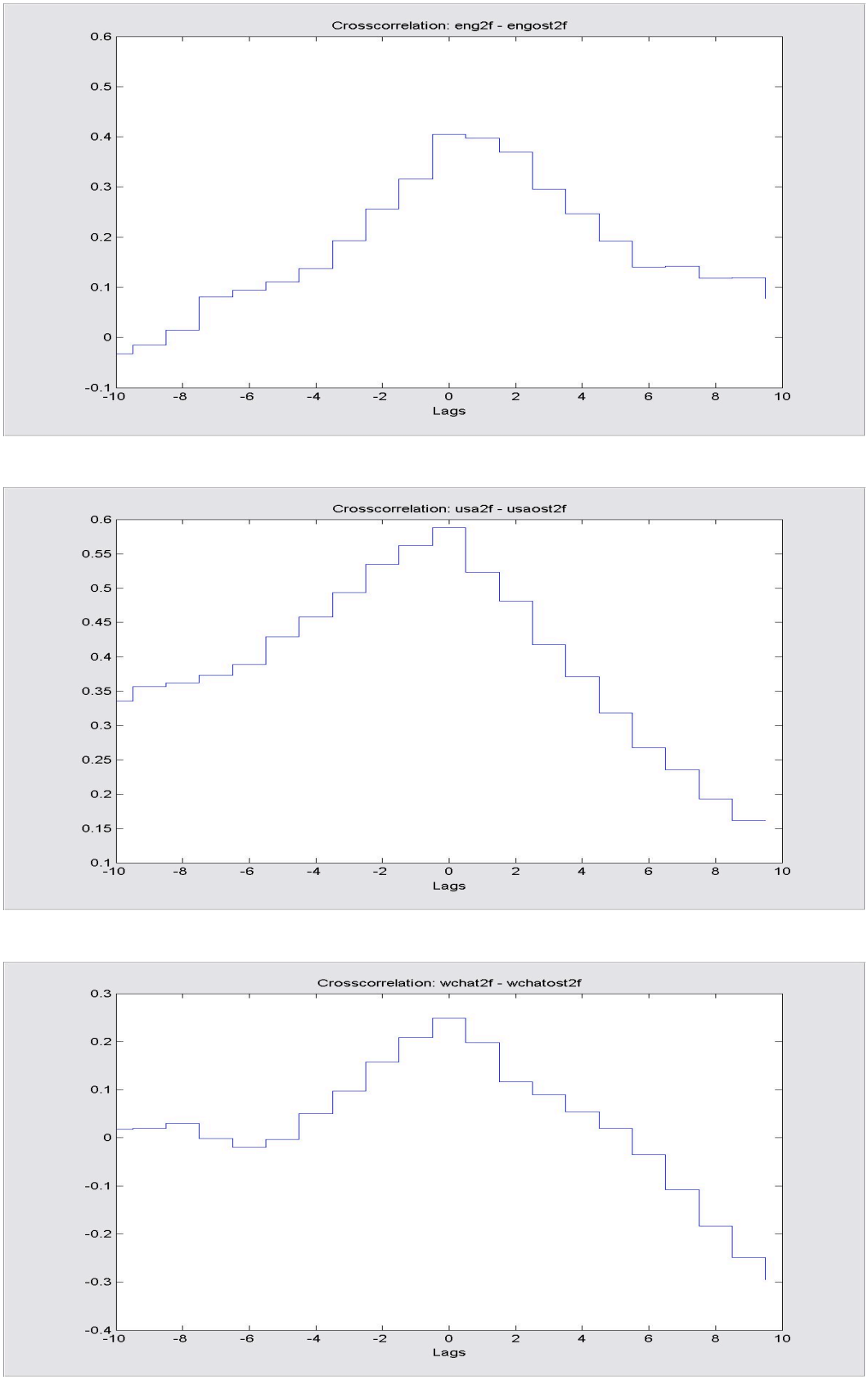


Figure 27: Cross-correlations between ostracism and number of comments. X-axes represent lag (minutes) and y-axes represent correlation co-efficients.

These cross-correlations indicate mainly symmetrical distributions around 0, suggesting there is no temporal relationship between these two variables. However, australia, usa and worldchat show a slight asymmetry, such that the correlation co-efficient shows smaller reductions in a negative rather than positive lag time. This suggests that in the period after ostracism, there may be a higher level of comments than before ostracism, which maintains a positive correlation between the variables rather than dropping away to a co-efficient of 0.

Discussion

The analyses reported here cover a wide range of findings, from gross level differences between Internet chat rooms in frequency of behaviour types, to underlying structure within number of comments and number of identity changes. The similarities and differences between groups reveal that, while certain aspects of the computer-mediated communication were common to all groups (e.g. the rate of comments) these were overlaid with group-specific patterns of behaviour types.

Gross differences

The general quantitative analysis revealed that there are differences between groups in how frequently certain behaviours are exhibited, with, for example, some groups having a much higher frequency of comments and others with a very low base rate of ostracism events. This fits within a scheme whereby particular online groups develop their own normative behaviours and stylistic approach, just as face-to-face groups have been observed to do (e.g. Sherif, Harvey, White, Hood & Sherif, 1961). These general quantitative trends are consistent with the findings reported in chapter 3, that not only are the types of behaviour exhibited by groups very similar to those exhibited in face-to-face settings, but that these groups vary the frequency of these behaviours to create a profile of behaviour frequency unique to that particular group.

Temporal structure

The power spectra of the groups constitute compelling evidence that there is an underlying temporal structure to the number of comments and identity changes made. The number of comments made showed cycles of approximately 30-50

minutes, 15 minutes and 7 minutes. Contrary to the apparent asynchrony of group computer-mediated communication, with different conversations often running concurrently, all chat rooms followed a similar rhythm of conversation, with longer cycles overlaid with shorter cycles of conversation. A similar pattern emerges in all groups, unlike frequency of behaviour type, indicating that such structure is inherent in the CMC, rather than normatively developed in individual groups. This shared cyclicity emerges not only in number of comments, but also in identity changes at similar cycle lengths. The periodicity of ostracism is less clear cut, possibly due to sparser data leading to a reduction in power. However, some evidence of structure can also be seen in this behaviour type, with an average cycle of approximately 30 minutes.

The typically $1/f - 1/f^2$ slopes in the power spectra of each group's comments also raises interesting questions. This property of the spectra render them scale-invariant. In other words, the time scale upon which the data are collected makes no difference to the pattern of periodicity that emerges. Gisiger (2001) likens the pattern of scale-invariant pink noise to the system having memory of earlier states. Contrary to white noise, where each event has no relation to previous events, events within a pink noise system may be considered to be predicated upon earlier events. Therefore, it is possible to predict future events within the system with a relatively small sample, as no matter where the sample occurs (scale) the system behaves in the same way (invariant). 1/f noise is ubiquitous in physical systems (e.g. Musha, Sato & Yamamoto, 1992) and biological systems (Gisiger, 2001), and has recently been reported in human cognition (Gilden, Thornton & Mallon, 1995; van Orden, Holden & Turvey, 2003; Correll, 2008). Gilden et al (1995) report that errors in latency estimation by participants produced a 1/f scale in the frequency

domain. However, the same pattern did not emerge when measuring simple reaction time to a stimulus. Gilden et al concluded that "… 1/f noises arise from cognitive mechanisms that mediate the judgement of magnitude, regardless of whether that magnitude exists in time or space." (p1838). The complexity of the cognitive task that a participant is required to do has also been shown to affect the production of 1/f noise. Correll (2008) measured reaction times on a racial stereotyping task. Participants who reported low effort to avoid racial prejudice during the task produced 1/f slopes in the power spectrum of reaction times, but those who reported high effort produced slopes significantly closer to 0. In a further task, participants who were instructed either to avoid all bias or to use racial cues produced flatter slopes in the power spectra of response times than control participants who were given no explicit instructions on how to complete the task. It would appear that in conditions of high cognitive load, the 1/f pattern does not emerge from the data as strongly. These findings suggest that 1/f noise is present in cognitive function, which perhaps makes the current finding of such structure in social communication less surprising. The interpretation of a 1/f structure in communication is fraught with difficulty, as the source, reason or function of this structure in any of the examples provided in previous research is poorly understood at the current time. However, while this remains unclear, it represents a novel method of considering data which may reveal further clues to the pattern of human social cognition.

Relationship between event type

The similarity of the groups' behaviour appears not to be restricted to periodicity. The results presented here indicate a negative correlation between the number of comments made and identity changes across all groups and baseline comments rate when the data are viewed on a large scale. The reason for this relationship is far from clear, due to the nature of the analysis. However, there is a number of possible, but speculative, interpretations which could be considered. Firstly, it may be that as the number of comments increase, the group becomes more stable, and consequently individual members are more likely to retain the same identity within the group. Secondly, identity changes may be more likely when there is less chatting between members, as identity play becomes a way to pass the time in lieu of conversation with other members. Thirdly, it is also possible that as identity changes increase, there is less conversation between members as they become more focused on their own identity and potential changes, thus removing attention from the more social aspects of the chat room and reducing the number of comments made.

The positive correlation between ostracism and number of comments made is also open to speculative interpretation. It may indicate that as the group comments more, stability increases and the more likely the group is to ostracize any newcomers or rule-breakers. Equally, it may be the case that when there are more comments being made, there is more social interaction and consequently more opportunities for ostracism to occur. Finally, it could be the case that both ostracism and number of comments are affected by the total group size present, or the average length of time using IRC for the group members, neither of which were amenable to data collection in this case. While there is no secure method to

support one of these interpretations over another with the current data set, the notion that the number of comments could be considered an index of group stability is consistent with the direction of the correlations, where a decrease led to identity change and an increase to ostracism events.

With finer resolution, the relationships become much less clear. Cross-correlations did not, in the majority of cases, reveal a temporal structure between these variables, suggesting that there is no causal relationship between them. However, the cross-correlation between ostracism and comments in three of the six rooms suggested that comments may increase in the period after ostracism. While there is no intuitive explanation for such a relationship, the work of Williams et al (2002) may provide some insight. They report that, during experimentally induced ostracism in online chat, participants tended to maintain their levels of contribution, rather than falling silent, as in face-to-face ostracism. Indeed, many participants commented upon the fact that they were being ignored. In extant chat rooms on the Internet, a similar response has been reported by Rintel & Pittam (1997). They also suggest that targets of ostracism may respond angrily, and, as reported in chapter 3, the group may respond to the individual to defend themselves. This behaviour may then account for some of the observed increase in comments approximately 6 minutes after an ostracism event, as targets of ostracism question more frequently and group members respond and defend themselves. This is a theme we return to in chapter 5.

In conclusion, the findings reported here indicate that, while different chat rooms show different behavioural profiles, in the frequency with which certain events occur, they do share a common, underlying structure. The first evidence of this can be gleaned in the analyses of identity changes as a function of number of

contributions (Fig 7) which is suggestive of a scheme whereby all groups obey an exponential relation between these variables. Moreover, the Fourier analyses indicate that all chat rooms demonstrated a very similar periodic pattern to the frequency of contributions, with longer cycles of general group chat overarching shorter, more single conversation-based, cycles. Intriguingly, this periodic pattern also shares a fundamental characteristic of such a structure, a 1/f slope in power, with many natural phenomena. Such a finding places the highly social behaviour of human communication squarely within the domain of physical systems. Despite gross level differences that distinguish social groups, their communicative behaviour shares a fundamental rythym that appears to be scale-invariant.

Chapter 5: Virtual bravado as a function of anonymity

Introduction

The findings of chapters 3 & 4 reveal that online group behaviour in general shares many common characteristics with face-to-face group behaviour, and also provided an indication of the frequency of ostracism events in online setting. Indeed, in many chat rooms, it is formalised to the extent that there are technical means to accomplish ostracism, most notably the "ignore" function. This allows the individual to block the comments of other people, so their comments will no longer appear on screen. This function is often highlighted to discussants in online fora as a social sanction *"If you find yourself being harassed ... you can quickly discourage the activity by clicking on CONFIG and selecting IGNORE for that person…"* (Pankoke-Babatz & Jeffrey, 2002, p231). As described in chapter 1, the consequences of such ostracism in online settings are similar to face-to-face settings, in that the targets of ostracism report lower levels of Williams' (1997) four needs: self-esteem, belonging, control and sense of meaningful existence.

Williams, Cheung & Choi (2000) developed a computer-based protocol (Cyberball) in order to investigate online ostracism (cyberostracism). In each game, one participant would play with two other computer-generated players. The computer-generated players were programmed to throw a virtual ball to the participant a fixed proportion of times. They found that participants who were ostracised reported a higher aversive impact, as measured by an outcome measure based on a combination of measures of mood, perceived intensity of ostracism and group cohesiveness, than those who were not ostracised. This increased as the proportion of throws received decreased. Ostracised participants also reported

lower levels of self-esteem and belonging, but not of control or meaningful existence.

However, as with the findings in chapter 3 of different expressions of certain group behaviours, the reported consequences of online ostracism are also not exactly the same as for the targets of face-to-face ostracism. Williams et al (2002) developed a computer-mediated protocol that employed simulated "chat" between two confederates and a participant. Williams et al found that ostracising participants in this online context resulted in similar affective outcomes to those found in face-to-face contexts (e.g. reports of feeling less in control, lower interpersonal liking, feeling less comfortable during the chat and less comfortable with the software than non-ostracised participants). However, in marked contrast to face-to-face studies where ostracised participants rarely said anything once they had realised they were being excluded, (for a review, see Williams & Zadro, 2001) Williams et al found that ostracised on-line participants continued to attempt to join the conversation, or comment on the fact that they were being ignored. They termed this behaviour "virtual bravado".

In light of this observation, Williams et al (2002) compared face-to-face and cyber-ostracism experimentally. The effect of ostracism revealed both similarities and differences across face-to-face and online contexts. Participants in both face-to-face and cyber-ostracism conditions reported lower levels of all four of the basic needs identified by Williams than non-ostracised participants. However, there was less difference in control and self-esteem between ostracised and non-ostracised participants in the CMC condition than reported in the face-to-face condition. Non-ostracised participants made similar proportions of comments in both forms of communication, but in the ostracism condition, only those face-to-face made

significantly fewer contributions, with cyber-ostracised participants roughly maintaining their level of participation.

The authors provided two possible explanations for the effects on the four needs they observed: firstly, that cyber-ostracism simply has less effect on self-esteem and control than face-to-face ostracism and secondly, that continuing to contribute to the conversation, despite being ignored, may provide a buffer against the negative impact often seen in ostracism by allowing the participants to retain some feelings of control and self-esteem. However, Williams et al offered no specific suggestion as to why the latter buffering strategy may occur in CMC but not face-to-face communication. Thus the reasons for the discrepant effect of ostracism in face-to-face and CMC are not clear, but the different characteristics of CMC and face-to-face may provide a starting point for explanation. One difference in these communicative modes is the level of anonymity they confer. Both the spatially distal characteristic of CMC and the relative ease with which its users may conceal their identity (herein these attributes are referred to jointly and severally as 'anonymity') are, *prima facie*, candidates for the explanation of the differences Williams has found between these communicative modes.

How may level of anonymity mediate such differences in ostracism's effect? Previous research on the effects of de-individuation (e.g. Siegel, Dubrovsky, Kiesler & McGuire, 1986) indicate that increased levels of anonymity may result in lower identification with the group, perhaps therefore decreasing the negative impact of ostracism. However, this seems an unlikely mechanism given Williams et al's (2002) finding that identification with the group is not a key factor in the impact of ostracism. Indeed, even when excluded by a despised out-group, ostracised participants still report an aversive impact (Gonsalkorale & Williams,

2007). Thus anonymity's effect of increasing de-individuation does not appear to be a likely mechanism for explaining its possible effect upon ostracism. However, anonymity may also confer positive consequences that may have a bearing. For example, Gergen, Gergen & Barton (1973) reported that discussants seated in a dark room were likely to disclose more personal information than those sat in a light room, a situation which has been compared to the Internet by McKenna & Bargh (2000). Thus, it is possible that the more physical and distal, rather than social, attributes of CMC may lie at the heart of its relatively mild mediation of ostracism. However, the effect of anonymity upon responses to ostracism has not previously been measured.

In order to investigate whether the anonymity conferred by CMC was an important contributory factor to William's et al's "virtual bravado", the physical anonymity of participants was manipulated in an experiment that concurrently measured the effect of ostracism upon affective variables and contribution to discourse before and after ostracism. Physical anonymity was manipulated by varying the proximity of participants to the confederates with whom they communicated via computer: in one condition participants communicated with confederates in the same room, in another condition, communication was distal and participants neither saw nor heard the confederates. Such a manipulation ensured that, while in the distal condition, the participant had no knowledge of the other confederates (and had not been seen by them), in the physically co-present condition the participants and confederates could see each other and were aware that, consequently, they may be recognized again in future, thus significantly reducing the anonymity of the participants. If anonymity is a fundamental factor in the expression of virtual bravado, then participants who are physically co-present in a

room, but nevertheless communicating via computers, should make fewer comments under ostracism than those who are physically distal. If this bravado behaviour provides a buffer against aversive impact, then if the co-present group make fewer comments, they should also show a greater aversive impact of ostracism. The first hypothesis is that ostracized participants will make fewer comments than non-ostracised participants. The second hypothesis is that ostracised participants in the co-present condition will make fewer comments than ostracised participants in the total anonymity condition. Finally, ostracized participants in the total anonymity condition will report less aversive impact than ostracised participants in the co-present condition. Alternatively, if the method of communication, *per se*, or some other attribute of CMC, mediates the effect of ostracism, then both groups should perform similarly in terms of contribution and aversive impact.

Method

Participants

Seventy-five participants from Royal Holloway, University of London (59 female, 16 male; mean age = 20.14, SD = 4.56) were pseudo-randomly allocated to either ostracised or non-ostracised conditions. 54.5% of participants had used either the programme in the experiment, or other, chat-based programmes before. 89% used the Internet at least every other day and all were familiar with computers.

Confederates

Each trial employed two confederates in order to manipulate the level of ostracism. These confederates were drawn from a pool of staff, postgraduate and undergraduate students. All confederates were given a set of guidelines explaining what was required of them and were also always encouraged to talk to the experimenter about any problems or concerns about the procedure.

Design

An independent measures design was employed with two independent variables: inclusion (ostracised vs included) and anonymity (total vs co-present). Five dependent variables were measured: number of comments made, self-efficacy, self-esteem, perceived group cohesion and interpersonal liking.

Materials

Computer software:

The participants communicated with confederates using an Internet Messenger protocol (Microsoft Messenger 5.0, Microsoft Corporation 2002) on IBM compatible PCs. Three identical PCs were situated within the same room in the case of the co-present condition and in separate, physically distal, rooms in the case of the total anonymity condition.

Post-test questionnaires:

The questionnaire comprised a series of demographic questions, measures of perceived inclusion and perceived proportion of comments made, to assess whether participants had been aware that they were being excluded. The affective measures included were based on Williams' (1997) need-threat model: for a sense of control, the Generalized Self-Efficacy Scale, (Schwarzer & Jerusalem, 1995) and for self-esteem, the Rosenberg (1965) self-esteem scale. To assess belonging, a short measure of group cohesion (based on questions from Schacter, 1951; Schacter, Ellertson, McBride and Gregory, 1951; Indik, 1965) was included and a measure of interpersonal liking (written by the author).

Scripts

Two scripts – one in favour of Internet relationships and the other against - were constructed upon the basis of transcripts of free conversation between students on Internet relationships.

Procedure

In each trial, there was one participant, and two confederates. These were given online screen names of participant 1, participant 2 and participant 3. The genuine participant was always participant 2, to ensure that there could be no variation in effect of participant number (e.g. any potential perception that the participant labeled "1" may be more important) on the mood of the participants. Participants were informed that the study constituted an experiment about group discussions of Internet relationships. In the total anonymity condition, the participant was seated at a computer in a physically distal room. In the co-present condition, the participant was seated in the same room as the two confederates. At the beginning of the experimental session on-screen instructions were presented that instructed the participants to have a conversation about Internet relationships for 10-15 minutes. Once the participant had read this information, they were asked to begin the discussion.

In all trials, the three discussants were instructed to start with a general discussion for five minutes. This allowed participants time to familiarise themselves with the software, where necessary, and for the experimenter to determine the opinion of the participant. After the initial five minutes, the confederates were made aware of the beginning of the experimental period by the experimenter making an auditory signal. The experimental period had a duration of seven minutes, during which the confederates were instructed to type from one of two scripts in the ostracism trials or continue chatting in the non-ostracism trials. The script was chosen by the experimenter to represent the opposing view to that expressed by the participant during the control period. This ensured a consistency of experience for all participants, as in all trials the confederates took the opposing point of view. In

non-ostracised trials, the discussion continued with all three people participating freely in the discussion. In ostracism trials, the confederates typed a script, not acknowledging any of the participant's comments. Unlike in the Williams experiments, the participants and confederates were not instructed to indicate at the beginning of every comment which co-discussant(s) it was intended for (e.g. *P1*: P3: what's your position?). The participant completed the post-test questionnaire at the end of the discussion session. Participants were subsequently fully debriefed, and reassured that they had been allocated completely randomly to their condition.

Results

Perceived inclusion

A two-way independent measures ANOVA was conducted, with anonymity and inclusion as the independent variables and perceived inclusion as the dependent variable. This revealed no significant main effect of anonymity ($F(1, 71) = 0$, $p>0.05$) or interaction effect ($F(1, 71) = .072$, $p>0.05$). There was a highly significant effect of inclusion ($F(1, 71) = 17.50$, $p<0.001$) where participants who were ostracised scored significantly lower ($\mu = 2.69$, $\sigma = 0.83$) than non-ostracised participants ($\mu = 3.44$, $\sigma = 0.69$). This indicates that the participants in the ostracism conditions were aware that they were being excluded by the two confederates.

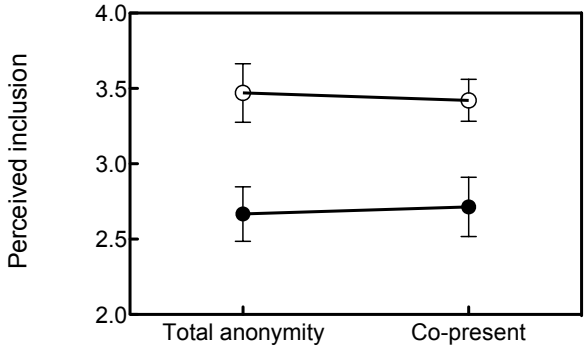


Figure 1: Mean perceived inclusion in ostracised (closed circles) and non-ostracised (open circles) conditions. Error bars represent ±1 SEM.

Confederate rate of comments

In order to confirm that the confederates had performed similarly across inclusion and anonymity conditions, a ratio of strike rate (comments per minute) for the experimental period to control period was calculated and compared across

conditions. An independent t-test revealed no significant difference in strike rate between ostracism ($\mu = 0.96$, $\sigma = 0.40$) and non-ostracised ($\mu = 0.79$, $\sigma = 0.20$) ($t(33) = 1.56$, $p>0.05$, two-tailed) in the total anonymity condition (Fig 2, panel A). There was similarly no difference in the co-present conditions (ostracised: $\mu = 0.92$, $\sigma = 0.40$; non-ostracised: $\mu = 0.92$, $\sigma = 0.31$) ($t(37)=0.03$, $p>0.05$, two tailed) (Fig 2, panel B). These results indicate that the confederates maintained a consistent pace of contribution across all conditions.

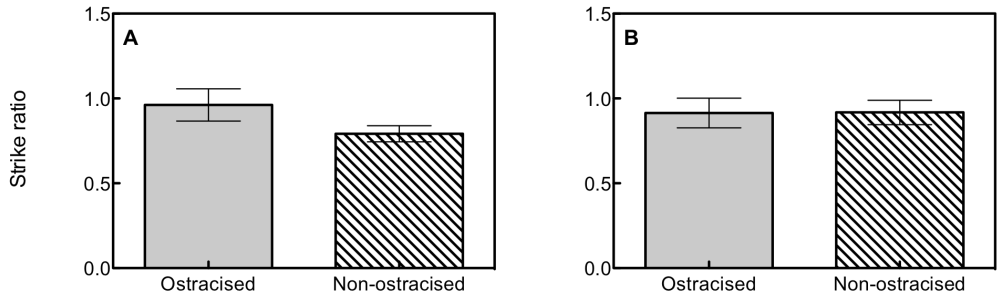


Figure 2: Strike rate ratio between control and experimental periods for the confederates in ostracised (solid grey) and non-ostracised (cross-hatched) conditions. Panel A represents total anonymity trials. Panel B represents co-present trials. Error bars represent ±1 SEM.

Affective measures

A MANOVA was conducted on the data, with self-esteem, self-efficacy, group cohesion and interpersonal liking as the dependent variables. Inclusion (ostracised vs non-ostracised) and anonymity (total vs co-present) were the independent variables. This revealed no significant effect ($p>0.05$) of anonymity on any of the four measures. There was also no significant effect ($p>0.05$) of inclusion on self-esteem, self-efficacy or interpersonal liking. There was a significant effect of inclusion on cohesion ($F(1, 71) = 8.65$, $p<0.005$), with those in the ostracised

conditions reporting lower cohesion ($\mu = 7.54$, $\sigma = 2.65$) than those in the non-ostracised condition ($\mu = 9.28$, $\sigma = 2.48$).

Overall, the results from the affective measures do not indicate a lowering of the affective measures as proposed by Williams (1997). While the perceived inclusion ratings indicate that participants were aware of being excluded, this had no significant effect on any of the affective measures.

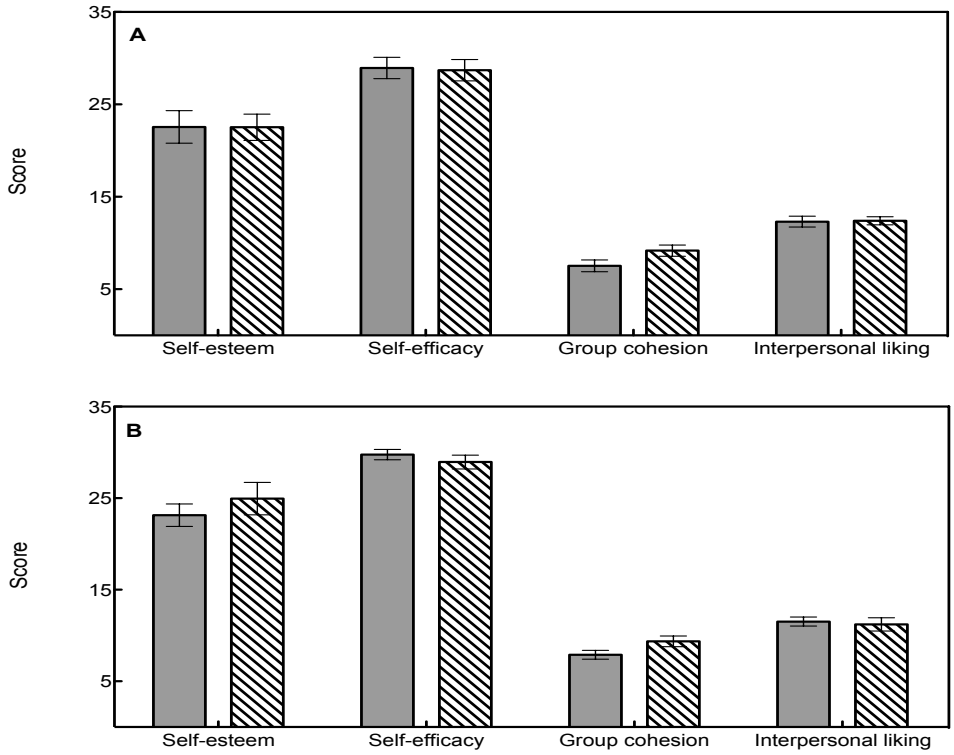


Figure 3: Mean scores on each of the affective measures. Solid grey bars represent ostracised conditions. Cross hatched bars represent non-ostracised conditions. Panel A shows total anonymity results. Panel B shows co-present results. Error bars indicate ±1 SEM

Estimated vs actual contribution

A three-way analysis of variance revealed no significant difference between participants' estimated and actual contributions to the discussions ($F(1, 70) = 3.586$, $p>0.05$), interaction with ostracism ($F(1, 70) = 0.188$, $p>0.05$) or anonymity ($F(2, 70) = 0.468$, $p>0.05$).

Virtual bravado

While social bravado could also be construed as *what* the participant says (e.g. sarcastic tone), for the purposes of this experiment, and in line with the reported findings of Williams et al (2002), only the simple number of contributions has been analysed. The number of contributions made by participants was measured in two ways. Williams et al (2002) coded only statements that "added something to the discussion", thereby excluding statements like "uh huh" or simple agreements. For consistency and to enable a direct comparison with Williams et al's results, this method of coding is also reported here. However, given that all comments made by the participant in CMC must be actively typed, the appropriateness of excluding some comments for not being "self-initiated" (Williams et al, 2002, p76) seems, at best, questionable in this setting. Thus the results based upon coding of all comments is also reported here. The number of comments made by the participant has been converted into a percentage of the total number of comments made. Thus, a score of 33 indicates an equal, one third share of the conversation.

Williams' coding

A two-way analysis of variance revealed that ostracised participants (from both total anonymity and co-present conditions) made proportionally fewer comments

($\mu = 25.73$, $\sigma = 8.29$) than non-ostracised participants ($\mu = 29.3$, $\sigma = 6.7$)($F(1, 70) = 3.969$, $p = 0.05$, two-tailed, $\delta = 0.47$). A significant main effect of anonymity level was also revealed, with participants (both ostracised and non-ostracised) in the total anonymity condition ($\mu = 29.8$, $\sigma = 7.58$) making proportionally more comments than those in the co-present ($\mu = 25.27$, $\sigma = 7.35$) condition ($F(1, 70) = 6.62$, $p<0.05$, two-tailed, $\delta = 0.61$). There was no interaction between condition and ostracism ($F(1, 70) = .345$, $p>0.05$, two-tailed). These results indicate that ostracised participants overall made a lower proportion of the contributions to the discussion than non-ostracised participants. However, the level of anonymity did not affect the percentage of comments made by ostracised participants. (Fig 4, panel A).

All comments coding

The pattern of results revealed by coding all comments was very similar to that revealed by Williams' coding method. There was a significant main effect of ostracism, where ostracised participants ($\mu = 30.55$, $\sigma = 8.97$) made a lower proportion of comments than non-ostracised participants ($\mu = 34.58$, $\sigma = 7.96$) ($F(1, 70) = 4.05$, $p<0.05$, two-tailed, $\delta = 0.48$). There was also a significant main effect of anonymity level, where participants in the total anonymity condition ($\mu = 34.89$, $\sigma = 8.71$) made a higher proportion of comments that participants in the co-present condition ($\mu = 30.28$, $\sigma = 8.17$) ($F(1, 70) = 5.36$, $p<0.025$, two-tailed, $\delta = 0.55$). Again, there was no interaction between anonymity level and ostracism ($F(1, 70) = 0.11$, $p>0.05$, two-tailed) (Fig 4, panel B).

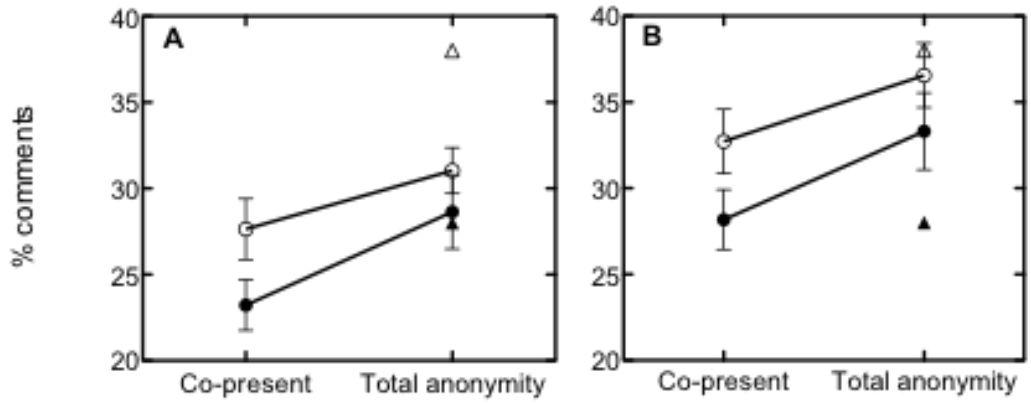


Figure 4: Percentage of comments made during experimental period as a function of ostracised (closed symbols) and non-ostracised (open symbols) condition in co-present and total anonymity conditions. The reported means of Williams et al (2002) are represented by open triangles (non-ostracised) and closed triangles (ostracised) in the total anonymity condition. Error bars represent ±1 SEM. Panel A shows data as coded by Williams et al (2002). Panel B shows data where all comments have been included.

Control vs Experimental periods

The results above refer only to the comments made in the second period of the experiment. Fig 5 shows the ratio of percentage of comments made in the second and first period of discussion. Values greater than 1 indicated an increase in proportional contribution during the experimental period and values less than 1, a decrease. Given that Williams et al's coding and the all comments coding produced very similar results and the potential problem of removing comments, outlined above, this further analysis included all comments. The analysis revealed that ostracised participants showed a reduction in comments during the experimental period ($\mu = 0.81$, $\sigma = 0.18$) whereas the non-ostracised participants did not ($\mu = 1.04$, $\sigma = 0.18$). A two way analysis of variance revealed this to be a significant main effect of ostracism ($F(1, 70) = 28.67$, $p<0.001$, $\delta = 1.28$). There was no significant effect of level of anonymity ($F(1, 70) = .071$, $p>0.05$) or interaction between ostracism and level of anonymity($F(1, 70) = .002$, $p>0.05$).

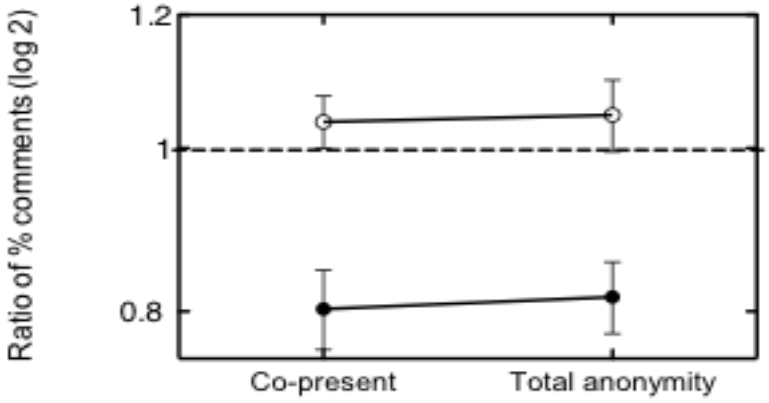


Figure 5: Change in proportion of comments made in experimental period/control period for co-present and total anonymity conditions. Open symbols represent non-ostracised conditions, closed symbols represent ostracised conditions, with the Y axis on a log 2 scale. Error bars represent ± 1 SEM. Broken line indicates no change.

The effect of script

The total anonymity condition

The pro-internet script was used in 10 trials and the anti-internet script in 8. Mann-Whitney tests revealed no significant difference between scripts in scores for ostracised participants in efficacy ($U = 21.5$, $N = 17$, $p>0.05$, two-tailed), esteem ($U = 26.5$, $N = 16$, $p>0.05$, two-tailed) or interpersonal liking ($U = 17.5$, $N = 16$, $p>0.05$, two-tailed). Participants who were presented with the pro-internet script reported significantly higher group cohesion (mean rank = 11.44) than those who were presented with the anti-internet script (mean rank = 6.25) ($U = 14$,$N = 17$, $p<0.05$, two-tailed). Independent t-tests revealed no significant differences in proportion of comments made between scripts for either Williams et al's coding ($t(16) = .299$, $p>0.05$, two-tailed) or all comments ($t(16) = .028$, $p>0.05$, two-tailed). Mann-Whitney tests excluding the pro-internet script participants to avoid any issues of script bias, revealed no significant differences between ostracised and

non-ostracised groups in efficacy, esteem or interpersonal liking. However, ostracised participants reported significantly lower cohesion (mean rank = 7.44) than included participants (mean rank = 15.62) ($U = 23.5$, $N = 25$, $p<0.01$, two-tailed).

The co-present condition

The pro-internet script was used in 12 trials and the anti-internet script in 8. Mann-Whitney tests revealed no significant difference between scripts in scores for ostracised participants in efficacy ($U = 46$, $N = 20$, $p>0.05$, two-tailed) or cohesion ($U = 38.5$, $NN = 20$, $p>0.05$, two tailed). However, participants presented with the pro-internet script reported significantly lower (mean rank = 8.33) self-esteem than those presented with the anti-internet script (mean rank = 13.75)($U = 22$, $N = 20$, $p<0.05$, two tailed). Those presented with the pro-internet script also reported higher interpersonal liking (mean rank = 8.33) than those presented with the anti-internet script (mean rank = 13.75)($U = 22$, $N = 20$, $p<0.05$, two-tailed). There was no significant difference between scripts on the proportion of comments made in either Williams et al's coding ($t(18) = .399$, $p>0.05$, two-tailed) or all comments coded ($t(18) = 1.07$, $p>0.05$, two-tailed). Mann-Whitney tests excluding the pro-internet script participants to avoid any issues of script bias, revealed no significant differences between ostracised and non-ostracised groups in efficacy, esteem, cohesion or interpersonal liking.

Discussion

The present results are consistent with Williams et al's previous reports of a reduction in comments made following ostracism. Moreover, the number of comments made in both ostracised and non-ostracised conditions were quantitatively similar to those previously reported by Williams et al. Thus the present results display striking quantitative similarities in the effect of ostracism, despite some methodological differences. However, the present results provide no support for the notion that the differential effect of ostracism in CMC and face-to-face scenarios may be mediated by differences in anonymity. Whilst there was a significant difference between levels of anonymity and number of comments made (i.e. those who were spatially co-present tended to make fewer comments than those who were spatially distal), no significant interaction between level of anonymity and ostracism was found. Rather, the results indicate that ostracism significantly reduces the number of comments made, regardless of whether the participant is physically anonymous or co-present. Thus, the "virtual bravado" described by Williams et al (2002) appears to occur in all computer-mediated communication, regardless of level of anonymity.

Despite the significant behavioural changes induced by ostracism, no difference in affective measures was observed between ostracised and non-ostracised groups. This lack of difference between ostracised and non-ostracised participants in affective measures is of considerable interest. Despite reported lower perceived inclusion and reduced proportional contribution from the ostracised participants, there appears to have been no effect on self-esteem, self-efficacy or interpersonal liking. A significant difference was found in perceived group cohesion for the total anonymity group only, once the potential confound of script choice had been

removed. Nonetheless, the present findings are discrepant with the reports of Williams et al (2002). The reasons for this inconsistency are not clear, but some possibilities present themselves.

While the measures employed here were based on the needs identified by Williams et al, there were some differences in the measures used. The measures of Williams' four needs were shorter than the measures used here. It may be the case that either ostracism did not affect the mood of the participants, or that its aversive effect was too short-lived to be picked up by the measures employed here. In other words, Williams et al's measures may have detected temporary shifts in affect more effectively, perhaps as the shorter measures were more direct measures of his "four needs" than these more general measures. However, it would seem to be the case that if the effect of ostracism is aversive in CMC, even if to a lesser extent than face-to-face, then one would still expect these measures to have detected a slight (if non-significant) difference between ostracised and non-ostracised participants. Rather, the mean values for each scale were nearly identical, with a difference in cohesion only in one group and including only the participants with the greatest differences in cohesion, due to a possible script confound.

Another possible methodological factor in the apparent lack of affective impact is that, of the 12 minute duration of the exchange, ostracized participants only experienced the ostracism for the second 7 minutes, after 5 minutes of inclusion. It may be the case that, on reflection upon the entire exchange when completing the questionnaire at the end, the ostracism became somewhat covered by the initial 5 minutes of exclusion. This cannot account for the differences between the results here and those reported by Williams, as the ostracism period was 2 minutes longer here than that applied by Williams et al. However, future research using this

methodology should perhaps redress the balance between ostracism and non-ostracism time, such that the ostracism period is more pronounced. One possible theoretical, rather than methodological, explanation of the discrepancy between the present results and those reported by Williams et al (2002) may lie in Twenge, Catanese & Baumeister's (2003) proposal that rather than an increase in negative affect, rejection leads to a flattening of affect. However, the affective data collected here does not allow for an analysis of strength of affect to directly address this possibility and there is a clear need for further consideration of the role, if any, of ostracism in affective modulation in CMC.

Regardless of the discrepant findings pertaining to affect, the results clearly indicate that there is an effect of ostracism in an online setting, in that targets of ostracism feel less included in the discussion and make fewer contributions. However, the effect appears to be smaller than that found in face-to-face encounters with ostracism. The contributions made to discussion do not reduce as much as that previously reported for face-to-face incidents of ostracism and other measures, including self-esteem and interpersonal liking, do not appear to be affected. Previously reported differences between online and face-to-face ostracism contrast sharply with the similarities found in CMC across levels of anonymity. Thus it seems reasonable to assume that the seat of the relatively mild effect of ostracism in CMC is closely related to the act of using a computer, rather than an extraneous consequence of communicating via computer, such as anonymity.

The lack of any significant effect of anonymity upon the effect of ostracism is intriguing given the substantial evidence that anonymity influences many different aspects of online behaviour such as group polarisation (Spears, Lea & Lee, 1990), adherence to group norms (Postmes, Spears, Sakhel & DeGroot, 2001) and

typically anti-normative behaviour (Lea, O'Shea, Fung & Spears, 1992). To provide a theoretical framework for such findings, Lea & Spears (1991) developed the Social Identity model of Deindividuation Effects (SIDE). One clear prediction of the model is that the group becomes more important to the individual as in-group differences become less salient. Thus, one would expect that as anonymity increases, the effect of ostracism should increase since exclusion by the group should be more challenging to the self. The present results are clearly not consistent with such a scheme. However, the model does not address the issue of the effect of reducing the salience of in-group *similarities*. The present results appear to reflect a scheme whereby, rather than identifying with the group, the participants became less attached to the group (as indicated by the non-significant lowering of reported perceived group cohesion) thus making any social sanction, such as ostracism, less aversive. However, if anonymity is not the driving force behind the differential effects of ostracism, the question remains open as to which characteristics of CMC are mediating these outcomes.

The asynchronous nature of CMC may mean that the negative effects of ostracism are much more subtle for its target. Although all discussants are communicating at the same time, CMC is not characterised by the strict turn-taking or temporal order of comments typical of face-to-face discussions (e.g. McKenna & Bargh, 2000). This lack of clear surface structure to the conversation may serve to mask, or reduce the saliency, of ostracism. It is possible that a longer period of exposure to ostracism may result in a heightened effect of ostracism. Williams et al (2002) exposed participants to ostracism for a period for 5 minutes, in comparison to the 7 minutes employed here. For these relatively brief durations of exposure to

ostracism, at least, there is clear evidence that ostracism's effect is attenuated in CMC.

In conclusion, targets of ostracism continue to contribute to discussions conducted through CMC, although at a lower percentage of the discussion than those who are not ostracised. The level of anonymity afforded to these targets had no effect on the reduction in contribution found in ostracised conditions. While it is clear that physical anonymity is not a critical factor in the virtual bravado described by Williams et al (2002), the mechanisms that underlie the differences in face-to-face and CMC ostracism are still far from clear. The lack of difference in affective measures between ostracised and non-ostracised participants is inconsistent with previous findings (e.g. Williams et al, 2002) and may reflect differences in the measures used, a genuine lack of negative affect as a result of ostracism (c.f. Twenge, Catanese & Baumeister, 2003) or temporal differences in the course of the effect mediated by the temporal asynchrony of CMC. More generally, it would seem to the case that the impact of ostracism on affect, which appears to be highly dependent on method of ostracism induction and how affect is measured, is still uncertain. The apparent high dependency of previous findings on methodology may underlie previous discrepant findings regarding the behavioural outcomes of ostracism (e.g. Williams' pro-social behaviour or Baumeister and co-workers' aggression, e.g. Twenge, Baumeister, Tice & Stucke, 2001). Thus, there is a clear imperative to develop consistent and appropriate instruments for the delivery and measurement of ostracism and its effects. However, whilst the underlying mechanisms of ostracism remain poorly understood, the identification and development of such delivery mechanisms and outcome measures may prove elusive.

Chapter 6: New perspectives in social cognitive neuroscience

Physiology and psychology, instead of prosecuting their studies, as some now recommend, more strictly apart from one another than at present, will find it serviceable for each to give to the results achieved by the other even closer heed than has been customary hitherto.

(Sherrington, 1906, p387)

Thus far, it is clear that whilst social psychological research on ostracism has progressed our understanding of the topic significantly, it has also thrown up a number of contradictions and harbours gaps in our understanding of, for example, how outcomes of ostracism may be predicted. These contradictions make the interpretation of experimental results difficult, if not impossible. For example, Williams and co-workers report an increase in pro-social behaviour after ostracism, whereas Baumeister and co-workers report increases in aggression after social exclusion. Whether these differences are due to methodological approaches or a fundamental difference between the experience of ostracism and social exclusion is impossible to determine within the current literature. The possibility of addressing these issues from a new perspective, that may be articulated with more traditional social psychological methods and constructs, in order to shed light on some of these contradictions and lacunae is therefore both timely and attractive. Indeed, both of the main researchers in this area, Baumeister (DeWall & Baumeister, 2006) and Williams (Eisenberger, Lieberman & Williams, 2003), have begun to look to other methods to consolidate and extend their previous research. This chapter aims to provide an overview of what has already been revealed by consideration of

ostracism from a neuroscientific perspective, with a view to using this information to better inform the design of future experiments on ostracism. A consideration of these findings at this lower, neurological level, may reveal links to potential behavioural consequences of ostracism that have not yet been measured or considered on this basis.

Whilst social cognitive neuroscience is a relatively new field within Psychology, it has yielded promising results in its application to a variety of research questions (including ostracism) that have previously only been addressed using traditional social psychological methods (see Ochsner (2004) for a short review of these recent developments). For instance, the techniques of neuroscience have, so far, been successfully applied to the perception of social cues (e.g. Anderson, Christoff, Panitz, De Rosa & Gabrieli, 2003), social evaluation (e.g. Cunningham, Johnson, Gatenby, Gore & Banaji, 2003) and social interaction (e.g. Rilling, Gutman, Zeh, Pagnoni, Berns & Kilts, 2002). It may be that the extant discrepancies between Baumeister and Williams' empirical work, such as increased aggression after social exclusion as opposed to increased pro-social behaviour after ostracism, are simply an artefact of the manipulations used. Should this be the case, a traditional social psychological approach could appropriately be used to investigate and resolve such discrepancies. However, the parameter space that describes these manipulations is very large indeed and identifying which manipulations are responsible for the discrepant results would be, to say the least, challenging. However, the reliance of neuroscientific techniques upon well defined parameter spaces and the re-framing of social psychological constructs within a paradigm that demands a relatively rigorous level of operational definition may enable a more rapid and harmonious convergence of the approaches of these two groups' constructions of ostracism. In

terms of Baumeister's work, the observed drop in higher cognitive function (Baumeister, Twenge & Nuss, 2002) and reduction in ability to self-regulate (Baumeister, DeWall, Ciarocco & Twenge, 2005) he and his co-workers have described may be readily amenable to direct investigation using neuroscientific methods. For instance, it may be the case that cognitive and self-regulatory functions are integrally linked at the level of the neural network, such that the reported reduction of both functions in excluded participants may be at least partially explained by the impact of exclusion on a neural system which underlies both.

However, the cognitive neuroscience approach is not without its own issues of interpretation. While fMRI research can provide clear indication as to which areas of the brain may be active at any given point, there is still much doubt about the reliability of such methodologies, in that the Blood Oxygen Level Dependent (BOLD) response measured by fMRI is not necessarily directily related to neural activity (e.g. Logothetis, Pauls, Augath, Trinath & Oeltermann, 2001). Consequently, the findings from fMRI should be juxtaposed with results from other fields, such as EEG, MEG, or, behavioural data. In so doing, the activation reported in fMRI can be combined with other data in a variety of stimuli to produce a fuller picture to address the question: "what is the nature of ostracism and how can its outcomes be predicted?" While behavioural and imaging data are not necessarily directly related, and may measure different aspects of a phenomenon, such a combination of approaches allows for the weaknesses of each to be countered by the strength of the other. For example, the issues surrounding the relationship between actual neural activity and the BOLD response imply that it is impossible to claim that increased BOLD response to a particular stimuli has any

material neural effect on the individual. However, by acquiring behavioural data on the response to such stimuli provides support for the notion that the increased in BOLD response recorded by the fMRI scanner has a meaningful impact on the behaviour of the participant.

Neuro-anatomy & fMRI research

A neuroscientific approach has already begun to be applied to the research on ostracism. Eisenberger, Lieberman & Williams (2003) conducted an experiment using fMRI to investigate how the brain responded while the participant was being ostracised using the Cyberball protocol. There were three conditions in the experiment – included, implicit ostracism (where the participant was told that they could not participate in the game due to technical issues, but to just watch) and explicit ostracism (where the two computer generated players only threw the ball to each other). They found that during explicit ostracism, activity in the dorsal anterior cingulate cortex (dACC) increased relative to conditions where the participant was included. Interestingly, the increase in dACC activity was also correlated with an increase in self-reported distress after the ostracism period. The dACC has been previously linked to the affective component of physical pain. Using hypnosis, Rainville, Duncan, Price, Carrier & Bushnell (1997) manipulated the perceived unpleasantness, but not intensity, of a noxious stimulus (immersion of the hand in "painfully hot" (45°C) water). Positron Emission Tomography (PET) revealed that participants in a control condition showed activity in the ACC, the rostral insular (IC) and both primary sensory regions of SI and SII. Under hypnosis conditions, activity in ACC increased under a hypnotic suggestion of increased pain unpleasantness and decreased under a hypnotic suggestion of decreased pain unpleasantness. There was no change in activity in SII. These

activation changes were also reflected in the unpleasantness reported by participants. The authors claim that this dissociation of the ACC and SII represent different components of the pain system, such that while the primary sensory site, SII codes the intensity of pain (thereby not responding to suggestions of increased unpleasantness), the ACC codes the affective component of the pain experience, i.e. for unpleasantness rather than intensity of pain. Similarly, Sawamoto, Honda, Okada, Hanakawa, Kanda, Fukuyama, Konishi & Shibasaki, (2000) report increased activation in the ACC for non-painful stimuli when interspersed with painful stimuli (uncertain) than when only non-painful stimuli were presented (certain). Participants also reported increased sensations of unpleasantness for non-painful stimuli in the uncertain condition. The authors suggest that the ACC modulates the affective component of pain, such that identical stimuli are rated as more unpleasant under uncertain than certain conditions.

Eisenberger et al (2003) report that the right ventral pre-frontal cortex (rvPFC) increased in activity during explicit ostracism, but not in implicit ostracism. The rvPFC has previously been linked to the self-regulation of pain and emotion. Using PET, Petrovic, Kalso, Petersson & Ingvar, (2002) reported increased activation in the ventromedial prefrontal cortex in both opoid and placebo analgesia. Hariri, Bookheimer & Mazziotta, (2000) revealed through fMRI imaging that matching a face with a negative facial expression to a target face produced increased activation in the amygdala. However, participants who were required to choose a label for the negative emotion of a target face, showed reduced activation in the amygdala and increased activity in the right prefrontal cortex (rPFC). The authors suggested that this finding indicates a mediational role of the rPFC on the emotional response to negative affect. Similarly, Eisenberger et

al found that activation in the rvPFC had a mediating effect on the dACC such that increased activity in the rvPFC was associated with reduced activity in the dACC and lower reported self-distress from ostracized participants. This is analogous to the findings of Lieberman, Jarcho, Berman, Naliboff, Suyenobu, Mandelkern & Mayer (2004) in relation to physical pain. They report that Irritable Bowel Syndrome (IBS) patients taking placebo showed reduced increased activation in the right ventrolateral prefrontal cortex and decreased activation in the dACC, compared to before the administration of placebo. These changes in activation were also correlated with improvement in self-reported symptoms. Eisenberger et al concluded that "…a pattern of activations very similar to those found in studies of physical pain emerged during social exclusion…" (Eisenberger, Lieberman & Williams, 2003).

The idea that social and physical pain are linked is not necessarily a new one, with some animal studies from the 1970's (e.g. Panksepp, Hermann, Connor, Bishop & Scott, 1978) suggesting precisely this, but Eisenberger et al's study makes this link explicit, and in humans. This proposed connection between the physical and social pain systems in the brain has been termed the "pain overlap theory" by Eisenberger & Lieberman (2004). They speculate that the response to social and physical pain may share parts of the same underlying neural processing system for evolutionary reasons. Whilst the findings of Eisenberger, Lieberman & Williams (2003) do not speak to any putative evolutionary mechanism, their finding that the dACC and rvPFC are activated in ostracism, as they are in physical pain, is consistent with the proposal that physical and social pain may be mediated, at least in part, by common neural pathways.

Moreover, their findings are convergent with a number of other areas of evidence. For example, the dACC has also been proposed to act as a discrepancy monitor, providing a warning when received information is contradictory to expectation or when goal conflicts may exist. For instance, Botvinick, Braver, Barch, Carter & Cohen (2001) argued that, based on previous empirical work, the ACC was activated in three different types of task – response override (e.g. Stroop task), undetermined responding (e.g. stem completion), and error commission (e.g. errors on speeded response time tasks). Each of these tasks represents a conflict for the participants, either between automatic and desired response (Stroop) or between alternative pathways to response (e.g. stem completion). Weissman, Giesbrecht, Song, Mangun & Woldorff (2003) presented participants with large letters made up of smaller letters and asked them to respond whether, for example, the large letter was an H or an S with one response button, and an X or an O with an alternative button in an fMRI experiment. They reported that dACC activation was significantly higher in tasks with perceptual and semantic conflict (e.g. a large H made of small Ss) and tasks with perceptual, semantic and response conflict (e.g. a large H made of small Xs) than trials with no conflict (e.g. large H made of small Hs).

Eisenberger & Lieberman (2004) propose that the proposed conflict discrepancy monitor process in the dACC forms the foundation for the social/physical pain relationship by acting as a "neural alarm system". In a physical pain situation, the dACC alerts the individual to a discrepancy between their current condition and a healthy physical state. Eisenberger & Lieberman argue that in a social pain situation, the dACC is again alerting the individual to a discrepancy, but in this case, between their current social position and their desire to be socially connected.

In other words, Eisenberger & Lieberman propose that the dACC serves to signal both physical and social insult via its role in monitoring discrepancies. Should this be the case, ostracism should produce the greatest aversive reaction (and possibly greatest activation of the dACC) in those who do not expect to be ostracized in a given situation or those who greatly desire social connection. However, no research as yet has diretly examined this proposal. Further support for the involvement of the dACC has been provided by Eisenberger, Lieberman & Satpute (2005). They measured dACC activity in response to a discrepancy detection task (the "oddball" task). They reported that participants who scored highly on a neuroticism scale also showed higher activation in the dACC than participants who scored highly in either extroversion or self-consciousness. dACC activation was also a better predictor of interoceptive accuracy (an outcome measure of neuroticism; (Critchley, Wiens, Rothstein, Ohman, & Dolan, 2004)) than self-reported neuroticism. They proposed that this increase in dACC activation in certain individuals reflected a more sensitive alarm system.

Further evidence for a shared neural substrate for physical and social pain emerges from a range of studies of three distinct systems within Gray & McNaughton's (2000) physical threat-defence model: the Behavioural Inhibition System (BIS), the Behavioural Activation System (BAS) and the Fight/Freezing/Flight System (FFFS). Gray & McNaughton propose distinct functions for these systems. The FFFS is proposed to be responsible for simple escape and avoidance behaviour, while the BAS is sensitive to reward and non-punishment and motivates behaviour towards reward and away from punishment or danger. The BIS is sensitive to cues related to punishment or non-reward and can interrupt ongoing behaviour to prepare the organism for a response to perceived threats. Thus, the BIS mediates

between the FFFS and BAS systems, by identifying potential conflict or danger situations and stopping behaviour which may be dangerous or inappropriate. The BAS is then responsible for moving the animal on once a plan of action in response to the threat has been established.

Gray & McNaughton (2000) proposed that the neural path of the FFFS runs from the Periaqueductal Gray (PAG), through the medial hypothalamus and onto the amygdala. From the amygdala the path moves onto the ACC and from there to the prefrontal ventral stream. The BIS runs concurrently with the FFFS from the PAG up to the amygdala, but then moves onto the septo-hippocampal system, the posterior cingulate and finally the prefrontal dorsal stream. The lower levels of this system (PAG, hypothalamus) are particularly engaged in situations with a low defensive distance and are related to panic type responses. The higher levels in these pathways (prefrontal cortex) are engaged with high defensive distance situations, and reflect the higher levels of processing involved in high distance, future predictions and assessments.

The BAS takes a slightly different path, starting at the ventral tegmental area, onto the ventral pallium, through the ventral striatum and onto the prefrontal cortex. While there is crossover in places between these three systems (e.g the beginning of the routes for the BIS and FFFS; all three finish in the prefrontal cortex, with the BAS taking the largest, though non-specified area) they are considered to be distinct systems (Gray & McNaughton, 2000).

At the heart of the BIS lies the conflict between the desire to avoid potential danger (fear, resulting in escape behaviour) and the need at times to approach danger (anxiety). For example, a mouse on the edge of an open field may fear entering the

field, as they would be exposed to predators. However, if they need food, then they must enter the field and therefore need to overcome the fear. Gray & McNaughton's (2000) model proposes that a mouse in the latter situation will have higher levels of anxiety (rather than fear) and will make cautious approaches into the field, perhaps entering the field briefly, before returning to a safe place at the edge of the field. This type of behaviour is highly reminiscent of Baumeister's (2007) characterisation of the excluded individual as desiring social connections, but being afraid of further rejection. The balance between these two behaviour types – defensive avoidance and defensive approach – is in part determined by how imminent or severe the threat is (defensive distance). In low defensive distance situations, where the threat is imminent or very severe, the animal is more likely to tend towards defensive avoidance behaviours. Alternatively, if the defensive distance is high, the animal may tend towards defensive approach.

MacDonald & Leary (2005) argue that these systems are involved in mediation of both physical and social pain. The PAG receives input from the nociceptive system (Craig & Dostrovsky, 1999) and has been reported to reduce pain transmissions through release of opoids (Fields, 2000). Analgesic effects have been reported in rat pups post-separation from the litter (Kehoe & Blass, 1986) and Wiedenmeyer, Goodwin & Barr (2000) report that this analgesic effect is reduced in rats with lesions to the lateral or ventrolateral areas of the PAG. Similarly, separation cries were reduced in lesioned rat pups compared to non-lesioned rats. The ACC has also been implicated in both physical pain (e.g. Rainville et al, 1997) and ostracism (Eisenberger et al, 2003), as previously discussed.

The role of opoids and oxytocin may also provide evidence for a link between social and physical pain (MacDonald & Leary, 2005). Both endogenous and

exogenous opoids (e.g. morphine) have an acknowledged role on the mediation of physical pain (e.g. Panksepp, 1998). In social pain, the administration of low doses of morphine to rat pups (Carden, Hernandez & Hofer, 1996), primates (Kalin, Shelton & Barksdale, 1988), guinea pigs (Herman & Panksepp, 1978) and dogs (Panksepp et al., 1978) reduces separation cries. Oxytocin has been associated with a number of social and bonding behaviours (e.g. maternal behaviour in rats: Pedersen, Ascher, Monroe & Prange, 1982; increased social behaviour in rats: Witt, Winslow & Insel, 1992). Agren, Lundeberg, Uvnas-Moberg & Sato (1995) report that oxytocin reduced sensitivity to pain in rats, whereas oxytocin antagonists blocked the analgesic response. These studies suggest that increased levels of oxytocin play a key role in bonding and social behaviour and may also reduce physical pain. Thus, while not yet directly tested, it seems plausible that oxytocin may be involved in both physical and social pain responses.

Social & Physical pain: Adaptation & Potentiation

Evidence consistent with a scheme whereby physical and social pain may share a neural substrate is manifest in a wide range of neuro-anatomical structures and neuro-chemicals. However, much of this research is based on the activation of the same brain structures in discrete physical and social pain experiments. Were such a shared substrate to underlie responses to both physical and social pain, how should this be manifested phenomenologically? There are two ways in which social and physical pain could influence each other. The first possible effect is potentiation (e.g. Lomo, 1966), whereby the activation of the neurons through one type of pain produces an *increased* response to the other type of pain. The second possible effect is adaptation (e.g. Gibson & Radner, 1937), where an increase in

one type of pain *reduces* the responsiveness of the neurons, and therefore responses to the other type of pain.

Some early studies that investigated the effect of experiencing failure, arguably a phenomenon closely related to ostracism have provided evidence for a potentiation effect. Levine, Krass, Padawer (1993) showed that participants who were told that they had failed a reading comprehension task showed higher sensitivity to pain. This finding was replicated by van den Hout, Vlaeyen, Peters, Nelissen & van den Hout (2000), who found that students who were informed that they had performed poorly on an exam reported higher pain ratings on a cold-pressor task.

However, behavioural studies of the relationship between social and physical pain have tended more towards adaptation type responses. MacDonald, Kingsbury & Shaw (2005) report that people who were high in rejection sensitivity showed reduced pain sensitivity after ostracism (which would indicate adaptation), but this was not the case for those whose rejection sensitivity was low. DeWall & Baumeister (2006) additionally report that socially excluded participants demonstrated a lower sensitivity to pain. Further to this, they showed that participants who had been socially excluded were less extreme in how happy they thought they might be in response to a positive future event, and less extreme about how upset they might feel after a future negative event. Excluded participants were also less likely to show empathy towards another person who had suffered either social or physical pain. Eisenberger, Jarcho, Lieberman & Naliboff (2006) tested pain unpleasantness threshold (using a thermal probe) before ostracism and reported that low threshold was associated with higher self-reported distress after ostracism. During the final 30 seconds of the ostracism manipulation, participants received three further pain stimuli (again, with thermal probe) and rated the

unpleasantness of the stimuli. Participants who reported higher levels of distress after ostracism also reported higher pain unpleasantness ratings for the final pain stimuli. The authors propose that these findings indicate firstly, that individuals who are more pain sensitive respond more strongly to social pain cues, and secondly, that those who experience higher levels of distress in response to social pain show increased sensitivity to pain.

Thus, the extant findings do not provide a straightforward characterization of the effect of social pain with respect to potentiation and adaptation processes and also raise the potential for individual differences in response. It appears reasonable to suggest that at least some of these discrepancies will only be resolved by a more detailed mechanistic understanding of the systems that mediate the social pain response.

Regardless of the uncertainties with respect to potentiation and adaptation to pain, there is now growing evidence for a strong inter-relationship between social and physical pain processing. Recent findings indicate that reducing social pain (or at least the potential for such pain) can also reduce physical pain. High levels of social support have been shown to reduce experimentally induced pain (Brown, Sheffield, Leary & Robinson, 2003) and also, in more applied settings, cancer pain (Zaza & Baine, 2002) and pain after coronary surgery (King, Reis, Porter & Norsen, 1993). Moreover, indirect evidence that the effect of social exclusion may be similarly modulated by social support has recently been reported by Onoda, Okamoto, Nakashima, Nitono, Ura & Yamawaki, (2009). In an fMRI study, they found that excluded participants who received messages of social support during ostracism displayed lower levels of activation in the vACC, like the dACC implicated in the response to physical pain, and increased activation in the left

lateral PFC which is proposed to be responsible for the amelioration of physical pain (Petrovic et al, 2002). The pattern of activation and co-modulation with social support found by Onoda et al is thus consistent with the notion that the ACC underlies the negative affect associated with ostracism and that the PFC underlies the attenuation of these signals, resulting in lower affective distress (Eisenberger et al, 2003). Thus, a number of studies has provided evidence that social pain can be reduced by social support and responses to social pain are, at least in part, correlated with anatomical structures implicated in the response to physical pain.

Very recently, evidence from pharmacological challenge has further strengthened the case for overlapping neural substrates of physical and social pain. DeWall, MacDonald, Webster, Masten, Baumeister, Powell, Combs, Schurtz, Stillman, Tice & Eisenberger (2010) have reported that the administration of Tylenol (acetaminophen; a physical pain suppressant) reduced self-reported daily social pain over a two-week period. A further experiment using fMRI revealed lower levels of activation in the dACC and anterior insula during ostracism (Cyberball) in participants in the acetaminophen condition than those in the placebo group. However, both groups self-reported similar levels of social distress, contrary to predictions, indicating that the relationships between affect, ostracism and neural activation remain unclear.

Neurochemical factors

A range of biomarkers have now been identified that may provide important clues in understanding the known individual differences in response to social pain (e.g. MacDonald et al, 2005). For instance, Maner, Miller, Schmidt & Eckel (2010) have proposed that progesterone, a hormone associated with higher levels of

affiliative desire, (e.g. Wirth & Schultheiss, 2006), is implicated in responses to exclusion. They report that participants high in rejection sensitivity recorded higher levels of progesterone (thereby higher desire to affiliate) than their low rejection sensitivity counterparts. However, participants high in social anxiety (who tend to shy away from social contact) displayed lower levels of progesterone (indicating a lessened desire to affiliate) after exclusion. In a similar vein, cortisol, a hormone associated with psychological stress (e.g. Lovallo & Thomas, 2000) has been reported to increase post-exclusion. Blackhart, Eckel & Tice (2007) reported that socially-rejected participants exhibited higher levels of salivary cortisol than accepted or control participants. However, participants who scored highly on defensiveness (repression or self-deception, as measured by the Marley-Crowne Social Desirability Scale: Crowne & Marlowe, 1964) showed significantly lower cortisol levels than low defensiveness participants. Similarly, Stroud, Salovey & Epel (2002) report that females, but not males, exhibited higher levels of cortisol after social rejection than baseline measurements. These studies indicate that cortisol levels tend to increase after social exclusion, as one would expect if the situation is stressful. However, the interaction between increases in cortisol and behavioural responses to ostracism may prove particularly instructive. Additionally, the relationship between individual differences in cortisol reactivity and reactions to ostracism may also provide further guidance to explain the multitude of different responses reported in the literature.

Ford & Collins (2010) report increased cortisol reactivity in response to rejection from an opposite sex partner in low self esteem, compared to high self esteem, participants. The higher levels of cortisol in low self-esteem participants also predicted higher derogation of the rejecting partner. The results of this study bear

on the models of ostracism previously reported. Firstly, the relationship evidenced between self-esteem and cortisol in rejection response provides a direct link to Williams' inclusion of esteem as one of the critical 'four needs' attacked by ostracism. Secondly, the mediating role of cortisol reactivity in a derogation response from rejected participants may also begin to provide a biological basis for the aggression reported by Baumeister's group, as well as the beginnings of an explanation for the variance in the display of such a response. However, Zoller, Maroof, Welk & Deinzer (2010) report no effect on salivary cortisol in ostracised participants (using Cyberball), indicating that any relationship between cortisol and ostracism is far from clear at these early stages of research.

In summary, while the relationship between physical and social pain is far from clear, there is now growing evidence that there may be at least some shared neural circuitry. Should this be the case, exposure to the two phenomena may also yield similar behavioural response patterns. Indeed, a link between social and physical pain has also gathered support from behavioural similarities between individuals suffering from the two types of pain. MacDonald & Leary (2005) argue that the aggressive responses to exclusion reported by Twenge et al (2001) is related to previous literature which suggests that physical pain can elicit aggressive responses in both humans and animals (e.g. Berkowitz, 1993; Scott, 1966). However, aggression has not consistently been reported in the ostracism literature, and the mechanisms which may mediate such responses need further exploration.

In conclusion, there is a growing body of evidence that social and physical pain may share a common neural substrate. Evidence of cross-over effects between the two has been suggested (e.g. Eisenberger et al, 2006; DeWall et al, 2010), along with similar behavioural outcomes (MacDonald & Leary, 2005). Given the

literature from fMRI and other neuroscientific methods outlined above, a potentially useful approach to experimentation on ostracism may be to consider it as a form of social pain, which is similar in behavioural consequences to physical pain. Thus one possible approach to characterizing and clarifying the effect of ostracism is to examine its behavioural sequela with respect to that already established within the physical pain literature. This theme is developed in Chapter 7, which examines the effect of ostracism upon a behaviour that has previously been shown to be affected by physical pain, namely cognitive performance.

Chapter 7 - The effect of ostracism on cognitive performance

Introduction

The notion that a qualitative difference exists between the experience of pain induced by social and physical insult is a motif that can be traced across millennia *cf* the early proposal of Pubilius Syrus that *"The pain of the mind is worse than the pain of the body"* (42 BC) and Derek Jarman's (1993) observation that *"Pain can be alleviated by morphine but the pain of social ostracism cannot be taken away"*. However, recent research has begun to provide evidence that our experience of these apparently different forms of pain may be, at least in part, mediated by a shared neural substrate. For instance, two of the cortical areas known to be implicated in the negative affect associated with physical pain, the dorsal Anterior Cingulate Cortex (dACC) and the right ventral Pre-Frontal Cortex (rvPFC) (see, e.g. Rainville, Duncan, Price, Carrier & Bushnell, 1997; Petrovic, Kalso, Petersson & Ingvar, 2002) also exhibit increased fMRI BOLD responses in subjects who are exposed to ostracism (Eisenberger, Lieberman & Williams, 2003). Since this initial discovery, a range of further research has provided evidence that the experience of social and physical pain may share overlapping neural substrates (see chapter 6). As such, social pain holds promise as a model for physical pain. Should such a model prove viable, it does not only offer theoretical interest but a potential methodology for studying pain with fewer ethical and technological hurdles.

The brain areas showing higher activation in both ostracism and physical pain, the dACC and the rvPFC, have also been implicated in cognitive function (e.g. Bush, Luu & Posner, 2000; Dagher, Owen, Boecker & Brooks, 1999). Inasmuch as social and physical pain are impacting upon the same cortical areas required for cognitive tasks, the effects of social and physical pain upon cognition should be qualitatively similar.

Whilst the precise detail of how pain interacts with cognitive performance is still a matter of contention, there is broad agreement that physical pain can have a deleterious effect upon cognitive function. For instance, Eccleston (1994, 1995) reported that high-intensity chronic pain patients recorded slower reaction times in cognitively demanding (but not relatively simple) tasks than low-intensity or pain-free participants. Similarly, Kewman, Vaishampayan, Zald and Han (1991) reported that, having controlled for affective distress, 32% of acute musculo-skeletal pain patients exhibited impairments in attentional performance on a range of neuropsychological tests. These effects appear to generalise to acute pain in otherwise healthy participants: Vancleef & Peters (2006a) reported an increase in reaction times to an auditory discrimination task following mild electrical stimulation of healthy volunteers. Similar findings were also reported by Crombez, Eccleston, Baeyens & Eelen (1996, 1997). Lorenz, Beck & Bromm (1997) showed decreased accuracy in a memory search task in healthy participants under tourniquet induced pain. However, a number of studies has failed to either unequivocally or entirely replicate such apparent cognitive impairment in healthy volunteers. For example, Houlihan, McGrath, Connolly, Stroink, Finley, Dick & Phi (2004) reported a *reduction* of reaction time in a memory task under a cold pressor pain condition but no significant differences in event related potentials.

Veldhuijzen, Kenemans, de Bruin, Olivier & Volkerts (2006) also showed no effect of pain on performance of a visual search task. Thus, there is general consensus that chronic physical pain has a deleterious effect on cognitive performance (e.g. Dick, Connolly, McGrath, Finley, Stroink, Houlihan & Clark, 2003; Harman & Ruyak, 2005; de Gier, Peters & Vlaeyen, 2003) and, at least under certain conditions, these same effects may be revealed in acute pain (e.g. Crombez et al, 1996, 1997). While a precise account of acute physical pain's effect on cognition is currently precarious, pain typically tends to reduce cognitive performance, particularly in complex tasks.

The manifold methodological differences between acute pain studies (such as differences in stimuli, tasks and dependent variables) may well offer an account of the discrepant findings. Alternatively, Seminowicz & Davis (2007) propose that the discrepant results found in acute pain studies may be due to other factors, such as individual differences in "pain catastrophizing" or fear of pain (e.g. Crombez et al, 1998). This potential for individual differences in pain catastrophizing provides both a methodological challenge and a valuable clue to analytic approach that is explored in further detail in the Results and Discussion.

There is encouraging indirect evidence to suggest that experience of social pain may also result in deleterious effects on cognitive function. Baumeister, Twenge & Nuss (2002) compared performance on an IQ test and the Graduate Record Examination (GRE) for participants who were told that they would find themselves alone in future life, those who were told that they would suffer some misfortune in later life and those who were told they would enjoy a close and positive social millieu in future life. They reported a drop in both IQ and GRE performance for the group who were informed they would be alone in the future, compared with the

other two groups. Moreover, the reduction in GRE performance was restricted to the more complex cognitive items, such as logic problems, with no effect on simple information processing tasks, a result highly suggestive of the dichotomy revealed by Eccleston for physical pain.

More recently, Chen, Williams, Fitness & Newton (2008) have measured the effect of rehearsing past experience of both physical and social pain on cognitive function. Participants were asked to recall *either* an episode of physical injury *or* an event where someone close to them had betrayed them. Performance was subsequently measured on a range of low and high cognitive demand tasks. Measures of the severity of recalled pain and mood revealed that social pain was recalled as more intense and resulted in higher negative affect. Those who rehearsed social pain scenarios also showed a variety of significant deficits in cognitive performance including increase in reaction times for low demand tasks and increased errors in high demand tasks.

Whilst recent work is suggestive of a parallel between the effect of physical and social pain on cognitive function, the effects of social pain in particular are still open to question. Neither Baumeister et al nor Chen et al measured the effect of directly socially induced negative affect on cognitive performance. In the former study, participants' negative affect was manipulated by suggesting that they would receive social insult in the future, in the latter study, participants were asked to recall the memory of physical or social insult. Furthermore, the absence of a control group in Chen et al's study renders interpretation of their results less than straightforward. Moreover, the limited spatial resolution, and difficulty in moving beyond correlative interpretation that is inherent in current imaging techniques, leaves open the possibility that either different neural circuitry, beyond the spatial

resolution limit of fMRI, independently mediates these experiences or that the common areas identified are artefactually related to different affective systems. However, if the affective components of physical and social pain are truly served by a common neural system then the experience of social or physical pain should result in similar behavioural sequela.

In order to test this prediction directly, the effect of ostracism, induced using the standard "Cyberball" technique, on the performance of two cognitive tasks has been measured: the counting Stroop Task (Bush et al, 1998) and the Remote Associates Task (Mednick, 1962). Performance in each of these tasks has previously been shown to be impoverished by the experience of physical pain (Seminowicz, Mikulis & Davis, 2004). These two tasks also address different aspects of cognitive performance. The Counting Stroop addresses low level attentional processing, whereas the Remote Associates Task requires higher level cognitive processing. The combination of the two therefore allows for measurement of the effects of ostracism on differing levels of cognitive performance. The Counting Stroop Task has been previously shown to increase the bold response of the dACC (Bush et al, 1998). Intriguingly, Eisenberger et al have reported similar increases in dACC response following ostracism. While the counting stroop task is relatively simple and thus not a primary candidate for modulation by pain, this convergence of processing within the dACC is highly suggestive. We hypothesise that there will be a difference in performance (measured by errors and reaction time) on the Counting Stroop task between ostracised and non-ostracised participants.

Correll (2008) reported that 1/f noise was present in reaction time data on a traditional (colour based, rather than counting) Stroop task and so the reaction time

data to the Stroop task here will also be analysed for evidence of 1/f noise. However, Correll (2008) also reports that as cognitive load was increased for participants on a prejudice task, the prevalence of 1/f noise reduced. This raises the possibility that the experience of ostracism may also increase task difficulty, thus reducing 1/f noise (a flatter gradient of slope in the power spectra) in reaction time data. To this end, the gradient of the slopes in power spectra for ostracized and non-ostracised participants has been compared to test the hypothesis that ostracised participants will show a flatter slope (closer to 0) in the power spectra than non-ostracised participants.

Performance of the more complex, Remote Associates Task has also been found to be reduced following exposure to recall of social insult (Chen et al, 2008) and its amenability to presentation at a range of difficulty levels allows a ready comparison with previous findings relating to the effects of physical pain on simple and complex tasks. In manipulating the difficulty of the RAT, performance on different levels can be compared both within individual participants and across groups. Such comparisons may reveal differing effects of ostracism at higher levels of difficulty than lower (e.g. Chen et al, 2008). The effects of ostracism on these tasks was measured at various points following the induction of ostracism and are considered here independently for strata who respond more or less positively to the experience of ostracism. The hypotheses are that there will be a difference in the performance (as measured by errors and reaction time) of ostracised and non-ostracised participants on the RAT, and that this difference will be more pronounced in participants who respond less positively to ostracism.

Method

Participants

Forty participants from Royal Holloway, University of London (32 female, 8 male; mean age = 23.27, SD = 8.13) were pseudo-randomly allocated to either ostracised or non-ostracised conditions.

Stimuli & Materials

Stimuli and tasks were presented at a resolution of 1024x768 on a 33x25cm CRT display at a viewing distance of 30 cm under computer control (Viglen DQ35JO). Stimulus presentation, randomisation of trial sequence and data acquisition were programmed using the DMDX (Forster & Forster, 2003) scripting application (see appendix 5 for the scripts used in the experiment). Presentation of the tasks in a pre-determined order was effected by a batch script. Ostracism was induced through the use of Cyberball, a bespoke application designed for this purpose (Williams, Cheung & Choi, 2000). Cognitive performance was measured by performance on the Counting Stroop (Bush et al, 1998) and the Remote Associates Task (Mednick, 1962). These tasks have previously been shown to suffer under acute physical pain (Stroop: Seminowicz et al, 2004) and recall of physical pain (RAT: Chen et al, 2008). Positive and negative affect were measured by the Positive and Negative Affect Scale (PANAS). Demographics and perceived inclusion were measured by self-report items in a questionnaire.

Cyberball

Cyberball is a computer programme designed to mimic a three way game of ball toss. Two "players" were programmed to throw the ball to the participant a set proportion of the 50 total throws (for a full description, see Williams, Cheung & Choi, 2000). In the ostracised condition, the participant received the ball once from each other player at the beginning of the game, then not at all (4% total). In the non-ostracised condition, the participant received the ball 33% of the throws, in a pseudo-random sequence determined by the Cyberball application.

Questionnaire 1

Questionnaire 1 comprised basic demographic details, measures of perceived inclusion using a visual analogue scale, reported percentage of throws received and the first ten items of the Positive and Negative Affect Scale (PANAS) scale (Watson, Tellegen & Clark, 1988).

Counting Stroop

The Counting Stroop task (Bush et al, 1998) consisted of 160 trials (80 neutral and 80 incongruent). Stimuli for each neutral trial comprised one of the words "dog", "cat", "bird" or "mouse". Stimuli for each incongruent trial comprised one of the words "one", "two", "three" or "four". In each trial, between one and four identical words appeared in separate quadrants of the screen centred upon a central fixation point. Stimuli were centred 100 pixels above or below, and 100 pixels to the left or right of the central point. Stimuli were presented for 1.5 seconds. Trial order and stimulus location were pseudo-randomly determined.

Remote Associates Task

The Remote Associates Task (RAT) was based on the task developed by Mednick (1962). Participants were presented with three practice trials before commencing the task. Trials were presented in pseudo-random order. Five word sets for each of three levels of difficulty were used. Word sets were pseudo-randomly selected from Bowden & Beeman (2003) for two of the three levels of difficulty (1 and 2). Level 1 trials were those where Bowden & Beeman (2003) reported higher than 80% success at 15 seconds presentation. Level 2 trials were those where there was lower than 20% success. Word sets for level 3 trials were pseudo-randomly selected from Smith & Blankenship (1991) and included distractor words in the presentation. For example, "wheel (*tyre*)/electric (*cord*)/high (*low*)" where the correct answer is chair.

Questionnaire 2

Questionnaire 2 comprised a question on how much the participants had thought about Cyberball during the tasks (rated on a 7 point Likert scale) and the final ten items from the PANAS scale.

Procedure

While Cyberball has been used as an ostracism manipulation in a variety of studies (e.g. Eisenberger, Lieberman & Williams, 2002; Williams, Cheung & Choi, 2000) the time course of the effect has not been measured. Oaten, Williams, Jones & Zadro (2008) report that the effect of ostracism on self-regulation can still be observed after 45 minutes in socially anxious, but not non-socially anxious individuals. However, it is not clear how long the effects of ostracism may be

expected to continue in normal participants, particularly on cognitive function as opposed to self-regulation. Consequently, in this experiment the time between the ostracism event and cognitive task was varied in order to evaluate the dynamics of any effect on the two cognitive tasks. The sequence of tasks is schematised in Fig 1. Instructions were presented to the participants on the computer screen. The tasks took approximately 20 minutes to complete. Participants were fully debriefed as to the nature of the experiment and the deception involved, prior to obtaining consent for the use of data.

The Cyberball Task

An opening screen informed participants that this was an experiment about mental visualisation. They were asked to concentrate on trying to clearly visualise the scene of the game they were playing. On receiving the ball, the participant selected the "player" they chose to pass the ball to using a mouse controlled cursor. The task was typically completed in five minutes.

The Counting Stroop Task

The participant's task was to indicate how many words were presented by keyboard button press. The task took, on average, four minutes to complete.

The Remote Associates Task

The participant was presented with a set of three words for 15 seconds and asked to type in the fourth word that connected the three presented. For example, for "cottage/swiss/cake", the answer would be "cheese". There were 15 word sets in total and the task typically took four minutes to complete.

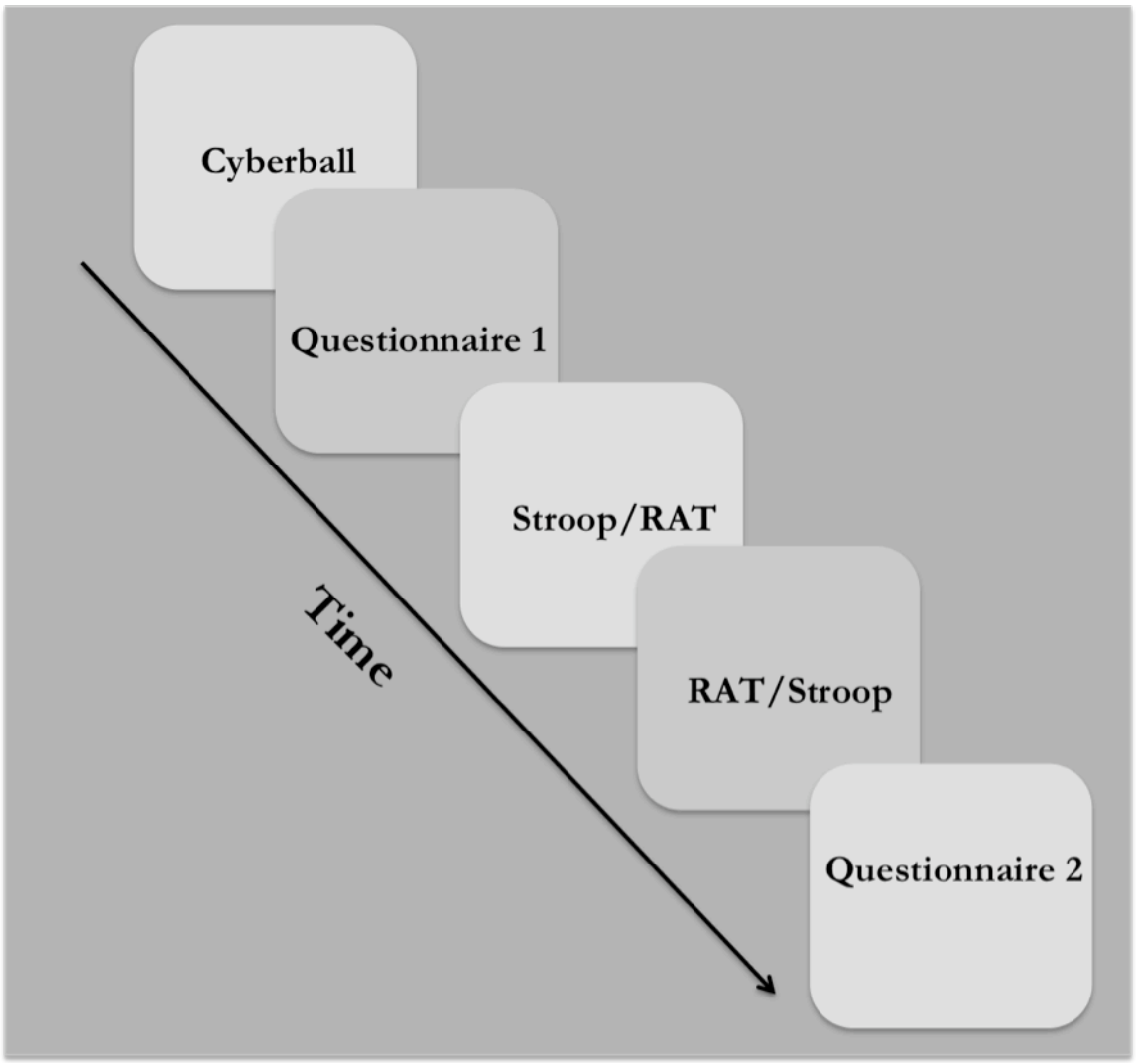


Figure 1: Schematic of experimental procedure.

Results

All parametric analyses reported here were preceded by a Kolmogorov-Smirnov test for normality that proved non-significant. The Stroop error data for one participant were discarded as an outlier, at +5.5 Z ($x = 73$, $\mu = 11.02$, $\sigma = 11.03$).

Evaluation of a Pearson's r statistic revealed a highly significant positive correlation between reaction times on neutral and incongruent trials across inclusion conditions ($r = .914$, $p<0.001$, two tailed). There was also a highly significant correlation within non-ostracised ($r = .849$, $p<0.001$, two tailed) and ostracised ($r = .982$, $p<0.001$, two tailed) conditions. Moreover, differences in reaction time between neutral and incongruent conditions were similar for both ostracised ($\mu = 28.43$, sd = 28.09) and non-ostracised ($\mu = 45.87$, sd = 42.98) groups. These mean differences were not significantly different between groups ($t(30.77) = 1.49$, $p>0.05$). For the sake of parsimony, the analyses we report here therefore takes the average reaction time index concatenated across incongruent and neutral trials.

Very few correct responses were evident in the two more cognitively demanding levels of the Remote Associates Task, (7.5% and 4%). Consequently, the analysis has been restricted to level 1.

Perceived inclusion in Cyberball

Evaluation of an independent t-statistic revealed that the non-ostracised group's ($\mu = 53.09$, $\sigma = 13.95$) self reports of perceived inclusion was significantly higher than those of the ostracised group ($\mu = 11.51$, $\sigma = 8.02$) ($t (27.15) = 10.96$, $p<0.001$, two tailed). A further independent t test revealed that participants in the ostracism

condition ($\mu = 7.45$, $\sigma = 7.26$) reported receiving a significantly lower proportion of the throws than participants in the non-ostracism condition ($\mu = 35.51$, $\sigma = 12.24$) ($t(38) = 8.82$, $p<0.001$, two tailed). Thus the results indicate that participants accurately perceived the degree to which they were included in the cyberball task.

Positive and Negative Affect

Evaluation of Spearman's R revealed a significant correlation between the subscales of the PANAS for the non-ostracised participants in Test 1 ($r_s = .464$, $N = 20$, $p<0.05$, two tailed). This finding is inconsistent with Watson et al's (1988) assertion that positive and negative affects are orthogonal. As noted by Russell & Carroll (1999), the independence of these two sub-scales is questionable. However, no significant correlation was found between sub-scales in PANAS Test 2 nor for the ostracised group in PANAS Test 1. The results for positive and negative affect are reported here discretely since further analyses revealed instructive differential effects.

Evaluation of the Mann-Whitney U statistic revealed a significant difference between non-ostracised (median = 5, range = 5) and ostracised groups (median = 7, range = 7) in negative affect in Test 1 ($U = 91.5$, $N = 38$, $p<0.005$, one tailed). There were no further significant differences between groups in either test 1 or test 2 (Fig 2).

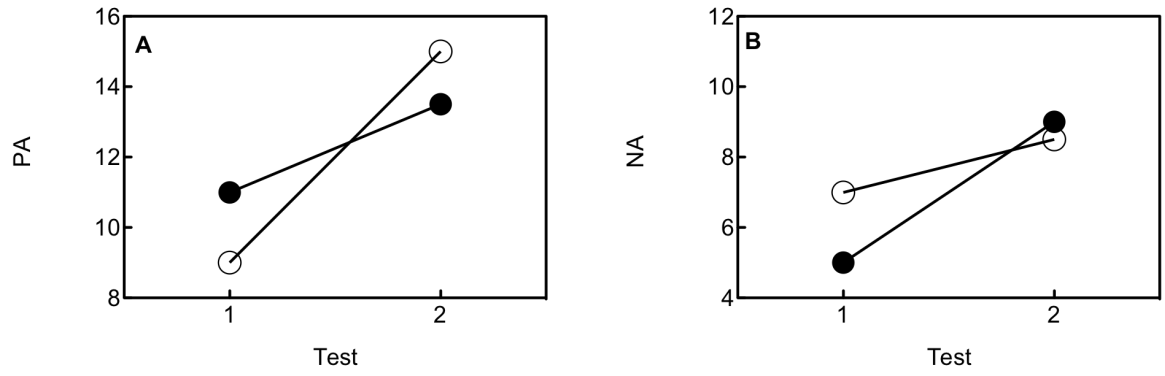


Figure 2: Median PANAS scores for non-ostracised (closed symbols) and ostracised groups (open symbols) as a function of test order. Positive and negative affect scores are represented in Panels A and B respectively.

Distraction effects

Evaluation of a Mann-Whitney U test revealed no significant difference between non-ostracised (median = 1.5, range = 5) and ostracized (median = 2, range = 6) groups in ratings of how often they had thought about Cyberball during the cognitive tests ($U = 153.5$, $N_1 = 20$, $N_2 = 20$, $p>0.05$, two tailed).

Effects on cognitive performance

Preliminary analyses revealed that the effects of ostracism were dependent on the temporal delay in exposure to cognitive tasks. We have therefore considered the effects immediately after ostracism and after a delay discretely.

The Stroop task

Interaction of ostracism status and time in the Stroop test

Two-way independent ANOVAs revealed highly significant interactions between ostracism status and cognitive task order. These interactions were found for both reaction times ($F(1, 35) = 10.536$, $p<0.005$, two tailed) and errors ($F(1,34) = 9.4$, $p<0.005$, two tailed). Thus the temporal order of the task significantly affects the

effect of ostracism status on performance. In the Stroop test immediately after Cyberball there is a significant effect of ostracism status, whereby those in the ostracism condition are slower to react and make fewer errors. In the Stroop test completed after a delay, there was no significant effect of ostracism status. This finding is in good agreement with that reported by Williams (2009), who reported a return to inclusion levels of positive and negative affect after approximately 1 minute, where no intervening task was completed.

Immediate Exposure

Mean reaction time for the non-ostracised group completing the Stroop test immediately after Cyberball was 632.27ms (sd = 60.12) and for the ostracised group was 781.68ms (sd = 115.89). An independent t-test revealed that the ostracised group's reaction times were significantly slower than the non-ostracised group ($t(18) = 3.62$, $p<0.005$, two tailed, $\delta = 1.62$). However, mean error for the non-ostracised group was 7.81% (sd = 2.61) and for the ostracised group was 3.19% (sd = 1.27). The ostracised group made significantly fewer errors than the non-ostracised group ($t(13.32) = 4.99$, $p<0.001$, two tailed, $\delta = 2.25$) (values of t and df adjusted due to a violation of the assumption of homogeneity of variance ($F = 6.96$, $p<0.05$)).

Delayed Exposure

For the non-ostracised group completing the Stroop after a 4 minute delay, mean reaction time was 646.57ms (sd = 88.77) and for the ostracised group was 615.35ms (sd = 72.41) (Fig 3a). Mean error for the non-ostracised group was 5.90% (sd = 3.71) and for the ostracised group was 6.75% (sd = 2.82) (Fig 3b). The ostracised groups mean errors are close to those reported by the non-ostracised

group in the immediate exposure condition. Therefore, the effect is entirely attributable to the immediate exposure after ostracism (see Fig 3a). Independent t-tests revealed no effect of ostracism on either reaction times ($t(17) = 0.844$, $p>0.05$, two-tailed) or errors ($t(17) = 0.564$, $p>0.05$, two tailed) in the delayed Stroop condition.

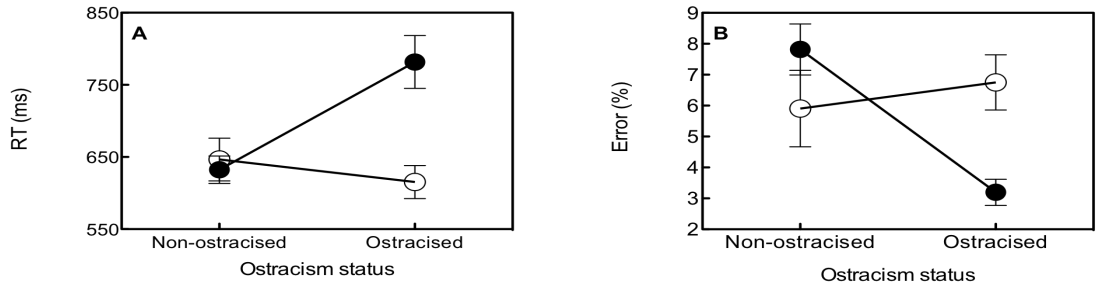


Figure 3: Panel A: Mean reaction times (ms) immediately after Cyberball (closed symbols) and after delay (open symbols) conditions as a function of ostracism status. Panel B: Mean error (%) immediately after Cyberball (closed symbols) and after delay (open symbols) as a function of ostracism status. Error bars represent ± 1 S.E.M.

The Remote Associates Task

Immediate Exposure

Mean correct responses to the Remote Associates Task for the non-ostracised group immediately after Cyberball was 50% (sd = 34.32) and for the ostracised group was 34% (sd = 32.73) ($t(18) = 1.067$, $p>0.05$, two tailed) (Fig 4).

Delayed Exposure

After a four minute delay, the mean correct responses for the non-ostracised group was 50% (sd = 28.67) and for the ostracised group was 36% (sd = 33.73) ($t(18) = 1$, $p>0.05$, two tailed) (Fig 4).

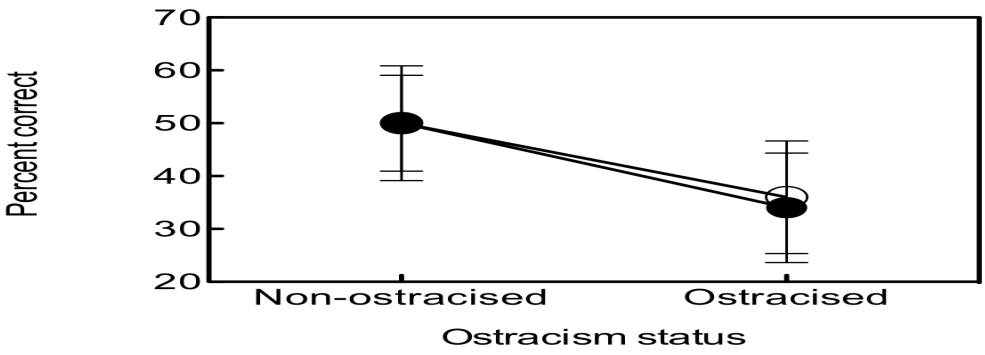


Figure 4: Mean percent correct on Remote Associates Task immediately after Cyberball (closed symbols) and after delay (open symbols) as a function of ostracism status. Error bars represent ± 1 S.E.M.

Interaction of ostracism status and time in the Remote Associates Task

A two-way independent ANOVA revealed no significant interaction between task order and ostracism status for the Remote Associates Task ($F(1,36) = 0.10$, $p>0.05$, two tailed). Data from groups completing the Remote Associates Task immediately after Cyberball and after delay were therefore concatenated. Mean correct responses for the non-ostracised group was 50% (sd = 30.78) and for the ostracised group was 35% (sd = 32.36) (Fig 5). Evaluation of an independent t-test revealed no significant difference between non-ostracised and ostracised groups in percent correct on the Remote Associates Task ($t(38) = 1.50$, $p>0.05$, two tailed).

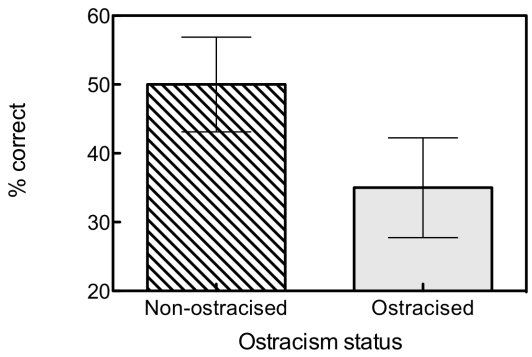


Figure 5: Performance on the RAT for non-ostracised (hatched bar) and ostracised (grey bar) conditions. Error bars represent ± 1 S.E.M.

Stratification

Amongst the explanations offered for the variety of effects of acute pain on cognitive performance is individual differences in response to pain. Indeed, it is well established that participants may be characterised as high or low pain catastrophisers in terms of physical pain and that those that are high pain catastrophisers are more likely to suffer cognitive impairment (Crombez et al, 1998). There is a number of theoretical constructs that have been proposed to explain known individual differences in social insult's effect on behavioural measures of aggression and self-regulation including rejection sensitivity (Downey & Feldman, 1996) and social anxiety (Oaten et al, 2008). However, we know of no study to date that has analysed the effect of social insult on cognitive performance as a function of individual susceptibility to social pain. One possibility is that these individual differences in susceptibility to social insult are in fact tightly linked to a common mechanism that mediates response to both physical and social injury and that may vary across individuals. We have therefore categorised participants upon the basis of their perceived inclusion in the cyberball task in order to investigate whether those individuals who perceive more social exclusion are more or less susceptible to cognitive impairment.

Participants' self-reports of perceived proportion of throws received was used as the criterion for stratification. Participants who reported receiving the ball no more than 125% of the actual proportion of balls that they received were categorised as "high responders" (ostracised group: N = 13, non-ostracised group: N = 17), those who overestimated their inclusion by more than 125% were categorised as "low responders" (ostracised group: N = 7; non-ostracised group: N = 3).

High and low responders' performance on the Stroop task.

The descriptive statistics for the non-ostracised group indicated little difference between high and low responders on either reaction time (High: μ = 645.99ms, σ = 74.03; Low: μ = 602.01ms, σ = 68.76) or errors (High: μ = 6.76%, σ = 3.24; Low: μ = 7.71%, σ = 3.82) (Fig 6a). Independent t-tests revealed no significant differences between non-ostracised high and low responders (RT: $t(17) = 0.95$, $p>0.05$, two tailed; Errors: $t(17) = 0.596$, $p>0.05$, two tailed).

Mean reaction time for the ostracised high responders was 700.47ms (sd = 153.58) and for low responders was 694.89ms (sd = 62.19). Evaluation of an independent t statistic confirmed there was no significant difference ($t(18) = 0.091$, $p>0.05$, two tailed). Mean errors for the ostracised high responders was 6.09% (sd = 2.88) and for low responders was 3.30% (sd = 1.76) (Fig 6a). This difference proved to be significant ($t(17) = 2.306$, $p<0.05$, two tailed, $\delta = 1.17$).

High and low responders' performance on the Remote Associates Task.

Mean correct responses for the non-ostracised high responders was 50.59% (sd = 28.39) and for low responders was 46.67% (sd = 50.33). This difference was not significant ($t(18) = 0.198$, $p>0.05$, two tailed) (Fig 6b). In the ostracised group, the low responders' (μ = 54.29%, sd = 27.6) performance was, on average, over twice as accurate as that of the high responders (μ = 24.61%, sd = 30.72) (Fig 6b). Evaluation of an independent t statistic revealed this difference to be significant ($t(18) = 2.13$, $p<0.05$, two tailed, $\delta = 1.02$).

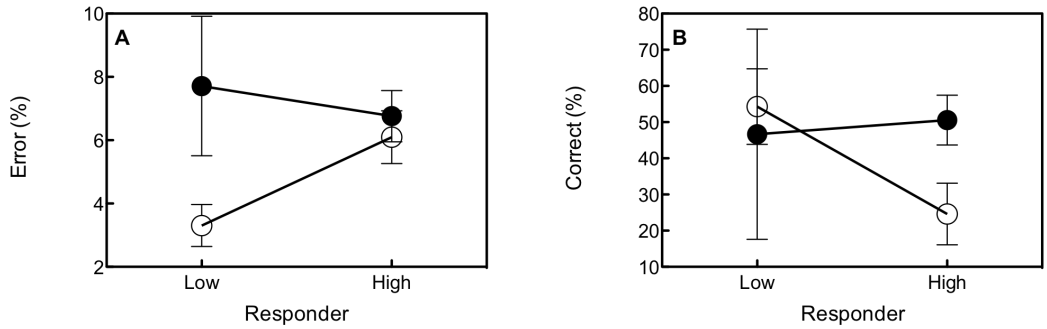


Figure 6: Panel A: Mean Stroop errors for non-ostracised (closed symbols) and ostracised (open symbols) as a function of responder. Panel B: Performance on the RAT for non-ostracised (closed symbols) and ostracised (open symbols) as a function of responder. Error bars represent ± 1 S.E.M.

High and low responders' affect scores

Affect scores on Test 1 for high (median = 7, range = 7) and low (median = 7.5, range = 7) responders in ostracised groups indicate little difference for negative affect. In the non-ostracised groups, the median negative affect scores for high (median = 5, range = 5) and low (median = 5 range = 1) responders in the non-ostracised groups are identical (Fig 7a). Positive affect was higher for low responders than high responders in both ostracised (high: median = 9, range = 6; low: median = 12, range = 12) and non-ostracised (high: median = 11, range = 15; low: median = 16, range = 7)(Fig 7b). Mann-Whitney U tests confirmed no significant difference in negative affect between high and low responders in either ostracised ($U = 25.5$, $N1 = 12$, $N2 = 6$, $p>0.05$, two tailed) or non-ostracised groups ($U = 25$, $N1 = 17$, $N2 = 3$, $p>0.05$, two-tailed). There were significant differences in positive affect for both ostracised ($U = 16.5$, $N1 = 13$, $N2 = 7$, $p<0.05$) and non-ostracised groups ($U = 7$, $N1 = 17$, $N2 = 3$, $p<0.05$, two tailed).

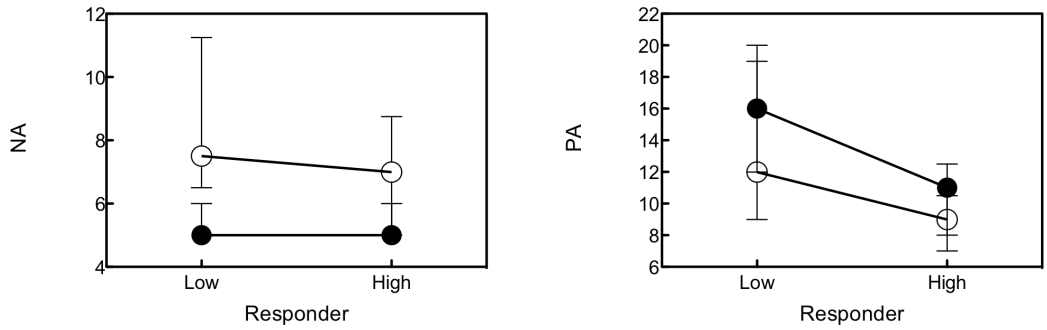


Figure 7: Panel A: Median negative affect scores for non-ostracised (closed symbols) and ostracised (open symbols) as a function of responder. Panel B: Median positive affect scores for non-ostracised (closed symbols) and ostracised (open symbols) as a function of responder. Error bars represent ± 1 S.E.M.

High responders' performance on the Remote Associates Task

Performance on the Remote Associates Task by high responders was compared across ostracism status (Fig 8). The non-ostracised group ($\mu = 50.59$, sd = 28.39) performance was significantly more accurate than the ostracised group ($\mu = 24.61$, sd = 30.72) ($t(28) = 2.40$, $p<0.025$, two tailed, $\delta = 0.88$).

No difference was found between non-ostracised ($\mu = 10.81$, sd = 5.18) and ostracised ($\mu = 9{,}75$, sd = 4.61) groups in errors on the Stroop task when only high responders were included in the analysis ($t(26) = 0.56$, $p>0.05$, two tailed).

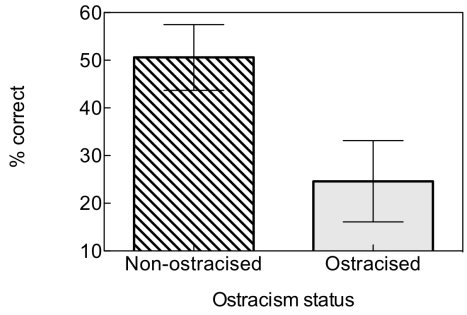


Figure 8: Performance on the RAT for non-ostracised (hatched bar) and ostracised (grey bar) high responders. Error bars represent ± 1 S.E.M.

The effect of affect on cognitive performance

It has previously been reported by both Chen et al and Baumeister et al that once affect has been accounted for, the observed differences between social insult and non-social insult groups remain significant. We have investigated whether these findings hold true with the present results using two Multivariate Analyses of Covariance (MANCOVA) that control for each level of stratification separately.

An initial MANCOVA excluded all low responders but included both immediate exposure and delayed exposure conditions. This revealed that negative affect score on Test 1 was significantly related to Stroop reaction time ($F(1, 24) = 7.549$, $p<0.025$, two tailed) but not error rate ($F(1, 24) = 0.004$, $p>0.05$, two tailed) or Remote Associates Task performance ($F(1, 24) = 0.140$, $p>0.05$, two tailed). Having partialled out negative affect variance there was no significant effect of ostracism status on either Stroop reaction time ($F (1, 24) = 0.167$, $p>0.05$) or error rate ($F (1, 24) = 0.198$, $p>0.05$, two tailed). However, there was a significant effect of ostracism status on Remote Associates Task performance ($F (1, 24) = 4.782$, $p<0.05$, two tailed).

A second MANCOVA excluded conditions where the Stroop task had been completed second, but included both high and low responders. This revealed that negative affect was significantly related to Stroop reaction time ($F (1, 14) = 22.880$, $p<0.001$, two tailed) but not error rate ($F(1, 14) = 0.308$, $p>0.05$, two tailed) or Remote Associates Task performance ($F(1, 14) = 0.038$, $p>0.05$, two tailed). With the negative affect variance partialled out, there was no significant effect of ostracism status on Stroop reaction time ($F(1, 14) = 0.007$, $p>0.05$, two tailed) or

Remote Associates Task performance ($F(1, 14) = 0.176$, $p>0.05$, two tailed). There was a significant effect on Stroop error rate ($F(1, 14) = 11.73$, $p<0.005$, two tailed).

These results indicate that negative affect accounts for much of the difference in Stroop reaction time between ostracised and non-ostracised conditions (both when the effect is at its strongest and when both are combined), but not error rate. The differences between high responding ostracised and non-ostracised groups recorded in Remote Associates Task performance are similarly unaffected by affect score.

1/f noise

High frequency noise in the data was firstly attenuated by a first order differential low pass filter with a cut off frequency of 120 cycles (2 trials). The filter removed artifactual frequencies above the Nyquist frequency and smoothed the signal. Power Spectral Densities of the reaction time data for each participant were estimated using the periodogram method and a rectangular window implemented in a bespoke function within the Matlab environment (Release 2009a; Mathworks inc: Mass.). The code may be found in Appendix B. The power from each participant's data was then normalized with respect to their maximum power, the first three points excluded and the subsequent power spectra examined for evidence of a 1/f slope (a gradient of -1) on log-log axes. The average normalised power of participants within each group indicates very little difference between the slopes (Fig 9, panel A & B). A t-test revealed no significant difference between the slopes of ostracised and non-ostracised participants ($t(17) = 0.74$, $p>0.05$, two tailed).

While there was no difference in gradient between ostracised and non-ostracised participants who performed the Stroop task first, the difference between ostracised Stroop first and Stroop second participants was similarly examined, to determine whether the shift away from difference from the non-ostracised participants observed in the data could be explained by a shift in the gradient of the slope in task order. Again, the averaged power spectra (Fig 9, panel A & C) indicate little difference in the gradient of the slope between ostracised participants who completed the Stroop task first and those who performed the task second ($t(17) = 1.01$, $p>0.05$, two tailed)

The combined (Stroop first and Stroop second) average power for ostracised and non-ostracised participants reveal no significant difference between groups ($t(35) = 0.25$, $p>0.05$, two tailed) (Fig 10). The gradient of the best-fit power slope for both ostracised and non-ostracised participants was significantly different from 0 (ostracised: $t(18) = 7.09$, $p<0.001$; non-ostracised: $t(17) = 17.27$, $p<0.001$) The data indicate that a 1/f slope is present in the Stroop reaction time data, as previously reported by Correll (2008). However, ostracism does not appear to affect the gradient of the slope.

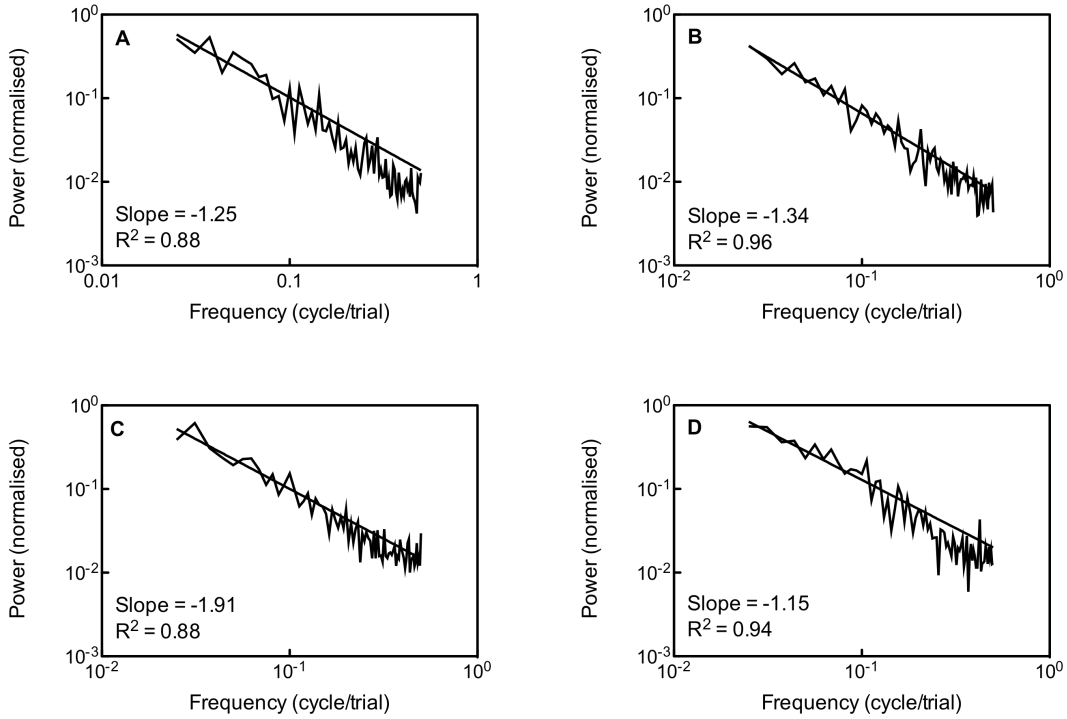


Figure 9: Normalised and averaged power spectra for ostracised, Stroop first (panel A), included, Stroop first (panel B), ostracised, Stroop second (panel C) and included, Stroop second (panel D).

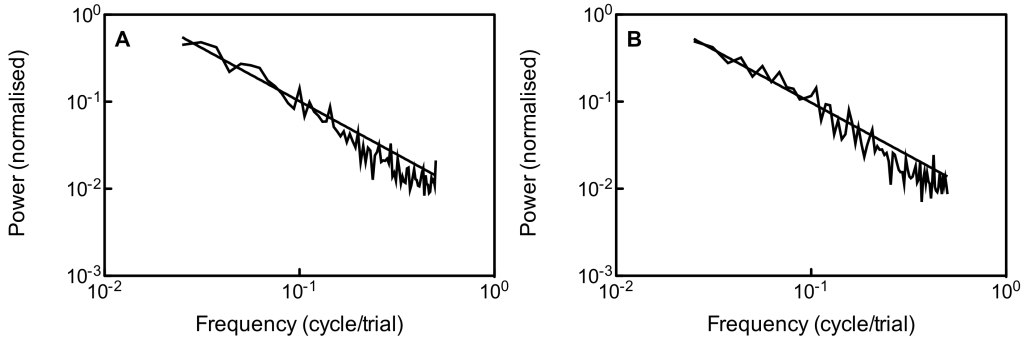


Figure 10: Normalised power spectra for all ostracized (panel A) and all included (panel B) participants.

Discussion

A number of characteristics of ostracism's effect upon cognitive performance are evident. Firstly, whilst those who experience ostracism are slower to perform the relatively undemanding Stroop task, the accuracy of their responses is better than those who do not experience ostracism. However these effects of ostracism are effectively abolished after no more than four minutes. The order of presentation of the Stroop task has a clear bearing on performance after ostracism. Performance on the more cognitively demanding RAT is however impeded regardless of presentation order. This absence of any order effect on performance of the more demanding task is suggestive of a scheme whereby ostracism has short-lived effects on certain cognitive tasks and rather more durable effects on others.

These findings suggest that susceptibility to ostracism's effects is heterogeneous with respect to both individual and cognitive load. At least two strata may be identified that may be characterised by high- and low- susceptibility to ostracism upon the basis of their perceived inclusion in the ostracising situation. Within this sample, 35% of those who experienced ostracism overestimated the degree to which they had been included in the social task. Immediately after experiencing ostracism, these participants reported significantly higher positive affect than those who more accurately reported their degree of social inclusion. Those who more accurately reported the extent of their ostracism and harboured lower positive affect gave significantly fewer correct responses to the high cognitive load task than non-ostracised participants. No such difference between and high- and low-responders to ostracism was found for the less demanding task. Thus the effect of ostracism is bifurcated with respect to cognitive load and susceptibility to ostracism: Relatively trivial tasks reveal a reduction in response time but no

detrimental effect upon accuracy whereas more demanding tasks are performed significantly more poorly by the stratum of ostracised participants who accurately report their social inclusion. Thus a picture is emerging whereby the effect of ostracism may be stratified both in terms of an individual's susceptibility and in terms of the susceptibility of differing cognitive tasks.

These findings bear similarity to those of Chen et al (2008) and Baumeister et al (2003), but there are also interesting differences. The increase in Stroop reaction time reported here mirrors that reported by Chen et al, despite the different versions of the test employed. The decrease in errors for the Stroop task, however, is not shown in the Chen study. One possibility is that the relatively low ostracised error rate found here is due to the concomitantly elevated response time. Those participants who take longer to respond also have longer to reflect upon the problem and may therefore be more likely to respond correctly: A perennial danger of using reaction time to assess cognitive function. Indeed, the increase in reaction time and accuracy for ostracised participants reported here is not dissimilar to the pattern of results found in anxious individuals. Eysenck, Derekshan, Santos & Calvo, (2007) report that anxiety can increase an individual's focus on dominant thoughts, leading to deficits in reaction time. However, the lack of any significant difference between ostracized and non-ostracised participants in self report of thinking about Cyberball suggests that such a focus, at least on thinking about the game, was not evident in these participants. The similarities in reported findings may, then, have other sources.

Direct comparison of these results and those of Chen et al is impeded by methodological differences. Firstly, Chen et al did not use a control group. Their results pertain to differences in performance between those who experienced

physical and social pain. Secondly, they employed only two difficulty levels compared to the three in the Remote Associates Task here. The failure to replicate the interaction between difficulty levels and ostracism reported by Chen et al is due to the very high failure rate in the two higher difficulty levels (>92%) which rendered any interaction intractable. Whilst the reasons for this are unclear, sampling bias appears the most likely explanation. The large standard deviations recorded for both non-ostracised and ostracised participants in RAT performance also indicate a wide variation within the sample in ability to complete this task, typically with one or two participants performing well and the majority performing very poorly. However, the results for the less demanding RAT level are qualitatively similar to those of Chen et al.

The presence of 1/f noise in the Stroop reaction time data is in agreement with the reported findings of Correll (2008). However, there was no alteration of gradient between ostracized and non-ostracised participants, or any change over time from the ostracism manipulation. Correll (2008) reported that increases in task difficulty should lead to changes in gradient in the power slope, and so the lack of any change suggests that the experience of ostracism does not increase the difficulty of the task. This may be contrary to expectations, but one possible reason may be that pink noise present in the Stroop task is harder to overwhelm with white noise than that evidenced in the prejudice task employed by Correll (2008).

In summary, the results show that ostracism has a detrimental effect on cognitive performance, but only for certain individuals and certain tasks. Those who accurately assess the degree to which they are ostracised tend to perform more poorly on relatively demanding cognitive tasks and the magnitude of this effect is stable for at least eight minutes. Ostracism's effect on the less demanding task was

short-lived and can be accounted for by the well- documented effect of negative affect on reaction times (Hale & Strickland, 1974). However, further analyses demonstrate that the poor performance on the more demanding task cannot be similarly explained by levels of negative affect. When the level of an individual's mood is accounted for, those who are ostracised still perform significantly worse on the high cognitive load task. Thus it appears that ostracism's effect is not limited to a general depression of mood but has a specific, more direct influence on cognitive function. The finding that there is no significant difference in performance on the low-demand Stroop task between high and low ostracism responders indicates that this ostracism-specific effect is only evident in relatively high-load tasks. How can these complex interactions of susceptibility of individual and task be accounted for? Some vital clues as to the source of these effects may lie in recent imaging studies.

Whilst the neural substrate of ostracism and its effect is currently speculative, encouraging parallels have recently begun to emerge between the behavioural and neural response to pain that may lend a clue to the individual and task dependent response to ostracism demonstrated here. Certain individuals', ('high pain catastrophizers') experience of pain is attended by self-reports of higher cognitive focus on the physical locus and experience of pain (e.g. Sullivan, 1995) and these high pain catastrophizers exhibit higher levels of fMRI BOLD response to physical pain in both the dorsal Anterior Cingulate Cortex (dACC) and the right ventral Pre-Frontal Cortex (rvPFC) (Gracely, Geisser, Giesecke, Grant, Petzke, Williams & Clauw, 2004). Similarly, Eisenberger et al (2003) have reported individual differences in the rvPFC BOLD response to ostracism. Thus one possibility that arises is that the individual differences we report here may be mediated by

individual differences in rvPFC activation, an area that is known to be active during performance of the Remote Associates Task (e.g. Razumnikova, 2007; Cerruti & Schlaug, 2008) but does not affect reaction times to the Stroop task following lesion (Vendrell, Junque, Pujol, Jurado, Molet & Grafman, 1995).

These recent findings provide intriguing, albeit speculative, parallels between individual differences in cortical activity and the individual differences in response to ostracism that we report here. The individual differences themselves may also go some way towards resolving the large discrepancies in the reported effects of social exclusion or ostracism on subsequent behavioural measures (see e.g. Warburton, Williams & Cairns, 2006; Williams & Sommer, 1997; Twenge, Baumeister, Tice & Stucke, 2001; Twenge, Baumeister, DeWall, Ciarocco & Bartels, 2002). Whilst a number of social-cognitive theories (e.g. Williams, 2009; Richman & Leary, 2009) has been proposed to address the variety of ways in which ostracism's effect has been reported to differ, a neuroscientific approach to the individual differences in human and task susceptibility to ostracism that we find may provide further clues to the nature of ostracism and its varying effects. Indeed, some social-cognitive theories (e.g. the proposal that failure to "self-regulate" underlies the deleterious effects of ostracism (Baumeister, DeWall, Ciarocco & Twenge, 2005)) are resonant with the suggestion that the rvPFC regulates dACC activity and thus distress (Eisenberger et al, 2003; Petrovic et al, 2002; see also Bishop's (2009) finding that high trait anxiety yields reduced activity in dorso-lateral PFC). The potential for neuroscience and social-cognitive psychology to combine in this way to address these questions represents a powerful and flexible method to approach the problem in future.

In conclusion, the pattern of results reported here is similar to those previously reported for the effects of predicted or recalled social exclusion on cognitive function. They are also very similar to many of the reported effects of physical pain on cognition. Thus a picture is emerging whereby social (and physical) insult leads to a reduction in cognitive function, though with complex interactions between individuals' perception of inclusion and the cognitive load of a particular task. While there are manifold differences in the experience and consequences of physical and social pain, current evidence points, albeit tentatively, towards a shared neural substrate. An approach which encompasses both social-cognitive psychology and neuroscience may enable better identification of high and low responders to ostracism through a variety of measures, and enhance our understanding of individual and situational differences in behavioural response to ostracism.

Chapter 8 - Discussion

One of the most important findings of this thesis is that it is becoming apparent that the articulation of a broad range of theoretical and methodological perspectives may prove critical to a fuller characterization of ostracism and its behavioural sequala. While much progress has been made in the social psychological literature, fundamental empirical discrepancies remain. Particularly salient in this regard are the apparently contradictory findings of Williams and co-workers, who report increased conformity and pro-social behaviour in response to ostracism, and Baumeister and co-workers, who conversely report aggression and inability to self-regulate. Not only has the impact of ostracism been found to vary across these research groups' respective methodologies but the current results suggest that the effect of ostracism may also vary between individuals (Chapter 1, 6 & 7) and between on- and off- line settings (Chapters 1 & 5) within the same methodology.

The reasons for the differences in outcome behaviour between the two groups of researchers are unclear, but the main source could plausibly be the nature of their respective methods. The different methods of inducing ostracism may produce differences produce slightly different experiences and expectations, and therefore responses, in participants. For example, Williams' method of Cyberball produces a more immediate exposure to ostracism, both in temporal and personal terms. Baumeister's method of manipulating personality test results to inform people they will be alone in future life not only places the ostracism at some point in the future, rather than the immediate exposure provided by Williams' method, but is also posited to be by a number of people, that the participants may not yet know. In Williams' method, there are only two other players and are currently playing the

game. While the direct action of this upon response is unclear, there may be an argument that in Williams' case, the participant feels closer to the group, and may therefore feel more inclined to attempt to rejoin the group, and therefore behave in a more pro-social manner. In Baumeister's case, as the ostracism is based in the future, the participant may therefore feel no compunction to ingratiate themselves with the current group of people they find themselves with in the experimental situation, and thus behave in a more aggressive or anti-social manner.

Possible explanations for individual differences in the effect of ostracism range from traditional social psychological mechanisms such as differences in perceived threat to self and esteem to differences in neuro-endocrinology, e.g. levels of progesterone or cortisol post-ostracism. Similarly, sources of differences between face-to-face and CMC communication range from social psychological theories, such as de-individuation or anonymity effects (Chapter 5) to differences in cyclicity and engagement of physiological mechanisms in such communication (Chapter 4). A pivotal future challenge is to elucidate the potential relations, impact and mediatory mechanisms that serve to articulate social psychological phenomena, such as group membership or identity and the neural mechanisms that may form the bases of individual response to identity threat and ostracism. As such, the eclectic approach of methods and theoretical grounding evidenced within this thesis may represent a necessary future direction for such research.

This combined approach has produced a number of important and novel findings here. A qualitative overview of group behaviour in pre-existing Internet chat rooms (Chapter 3) revealed that many of the group behaviours previously reported in face-to-face groups were also present in these on-line groups (e.g. status hierarchies, normative behaviour, ostracism), suggesting that this shift in

communication medium had little impact on the social structures of groups. While there may be subtle differences in the way that these behaviours are expressed (e.g. status cues based on technical knowledge, listing norms before entering the group) or the impact they have on their members (e.g. reduced effects of ostracism and virtual bravado) the fundamental behaviours were typical of those found in off-line communication (e.g. Turner, Brown & Tajfel 1979; Brown, 2000). Thus, the structure and types of group behaviour do not appear to fundamentally vary between on- and off- line settings. However, there are clearly further differences between on and offline communication and the potential impact of these upon group behaviour must be taken into account. For example, nonverbal behaviour and paralanguage may play a large role in face-to-face communication (e.g. Argyle, 1988; Duncan, 1972) which cannot be replicated in online communication. The use of emoticons addresses this issue to a certain extent, (e.g. Lea & Spears, 1992) but it is arguable whether the richness of physical nonverbal behaviour is achieved. Conseqeuntly, the similarites observed in chapter 3 indicate that group behaviours present in these two methods of communication map well onto each other, but in a wider context the impact of these, and other differences on comparisons between on- and off- line group behaviour is an area still to be fully explored.

Consideration of examples of identity management in these chat rooms (Chapter 3) was also revealing. The importance of a particular screen identity to individuals was clear from the data, as evidenced by the negative reactions to identity theft. However, many discussants used alternate identities to represent different aspects of their character, indicating that identity could be presented in a more fluid way than may be possible in off-line communication. The implications for this

increased fluidity on response to a threat to self such as ostracism, have yet to be established. However, if the protective effects of multiple identities (Chapter 2) are effective in CMC, it may be the case that this, rather than outright anonymity (Chapter 5), underlies the reduction in aversive effect of ostracism in CMC (Chapters 1 & 5).

Quantitative analysis of the same internet groups (Chapter 4) revealed that the frequency of particular behaviours was similar across groups in most aspects. Analysis of interactions between number of comments, identity change and ostracism events indicate significant correlations between these variables. The number of identity changes was negatively correlated with the number of comments, suggesting that perhaps those rooms with more comments tended towards more stable use of identity. Similarly, a significant positive correlation between ostracism and number of comments suggests that as the number of comments increased, a more stable group became less tolerant of outsiders and increased its rate of ostracism. The exponential relationships between these variables indicate that there is not only a linear relationship between each pair of variables, but that the rate of decrease in identity change and the rate of increase in ostracism decreased as a function of number of comments. Thus, it would appear that lawful behaviour regarding the frequency and relationships between events can be drawn from the discussions recorded.

While the emergence of lawful behaviour in online chat rooms with respect to different event types is an interesting and novel finding, the discovery of underlying structure in the most basic unit, the simple number of comments, is much more revealing. The finding that online groups show temporal structure in their patterns of communication (chapter 4) has never previously been reported in

the literature. Arguably more important than the existence of such structure is that the structure bears striking similarity to that reported in a range of natural events, with a 1/f frequency distribution in the power spectrum. This finding suggests that while computer-mediated communication may appear free-flowing, particularly in chat rooms, there is underlying and fundamental structure to the act of social communication. The further finding in chapter 7, that 1/f noise is also present in the Stroop reaction times has previously been reported by Correll (2008). However, while on this occasion there was no gradient change in the slope between ostracized and non-ostracised participants, such research opens up the possibility of considering slope to reveal differences between cognitive load in future experimentation.

While social psychology has provided a number of explanations for the group behaviour and the effects of ostracism, the differences in the outcome of ostracism between face-to-face and online contexts (see Chapter 5) have not, as yet, proven accountable within the paradigm. While anonymity has been put forward as a fundamental difference between these media of communication (e.g. McKenna & Bargh, 2000), the current results indicate that there is no significant effect of manipulating levels of anonymity on either affective response to ostracism or number of comments made by those ostracised. However, negative affect was significantly lower than non-ostracised participants and the number of comments made by ostracized participants was higher than that reported in Williams et al's (2002) face-to-face ostracism. Thus it appears that ostracism, while still used in chat rooms and noticed by targets (see Chapter 3 and Rintel & Pittam, 1997), is less aversive in an online setting than a face-to-face setting.

In summary, social psychology has provided us with a range of reported effects of ostracism (e.g. aggression, increased conformity, increased desire for control, reduced cognitive ability, increased passivity and reduced persistence on difficult/unpleasant tasks). However, by remaining within a strict traditional social psychology paradigm, the nature of ostracism, and therefore our understanding of its effects, remains highly constrained by the measures used both to induce ostracism and to measure its effects on the target. The potential for establishing a neural basis for these effects (see chapter 6) raises the possibility of articulating social psychological constructs with neural and endocrinological models of the mechanisms that may underlie the behavioural outcomes of ostracism. Such an approach may also allow for the existing contradictions within the social psychological literature to be at least partially resolved. For example, Baumeister and co-workers argue that the underlying feature of their observed effects of exclusion (such as aggression) is in fact a self-regulatory failure (see chapter 1). The rvPFC has previously been linked with the self-regulation of emotion and pain and the reduction of self-reported distress in ostracism (chapter 7). Thus, Baumeister's proposal, based on the social psychological construct of "self-regulation", may be supported by imaging studies which indicate that a particular brain region may firstly, be engaged in such activities, and secondly, that differences in activation in this area are correlated with different responses to exclusion. Such a study may prove technically challenging, as the pre-frontal cortex is implicated in a range of behaviours which may not necessarily be involved exclusively in emotional regulation. However, with careful control and a range of stimuli, it may be plausible to disambiguate patterns of activity in the critical areas. Additionally, the similarities between Baumeister's description of an

excluded individual, desiring social connections, but with very anxious avoidant behaviour due to fear of rejection, and the threat-defence model's description of the effects of high defensive distance leading to anxious approach behaviour suggest that Baumeister's approach may draw support from physiology, rather than that of Williams. However, Williams' model can be linked to the relationship between cortisol and self-esteem (Ford & Collins, 2010). It would appear that physiology and the neural bases of the ostracism response may successfully differentiate between the two main social psychological theories, but that elements of both are likely to be required for a fuller characterization of ostracism's behavioural effects.

The emerging link between ostracism and physical pain (chapter 6) is not only intuitively appealing, given the personal reports of targets of ostracism (e.g. Williams et al, 2000), but also provides us with a comparator with which to test our effects. The combination of social psychological with psychophysical or imaging techniques provides the opportunity for a complete and rounded understanding of ostracism, from the neural level to observable behaviour and emotional report.

The finding that ostracism reduces cognitive ability (see chapter 7 and Baumeister, Twenge & Nuss, 2002), as does physical pain, lends considerable credence to a social-physical pain model that has previously been suggested in the guise of Eisenberger et al's (2003) pain-overlap model and MacDonald and Leary's (2005) social pain model. While this similarity between social and physical pain may prove very valuable, at the current time there are still many possible interpretations of the mechanisms in action. It may be the case that the effect is caused by a shared neural system, as proposed both here and in Eisenberger et al (2003), but there are other possible confounding variables that need to be explored in further experiments. For example, the effect of distraction may not be related to the same

neural structures, but may also be implicated in a reduction in cognitive performance. While this was not evident in the experiment reported in chapter 7, more precise measurements of such phenomena and further comparison of the effects of physical and social pain on a range of outcome measures may serve to disambiguate these possibilities. The present results indicate that ostracized participants recorded longer response times on the Counting Stroop task (Bush et al, 2002) but significantly fewer errors than non-ostracised participants. However, this effect of ostracism on Stroop performance was extinguished within 4 minutes. The difference between ostracized and non-ostracised participants in performance on the Remote Associates Task (Mednick, 1962) revealed an interesting pattern of results. There was a clear stratification within the participant sample, such that 35% of those ostracised overestimated the percentage of throws they had received by 125% or more whilst 65% of those ostracized estimated their inclusion near veridically. Thus the sample appears to be stratified such that some individuals either overestimated their inclusion or underestimated the extent to which they were ostracized whilst others accurately reported their experience of ostracism. This stratification is mirrored in participants performance on the RAT. Those that overestimated their inclusion during ostracism performed at a similar level to non-ostracised participants on the RAT. However, those participants who accurately estimated their experience of ostracism performed significantly worse than non-ostracised participants on the RAT.

This stratification within the participant group in how they responded to ostracism is also very instructive – similar stratification has previously been reported in the ostracism literature, such as the effects of rejection sensitivity (Downey & Feldman, 1996) on aggressive response to exclusion. Ayduk, Gyurak & Luersson,

(2007) report that individuals high in rejection sensitivity assigned more hot sauce to the source of exclusion (who was known to dislike spicy food) than low rejection sensitivity individuals. Similarly, within the pain literature, Sullivan, Bishop & Pivik, (1995) reported that certain individuals report higher intensity of pain than others and focus more on their pain, a phenomenon they termed "pain catastrophisation". Gracely et al (2004) report higher activation of the dACC (the same region reported to be activated in ostracism by Eisenberger et al, 2003) in fibromyalgia patients who scored above the median score on a pain catastrophisation scale. Moreover, Scott, Stohler, Egnatuk, Wang, Koeppe & Zubieta (2007) report a correlation between high activation in the nucleus accumbens (NAC) and increased placebo response, indicating individual differences in affective pain response.

The experiments reported here have covered a wide range of theoretical backgrounds and techniques. While the link between physical and social pain that emerges from both previous research and the experiment reported in chapter 7 here, it is clear that it is still far too early to assert such a link with complete confidence. As such, the work presented here is necessarily speculative at times, but represents a first step towards resolving some of these issues. Further research through a combination of different approaches may help to consolidate the relationship between physical and social pain and the neural systems that may underlie these experiences.

Future research

The understanding of the stratification of response to ostracism and its relationship with pain may prove critical for the advancement of our understanding of ostracism itself. Experiments into the effects of ostracism cannot be fully controlled until any stratification of participant samples can be accounted for within the design, or removed altogether through screening. There are several potential methods for developing such an understanding or screening method, four promising possibilities are outlined below.

Firstly, straightforward extant behavioural measures may constitute viable candidates for predicting social pain response. The Pain Catastrophisation Scale (Sullivan et al, 1995) has been developed to identify individuals who may experience higher intensity of pain than average. If, as proposed (chapters 6 & 7), the mechanisms underlying physical and social pain are shared, then it appears reasonable to argue that the stratification in response to pain may also be shared. Therefore, those who score highly on the PCS may also catastrophize social pain and respond more strongly to a socially painful stimulus, such as ostracism. Further extant measures from social and personality psychology may also be compared to predict social pain response. For example, Downey & Feldman (1996) have produced the Rejection Sensitivity Questionnaire (RSQ) which has been used in a variety of experiments (e.g. Ayduk, Downey & Kim, 2001; Downey, Feldman & Ayduk, 2005). This scale is based on attachment theory and the effect of early rejection on cognitive-affective processing and as such it may prove an interesting comparison for a scale based on physical pain, such as the PCS. Personality dimensions, such as neuroticism, may also provide further

sources for predicting social pain response. For example, it is plausible that participants who score highly in neuroticism would also experience higher levels of social pain. An initial experiment may look to establish whether any of these extant, paper and pen scales successfully predict the response to social pain, and whether any of these confer any advantage in either resolution or reliability.

Secondly, Eisenberger et al (2003) have demonstrated that high levels of activation in the right ventral PFC (rvPFC) are correlated with lower self-report of distress subsequent to ostracism. The present results indicate that Remote Associates Task performance after ostracism is also correlated with affective self-report (see chapter 7). Thus the possibility emerges that recording rvPFC activation levels during an ostracism event should allow one to predict subsequent performance on the RAT. However, this is not the only way in which the strength of the ostracism response may be predicted.

Thirdly, a direct overlap between the brain regions associated with the affective (but not sensory) component of physical pain and social pain is not necessarily the only connection between these two events. Indeed the connections between research findings in relation to various areas of the brain in this area are ever growing (for a schematisation of the key points, see fig 1).

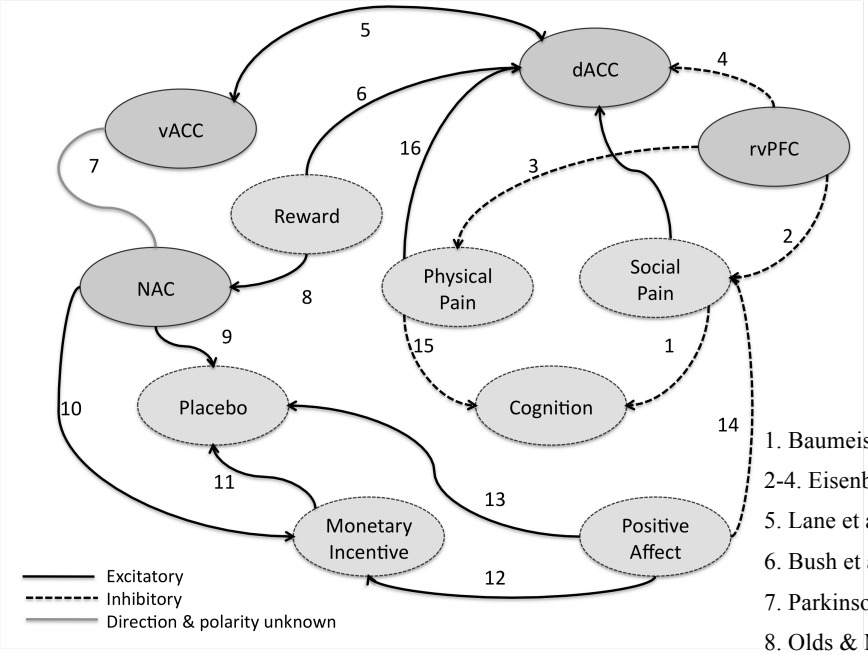


Figure 1: Schematisation of the key overlap areas between physical and social pain research.

Izuma, Saito & Sadato (2008) report that anticipation of monetary and social reward appear to share at least part of the same neural substrate. FMRI imaging of the striatum during exposure to monetary reward task compared to a social reward task (where participants were shown pictures of themselves with positive descriptors, e.g. trustworthy) revealed that the bilateral caudate nucleus and the bilateral putamen during both tasks. The nucleus accumbens (NAC) is a part of the reward system (Schultz, 2006) and forms part of the ventral striatum, connected to both the caudate and putamen regions. The NAC has been linked with a variety of behaviours, such as addiction (Di Chiara, Bassareo, Fenu, De Luca, Spina, Cadoni, Acquas, Carboni, Valentini & Lecca, 2004) or Pavlovian learning (Kelley, Smith-Roe & Holahan, 1997) but most interestingly from the pain perspective, the

placebo effect. Scott et al (2007) firstly reported that the NAC showed higher levels of activation in participants who reported greater efficacy of a placebo in response to pain. They subsequently presented participants with the Monetary Incentive Delay (MID; Knutson, Westdorp, Kaiser & Hommer, 2000) task. This task requires participants to press a button at the cued time in order to either win a sum of money shown on screen or to avoid losing that amount of money. Scott et al reported that individuals who show increased BOLD response in the nucleus accumbens (NAC) when presented with higher amounts of money in the task were those who also reported greater efficacy of a placebo in response to pain. In terms of the social and physical pain link, it would seem reasonable to consider the possibility that those who respond to the MID and placebo in this way may also respond less strongly to social injury. To speculate, one could argue that perhaps these participants are more able to protect themselves through framing the situation in a more pleasant manner (such as overestimating the number of throws received): could these be considered as social placebos? In light of this research, the third potential method to predict ostracism response would be NAC response to monetary reward.

Finally, in terms of developing a screening task for social pain response, NAC activation levels in response to the monetary incentive delay task is of little practical use, as neural activation levels (as measured by the BOLD response) to reward need to be measured. However, certain gambling tasks may be more amenable to pen and paper or computer based presentation, which are of much more practical value. Although both the monetary incentive delay task and gambling share a monetary reward component, a clear relationship between the two has yet to be defined. However, individuals who showed high activation in the

NAC in Scott et al's (2007) study also reported higher positive affect, as measured by the PANAS. Individuals with high positive affect have previously been shown to be more risk aversive, at least in situations where the risk of losing is relatively high (e.g. Isen & Patrick, 1983; Isen & Geva, 1987; Isen, Pratkanis, Slovic & Slovic, 1984). Therefore, one might reasonably expect that participants who show high activation in the NAC in response to the MID task will also make less risky choices on a gambling task. If the arguments relating to the NAC, placebo and the social pain response hold, then these individuals may also show reduced effects of social pain.

Thus, four different possible methods of predicting social pain reaction and its behavioural outcomes are emerging: the Pain Catastrophizing Scale (Sullivan et al, 1995); rvPFC activation (as indicated by Eisenberger et al, 2003); NAC activation in response to the monetary incentive delay task (Scott et al, 2007) and risk taking decisions in a gambling task (Isen et al, 1984). Future research may be undertaken to assess one or more of these to determine whether they may prove useful indicators.

In summary, the combination of social psychological and neuroscientific literature and approaches has proved more fruitful than either alone. While social psychology has revealed patterns of behaviours and responses to ostracism, the underlying mechanisms remain unclear. A consideration of two different settings for ostracism, online and offline, reveal that, while group behaviour shares many of the same features, ostracism is experienced rather differently between the two. This difference does not appear to be caused by one of the key difference betweem settings – anonymity. However, by moving to a neuroscientific approach, it becomes possible to represent and understand the nature of ostracism in a more

consistent and objective manner. In so doing, the individual differences in response to ostracism may be better understood and predicted, along with the potential impact of situational factors, such as setting, on such responses. This consistency of approach may help to further our understanding of both the nature and consequences of ostracism.

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Appendix 1: Chat room transcriptions

Appendix 1a:

[13:58] -sade18f:#australia- click the boxes then seen my pic _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken

[13:58] -sade18f:#australia- click the boxes then seen my pic _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken

[13:58] -sade18f:#australia- click the boxes then seen my pic _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken

[13:58] -sade18f:#australia- click the boxes then seen my pic _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken _8,8#duken

[13:58] *** sade18f was kicked by cruizer (stop repeating_)

[13:59] <HuGGyBeaR> prick

[13:59] <HuGGyBeaR> grr

[13:59] <F|ash> im going to that channel to spam our channel

[13:59] <HuGGyBeaR> lol

[13:59] <HuGGyBeaR> naaaa dont do

[13:59] <HuGGyBeaR> that

[13:59] <bellj> _9,4T_13,8a_9,12k_7,2e_9,8 C_11,4a_8,7r_0,4e_0,0..___13*_4<_6:_12))__

[13:59] *** bellj was kicked by cruizer (Please do not use colours on this channel _(Auto Kick)__)

[13:59] *** bellj has joined #australia

[13:59] <F|ash> i did!

[14:00] <F|ash> lol

[14:00] <HuGGyBeaR> heh

[14:00] <HuGGyBeaR> norty

[14:00] <F|ash> im as bad as them :p

[14:00] <imran> hi

[14:00] <HuGGyBeaR> yes you are

[14:00] <SEBA-> hi irman

[14:00] <SEBA-> hi imran

[14:00] <HuGGyBeaR> you will get k-lined for ads :P

Appendix 1b

[16:40] <Shadow^T> wow... I thought you guys usually reserved that stuff for op/voice chat..
[16:40] <Kitten‘> lol
[16:41] <Kitten‘> Shadow^T Nothing wrong with haveing clean Fun
[16:41] <Chaplain> Shadow^T LOL Maybe they want all of us little people to know that they are humans just like us
[16:41] <Shadow^T> yeah, that’s right, and when it gets clean, let me know.:)

Appendix 1c

[15:50] *** QuinnM was kicked by CLEE-Ohh (traditionalist? welcome to the future!!_)
[15:50] <Luminous> agternoon peeps
[15:50] <QuinnM> oi !
[15:50] <QuinnM> for what ??
[15:50] <twiglet> agternoon
[15:50] <twiglet> thats a new one
[15:50] <bl|nk> Safire: That was rather mean :)
[15:51] <Luminous> doh
[15:51] <QuinnM> yeah !
[15:51] <twiglet> lol
[15:51] <Luminous> cant type 2day
[15:51] <CLEE-Ohh> just be nice now ok?
[15:51] <QuinnM> I am nice !
[15:51] <bl|nk> hehe
[15:51] <CLEE-Ohh> i’ll be da judge of that...
[15:51] <im_bored> im bored
[15:51] <bl|nk> QuinnM: Your an MSP
[15:51] <QuinnM> cleeoh
[15:51] <QuinnM> im being attacked by blink
[15:51] <CLEE-Ohh> QuinnM
[15:51] <QuinnM> so why dony u do anything ?
[15:52] <CLEE-Ohh> i dont see him attacking you
[15:52] <QuinnM> MSP ?
[15:52] <bl|nk> Dont mess with clee
[15:52] <QuinnM> see...

[15:52] <QuinnM> u just pick on me
[15:52] <bl|nk> Male Shovenistic pig
[15:52] <CLEE-Ohh> heh
[15:52] <QuinnM> there u go
[15:52] <CLEE-Ohh> ok ok kids
[15:52] <bl|nk> :)
[15:52] <QuinnM> thats uncalled for
[15:52] <CLEE-Ohh> play nice now
[15:52] <QuinnM> so tell her then !
[15:52] *** crazy1 is now known as psarakim
[15:52] <QuinnM> go on...
[15:53] <CLEE-Ohh> QuinnM
[15:53] <CLEE-Ohh> chill
[15:53] <QuinnM> what ??
[15:53] <QuinnM> ok fine
[15:54] <QuinnM> Blink...
[15:54] <QuinnM> ur a lesbian
[15:54] <QuinnM> u cant do nothing or ur sexist !
[15:54] <CLEE-Ohh> QuinnM did u hear what i said??
[15:54] <QuinnM> tell her then too !
[15:54] <CLEE-Ohh> he is not a she
[15:54] <QuinnM> whatever it is
[15:54] <Luminous> hmmm
[15:54] <bl|nk> QuinnM: How can i be a lesbian if im a guy
[15:54] <bl|nk> ?
[15:54] <Luminous> ta
[15:54] <QuinnM> ok ur gay
[15:55] <bl|nk> QuinnM: No, not that either
[15:55] <QuinnM> Well I'm not MSP okay ??
[15:55] <bl|nk> Yes, you are
[15:55] <QuinnM> ok ur gay then
[15:56] <Luminous> manic street precher?!
[15:56] <Luminous> +a
[15:56] <bl|nk> QuinnM: Sod off
[15:56] <QuinnM> No I'd rather not
[15:56] *** QuinnM was kicked by CLEE-Ohh (chill out_)
[15:56] *** M0ren021 is now known as Moreno21
[15:57] <bl|nk> thnx safire
[15:57] <CLEE-Ohh> np

Appendix 1d

[15:08] <LdySandra> What do you do The^Fiend...for work I mean?:)
[15:08] <johnCoffe> byeeeee byeeeeeeee folks, im goin
[15:08] <Zeus^Wrks> coz thats a start ..lol
[15:08] <johnCoffe> tc all
[15:08] <johnCoffe> hugz4all
[15:08] <LdySandra> take care johnCoffe:)hugs
[15:08] <eek‘> thx Zeus^Wrks
[15:08] *** KingWants is now known as jhjgdf
[15:08] <The^Fiend> erg. I qualify as a ‘student’. :)
[15:09] <LdySandra> ahh..ok:)
[15:09] <Blue^Army> But Hope OPs Will Remeber Me
[15:09] <Blue^Army> :))
[15:09] <johnCoffe> hugz back sandra
[15:09] <The^Fiend> heh. I’m a youngin, you know. :-p
[15:09] <LdySandra> Auw!...How young are you The^Fiend?:)
[15:09] <The^Fiend> heh. 19
[15:09] <sck> slt
[15:10] <LdySandra> Auw!...:p
[15:10] <ms^smile> back
[15:10] <ms^smile> whos 19 huh?:)
[15:10] <LdySandra> koolkunal talk to me in here please
[15:10] <LdySandra> wb flaura:)
[15:10] <ms^smile> thnx sis:)
[15:10] <ms^smile> pfftttt sandra sis..whos 19?:)
[15:10] * The^Fiend looks at ms^smile ‘err.. not me.. cause I’m uhh.. way.. older...’
[15:11] <LdySandra> The^Fiend flaura:)
[15:11] <LEDZEP> is donna of san diego here?
[15:11] <LEDZEP> is donna of san diego here?
[15:11] <LEDZEP> is donna of san diego here?
[15:11] <LEDZEP> is donna of san diego here?
[15:11] <ms^smile> really?:)
[15:11] <ms^smile> hmmmm

Appendix 1e

[13:36] <cowboybob> hi friends
[13:36] <cowboybob> anyone care to chat with an older guy college teacher
[13:36] <^fairy^> still keeping in there huh mag :)
[13:36] <supermag> yeah there was a time i talked a lot fairy
[13:37] <alee123> HI ALL
[13:37] <^fairy^> and still do mag....hhehehee
[13:37] <supermag> nah
[13:37] *** Guest4482 is now known as Nahla_27
[13:37] <supermag> there was someone who kept me busy all the last time fairy
[13:38] <^fairy^> our baby?
[13:38] <supermag> but he is now away
[13:38] <supermag> nope fairy
[13:38] <^fairy^> okay ;p
[13:38] <GetcaD> s
[13:38] <B_O_N_D> bæææææ
[13:39] <Pepsi'> I could not afford to go out with maggie
[13:39] <supermag> why? lol Pipes
[13:39] <Pepsi'> too expensive a date
[13:39] <supermag> well then i would spend my money for you Pipes:)
[13:40] <^fairy^> whoa
[13:40] <Pepsi'> lol
[13:40] <^fairy^> what a gal huh pipes?
[13:40] <^fairy^> go for it!! hhehee
[13:40] *** RIME is now known as AVRIL29
[13:40] <Pepsi'> super
[13:40] <supermag> yup:) emanzipate
[13:40] <Pepsi'> I can't take her money though
[13:40] <cowboybob> im new to undernet
[13:40] <Guest1348> geust3140 here
[13:40] <supermag> sure you can:) Pipes
[13:41] <cowboybob> any recommendations where an older guy might find chat
[13:41] <^fairy^> she's not giving you the money pipes, only spending it on you.....hhehee
[13:41] <supermag> right :) fairy
[13:41] <Pepsi'> hehehe
[13:42] <_Pavel_> hello

[13:42] <^fairy^> :)
[13:42] <^fairy^> hey pav
[13:42] <supermag> hey Pavel
[13:42] <_Pavel_> hey fairy
[13:42] <^fairy^> where have you been?
[13:42] <_Pavel_> hey Mag
[13:42] *** tecoy_f is now known as ^Bing^
[13:42] <_Pavel_> I was here fairy
[13:43] <cowboybob> am i visible here

Appendix 1f

[12:25] <||-_-||> jennywren is a nick ere
[12:25] <||-_-||> hmmm
[12:26] <AlchemisT> they come and go
[12:26] <Waitress> me old here
[12:26] <||-_-||> i come and take root
[12:26] <AlchemisT> usually they come, get pulled by one of the horny net geeks here and we hear nothing more from them
[12:26] <BenG^> LMAO
[12:26] <BenG^> in that the truth
[12:26] <Waitress> lol
[12:26] <boblet> afternoon
[12:26] <||-_-||> hiya boblet
[12:26] <Waitress> lol
[12:26] <Waitress> funny
[12:26] <AlchemisT> you know it :)
[12:26] <Waitress> so true
[12:26] <AlchemisT> hey Kev!
[12:26] <boblet> hi ||-_-||
[12:26] <boblet> hi skipy
[12:26] <||-_-||> lol
[12:26] *** debbie1 is now known as Cinta27
[12:27] <BenG^> then 4 months down the line they get dumped and come back and moan about it
[12:27] <AlchemisT> lol!! innit!
[12:27] <||-_-||> LMAO

Appendix 1g

[15:07] <S|rKn|ght> _4[_12_12Kn_4|_12ght-_4|_12rc v_4-_122.Ø_4-_12ß_4][_12Blade Soundtrack - Rave Scene_4][_12Mp³_4]
[15:07] *** S|rKn|ght is now known as |Bladez|
[15:07] * |Bladez| headbangs
[15:09] <cleverboY> global warming is one of the biggest problem for all people in the world becouse of Bush and Canada!
[15:10] <|Bladez|> well i never go outside so it doesnt affect me
[15:10] <james22> hello there
[15:10] <|r0nSh|eK> lol cleverboy. where r u from?
[15:10] <|Bladez|> zn
[15:10] <|Bladez|> nz
[15:11] <|Bladez|> arrghh!
[15:11] *** Psiholog was kicked by CW (banned: Shit Script! Download Clean mIRC from: www.mirc.com_)
[15:11] * |Bladez| does it properly ...
[15:11] <|Bladez|> _12New Zealand
[15:11] <|r0nSh|eK> cleverboy.....the EU and the european governments agreed to it initially but didnt ratify it in thier own paliaments. so it aint just US/Canada's fault..

[15:11] *** chriena has joined #chat-world
[15:11] <|Bladez|> _4Age_1224_4Sex_12Male_4Location_12Tauranga, New Zealand
[15:11] *** karima_20 is now known as karaa
[15:11] <cleverboY> ý am from sweden
[15:12] <|r0nSh|eK> heh
[15:12] *** Lovenotes is now known as ALoneGuy-
[15:12] * |Bladez| plays wif his other co0l toys too ...
[15:12] <cleverboY> ý hate bush and canadian gover ment!
[15:12] <|Bladez|> _4[_12There are currently_4 7 _12Ops,_4 15 _12Voiced and_4 162 _12Regulars on #chat-world, bringing the total to_4 181 _12users_4]
[15:12] <|Bladez|> _4[_12|Bladez| has seen_4 23 _12Kicks_4 21 _12Bans_4 876 _12Joins_4 267 _12Parts, and_4 578 _12Quits since he joined IRC_4]
[15:12] *** Udas_Lark is now known as Udas_Dil
[15:13] *** yooouupp is now known as love-no
[15:13] *** mustang^^ was kicked by Void (banned: Perm for Flooding_)

[15:13] <cleverboY> global warming is one of the biggest problem for all people in the world becouse of Bush and Canada!
[15:13] <|Bladez|> _4[_12Stop Repeating in #chat-world thanks cleverboY_4]
[15:14] <kevin20> hi
[15:14] <cleverboY> global warming is one of the biggest problem for all people in the world becouse of Bush and Canada!
[15:14] <cleverboY> global warming is one of the biggest problem for all people in the world becouse of Bush and Canada!
[15:14] <|Bladez|> thats it
[15:14] <No_FeAr> hi piçin ölü
[15:14] <|r0nSh|eK> lol
[15:14] <|Bladez|> out you go
[15:14] *** |Bladez| sets mode: +b *!*boss@195.175.160.96
[15:14] *** cleverboY was kicked by |Bladez| (_4[_12Repeating_4|_12Banned_4|_12Kick#248_4|_12Ban#51_4]_)
[15:15] *** crunchy is now known as nicer
[15:15] <kevin20> hi
[15:15] <kevin20> how
[15:15] <No_FeAr> _14,4 WWW.ÝKÝZTEPELER.COM ERKEK OLANLARIN KANALI TÜM ERKEK LERÝ BEKLIORUUUUUUZ
[15:15] *** No_FeAr was kicked by PoP-EyE (This is not an Advertisement Channel!!! (5 min Ban)_14<Kick #6855> _9Advanced _9P_14o_9P_14-_9E_14y_9E_14I_9R_14C__)
[15:15] <kevin20> hey
[15:16] <ratrik1> salut tlm
[15:16] *** |Bladez| is now known as S|rKn|ght

Appendix 1h

[13:31] <DReaDLoRD> GD more clones
[13:31] *** SEMIRAMIS has left #Worldchat
[13:31] *** fadi404 has quit IRC (Broken pipe_)
[13:31] <valpro> isn’t this exchange fascinating stu?
[13:31] *** Paresseux has joined #Worldchat
[13:31] *** nazareth has left #Worldchat
[13:32] <stuman27> meaning
[13:32] *** kont-40 has joined #Worldchat
[13:32] <stuman27> brb
[13:32] *** detay has joined #Worldchat

[13:32] <Balance> god is with us?
[13:32] <DReaDLoRD> Right y'all, prepare fer a li'l kickban flood
[13:32] *** X sets mode: +o DReaDLoRD
[13:32] * Balance hides
[13:32] *** br3akaway was kicked by DReaDLoRD (2 cl0n0rs detected from 202.8.232.228 (1) - Subgenius #_1017597_)
[13:32] *** UNGSUL was kicked by DReaDLoRD (2 cl0n0rs detected from 202.8.232.228 (2) - Subgenius #_0517598_)
[13:32] *** ahmad was kicked by DReaDLoRD (2 cl0n0rs detected from 203.135.10.237 (1) - Subgenius #_1417599_)
[13:32] *** sema was kicked by DReaDLoRD (2 cl0n0rs detected from 203.135.10.237 (2) - Subgenius #_1217600_)
[13:32] *** BuRRy was kicked by DReaDLoRD (2 cl0n0rs detected from ~br@212.253.184.229 (1) - Subgenius #_0517601_)
[13:32] *** diplomat_ was kicked by DReaDLoRD (2 cl0n0rs detected from ~br@212.253.184.229 (2) - Subgenius #_1217602_)
[13:32] *** maryyia was kicked by DReaDLoRD (3 cl0n0rs detected from 217.156.116.122 (1) - Subgenius #_1317603_)
[13:32] *** magdamary was kicked by DReaDLoRD (3 cl0n0rs detected from 217.156.116.122 (2) - Subgenius #_1217604_)
[13:32] *** marimagda was kicked by DReaDLoRD (3 cl0n0rs detected from 217.156.116.122 (3) - Subgenius #_1017605_)
[13:32] *** hakan_22m was kicked by DReaDLoRD (2 cl0n0rs detected from zmly@modem-as114-64.netone.com.tr (1) - Subgenius #_0517606_)
[13:32] *** diplomat_ has joined #Worldchat
[13:32] *** br3akaway has joined #Worldchat
[13:32] <Emma'> maybe with you..'cause he ain't here
[13:32] *** UNGSUL has joined #Worldchat
[13:32] *** maltepeli was kicked by DReaDLoRD (2 cl0n0rs detected from zmly@modem-as114-64.netone.com.tr (2) - Subgenius #_1017607_)
[13:32] *** BuRRy has joined #Worldchat
[13:32] *** CAPT_43 has quit IRC (Excess Flood_)
[13:32] *** ritika has joined #Worldchat
[13:32] *** querent has left #Worldchat
[13:33] *** DReaDLoRD sets mode: +b *!*josephega@202.8.232.*
[13:33] *** UNGSUL was kicked by DReaDLoRD (clones from *!*josephega@202.8.232.228 - Subgenius #_1417608_)
[13:33] *** br3akaway was kicked by KillaZzzz (Banned (*!*josephega@202.8.232.*)_)
[13:33] *** naiska has joined #Worldchat
[13:33] *** DReaDLoRD sets mode: +b *!*@212.253.184.229

[13:33] *** diplomat_ was kicked by DReaDLoRD (clones from *!*@212.253.184.229 - Subgenius #_1017610_)
[13:33] *** BuRRy was kicked by DReaDLoRD (clones from *!*@212.253.184.229 - Subgenius #_1417611_)
[13:33] *** DReaDLoRD sets mode: -o DReaDLoRD
[13:33] <BliC123> o hi's with Israel allways
[13:33] *** asklep has joined #Worldchat
[13:33] *** guitarboy has joined #Worldchat
[13:33] *** Criminal has joined #Worldchat
[13:33] <DReaDLoRD> Dayamn I done over 300kicks today

Appendix 1i

[15:38] <Pipes'> give me my nick back!
[15:38] <_alexis_> i am getting a headache, almost hallucinating **laughing out loud** all this paining all day long and sniffing that awful paint is just....ugh
[15:38] <nfn1> bye, bye lucy.
[15:38] *** loe is now known as cool^boy
[15:38] <MrMau> cya alki alki..take care
[15:38] <Pipes'> these nick theves
[15:38] <_alexis_> see ya around then rosie, have fun
[15:38] <Pipes'> cya lucy
[15:39] <nfn1> ask for it, pipes.
[15:39] * Chloe2 - http://www.multimania.com/clo
[15:39] <MrMau> lena; sounds like you are stoned..lol
[15:39] <lesicky> Hello everybody...
[15:39] <LucyR> i need to wash my car!
[15:39] <lesicky> Hello everybody...
[15:39] <LucyR> heeh
[15:39] <Pipes'> naw nfn1
[15:39] <nfn1> or use Pipez
[15:39] <MrMau> no pvts please!!
[15:39] <Pipes'> eww not nfn1
[15:39] <_alexis_> **laughing out loud** miau....agreeda nyway
[15:39] <MrMau> the rain is washing my car today hahahaha
[15:39] <_alexis_> anyway even, geez
[15:39] <nfn1> heh
[15:40] <Pipes'> Pipez sounds like some queer french guy
[15:40] <jo-cel> lol Pipes'

Appendix 1j

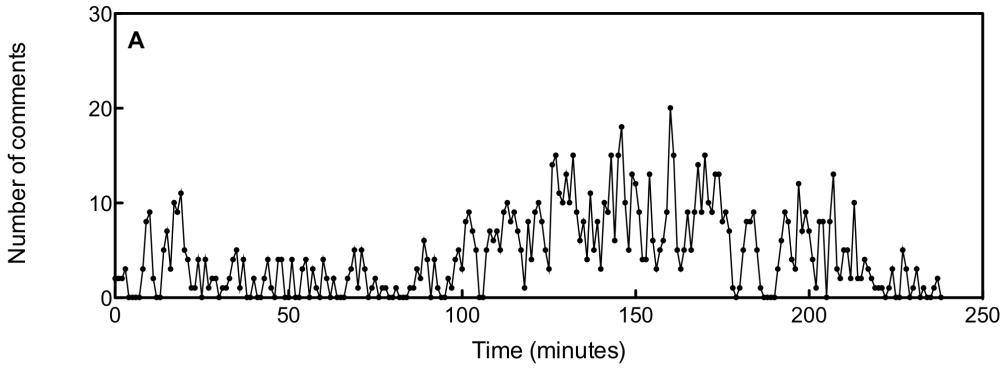
[15:23] <Rose_2> wb Balance
[15:23] <Rose_2> oooh thers' 2 of u
[15:23] <kutu> wher hv u been bal, buying cig?
[15:23] <Balance^> hello everyone
[15:23] <Rose_2> guess u ain't back
[15:23] <Balance^> yes
[15:23] <Rose_2> hello Balance^
[15:23] <Dubberman> HHHHHHHHHHHIIIIIIIIIIIIII
[15:23] *** ela0 is now known as wolf__
[15:24] <wolf__> uhhh
[15:24] <Balance^> hello hello
[15:24] <Rose_2> Dubberman lose the caps please
[15:24] *** Blondman is now known as rica20
[15:24] <Balance> rose_2 he's a lamer :)
[15:24] <Rose_2> which one?
[15:24] <Balance> hehe he took my nick the dumb a$$
[15:24] <Balance> im real
[15:24] *** irnnie is now known as alai^cute
[15:24] <Rose_2> lol i know i see the addies
[15:25] <Balance^> no,im real
[15:25] <Ursula> hello everyone!!!
[15:25] * Balance coughs
[15:26] <Ursula> ALGUIEN CONVERSA??
[15:26] *** Balance^ is now known as quwawa
[15:26] <kimmie> hi to all chatters!
[15:26] <Balance> there you go
[15:26] <trinityne> hi kimmie
[15:26] <Ursula> ANYONE INTERESTED IN TALKING?? SEND ME A MSG
[15:26] <Rose_2> lol
[15:26] *** Ursula was kicked by Asha'man (Caps abuse - 100% - Subgenius #_1317650_)
[15:26] *** quwawa is now known as rookie
[15:26] * Rose_2 slaps rookie up side the head !
[15:27] <Rose_2> stop nick changing

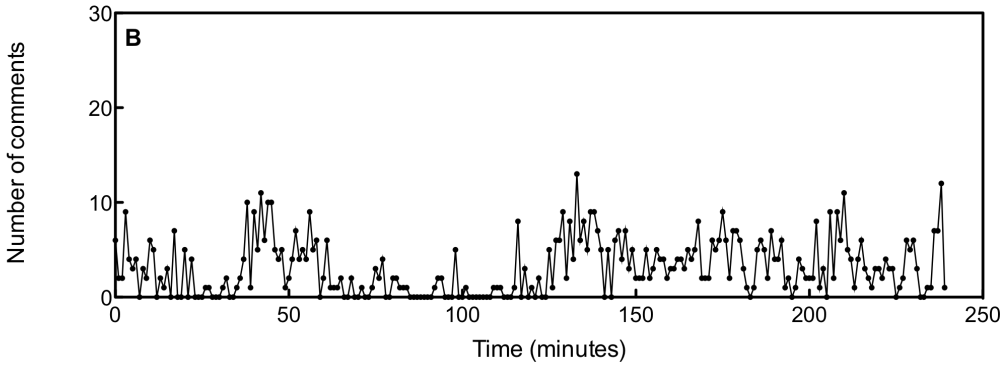
Appendix 2: Matlab code for Fast Fourier Transforms

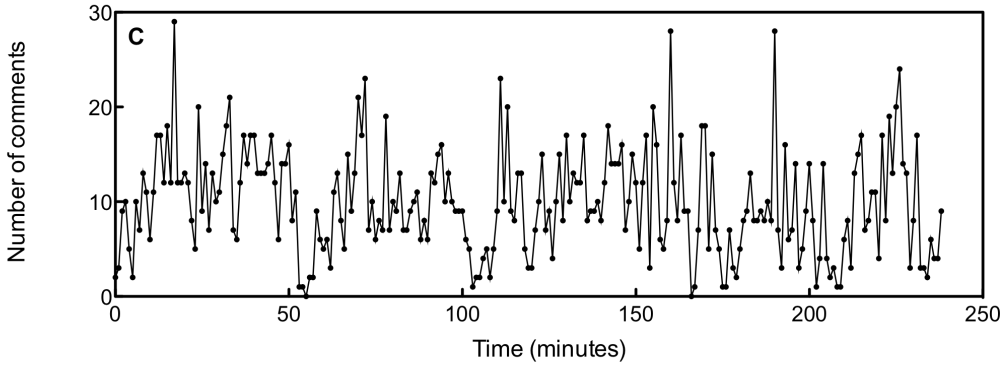
```
function ems_fft(ts,fname)
Y=fft(ts);
N=length(Y);
Y(1) = [];
power = abs(Y(1:N/2)).^2;
nyquist = 1/2;
freq = (1:N/2)/(N/2)*nyquist;
save(fname,'power')

figure;
plot(freq,power), grid on
xlabel('cycles/min')

assignin ('base', fname, power)

figure;
period = 1./freq;
plot(period,power), axis([0 max(period) 0 max(power)]), grid on
ylabel('Power')
xlabel('Period(mins/Cycle)')

end
```

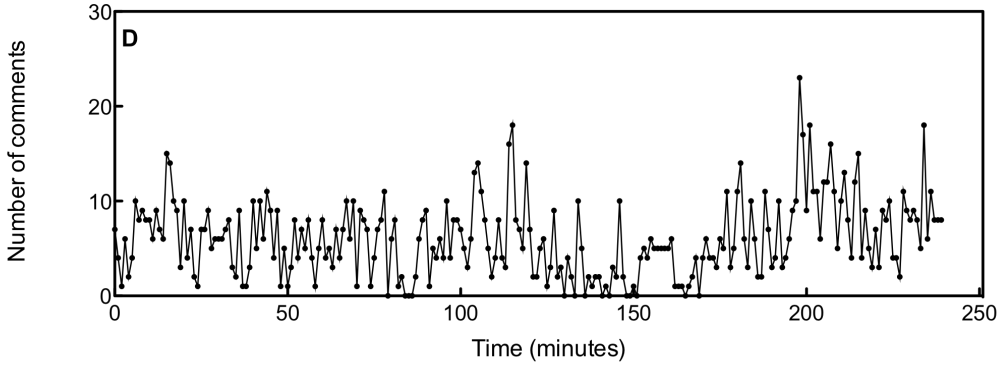
Appendix 3: Raw number of comments per minute data

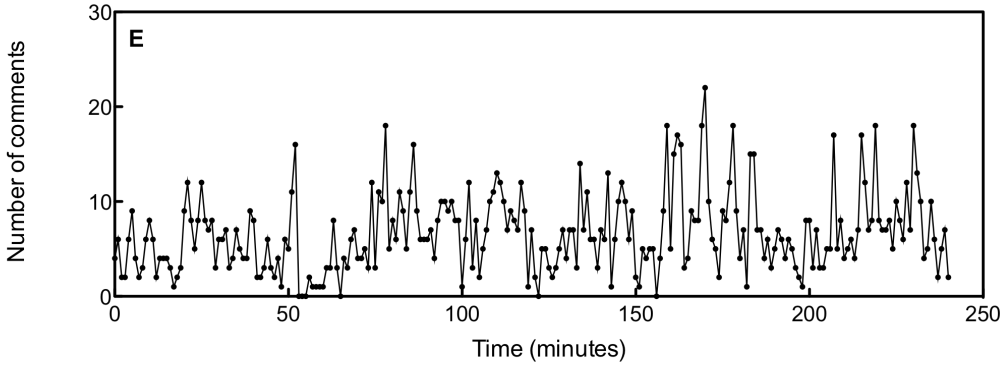
Panel A represents australia, panel B, chatworld, panel C, cyberchat, panel D, usa and panel E, worldchat.





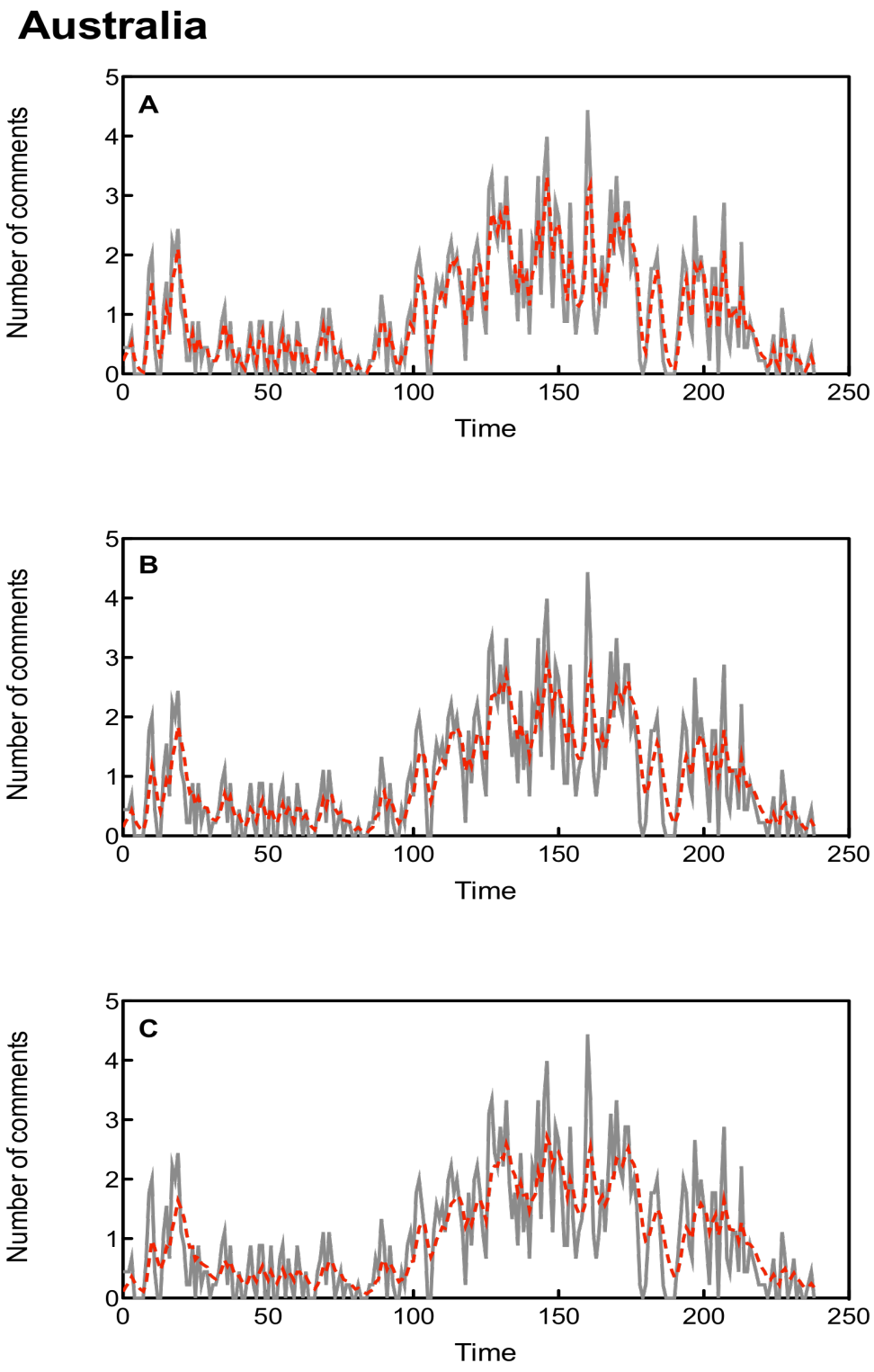


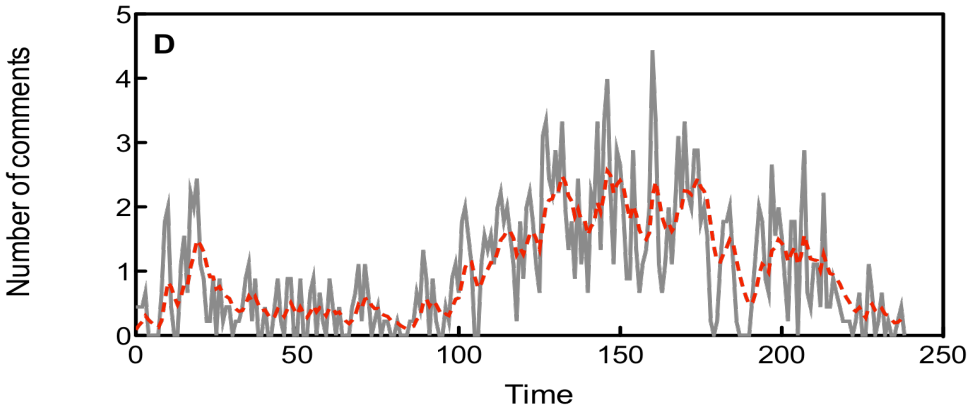

D
Number of comments
Time (minutes)
0
10
20
30
0
50
100
150
200
250

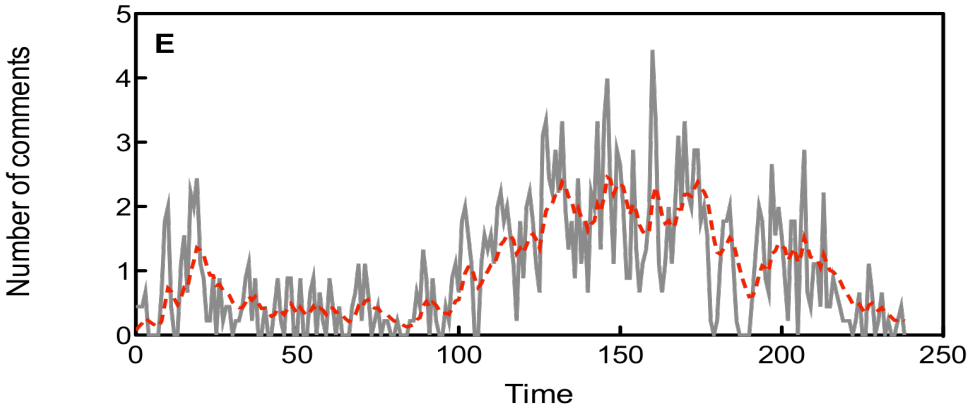

E
Number of comments
Time (minutes)
0
10
20
30
0
50
100
150
200
250

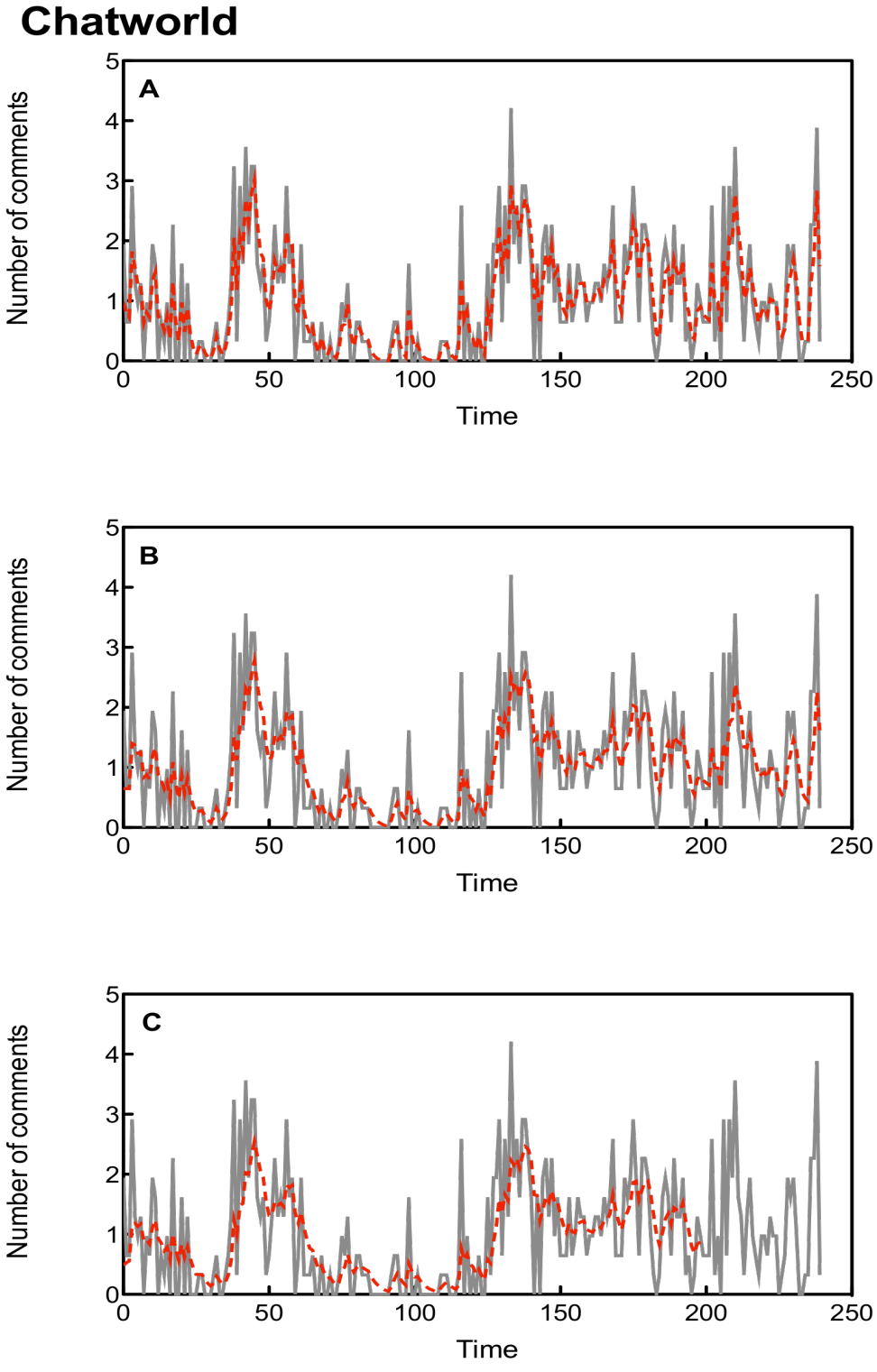
Appendix 4: Filter effects on number of comments data

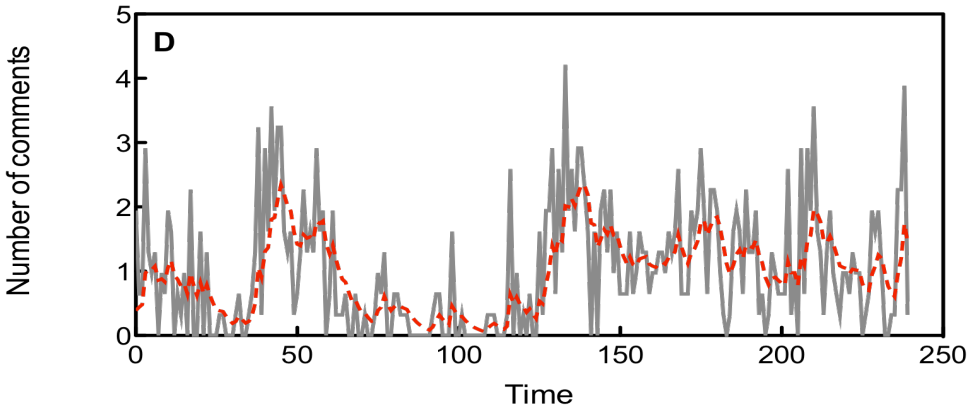
For all chat rooms, panel A represents a 1 minute filter, panel B, 2 minutes, panel C, 3 minutes, panel D, 4 minutes and panel D, 5 minutes.

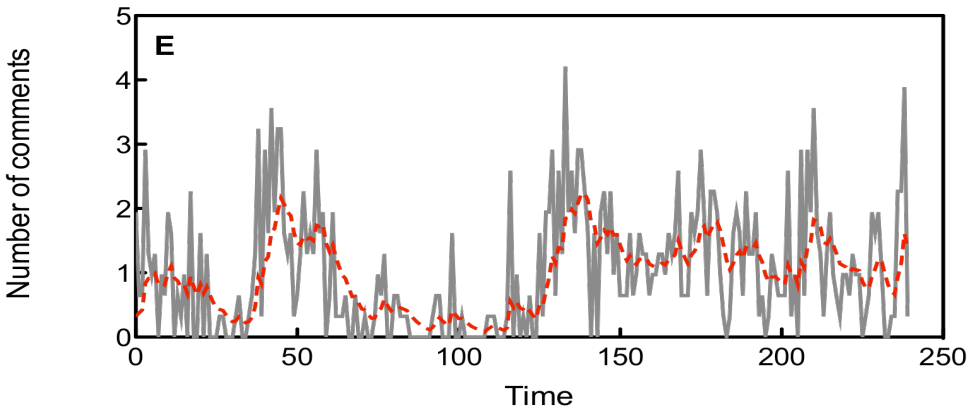


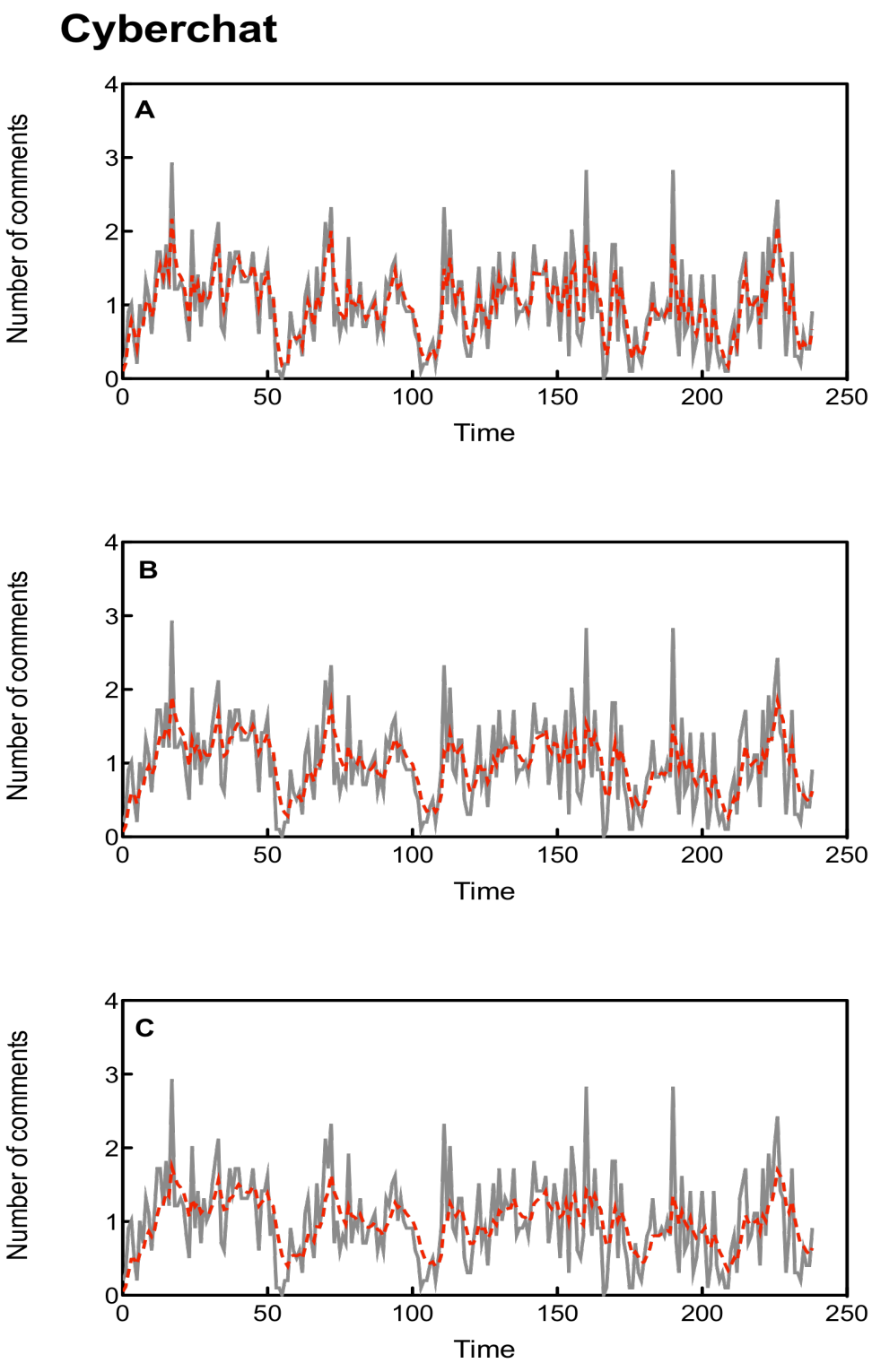

D
Number of comments
Time
0
1
2
3
4
5
0
50
100
150
200
250

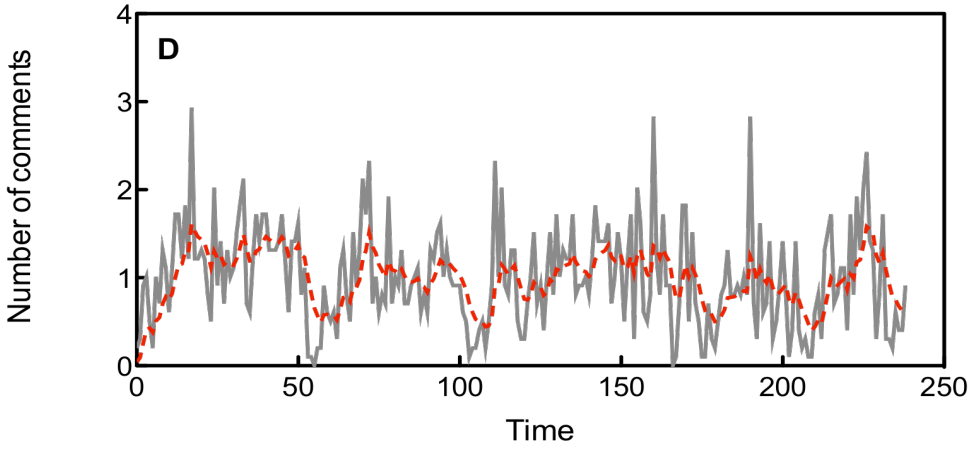

E
Number of comments
Time
0
1
2
3
4
5
0
50
100
150
200
250

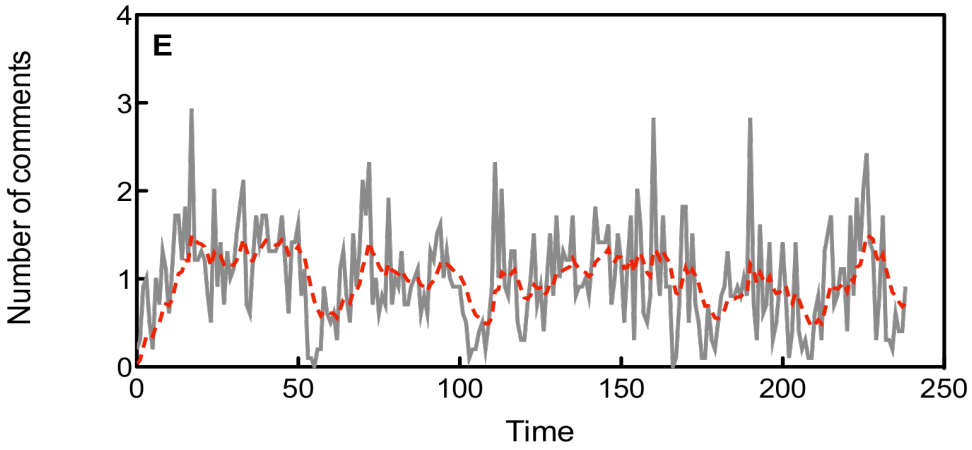

Chatworld
A
B
C
Number of comments
Time
0
1
2
3
4
5
0
50
100
150
200
250

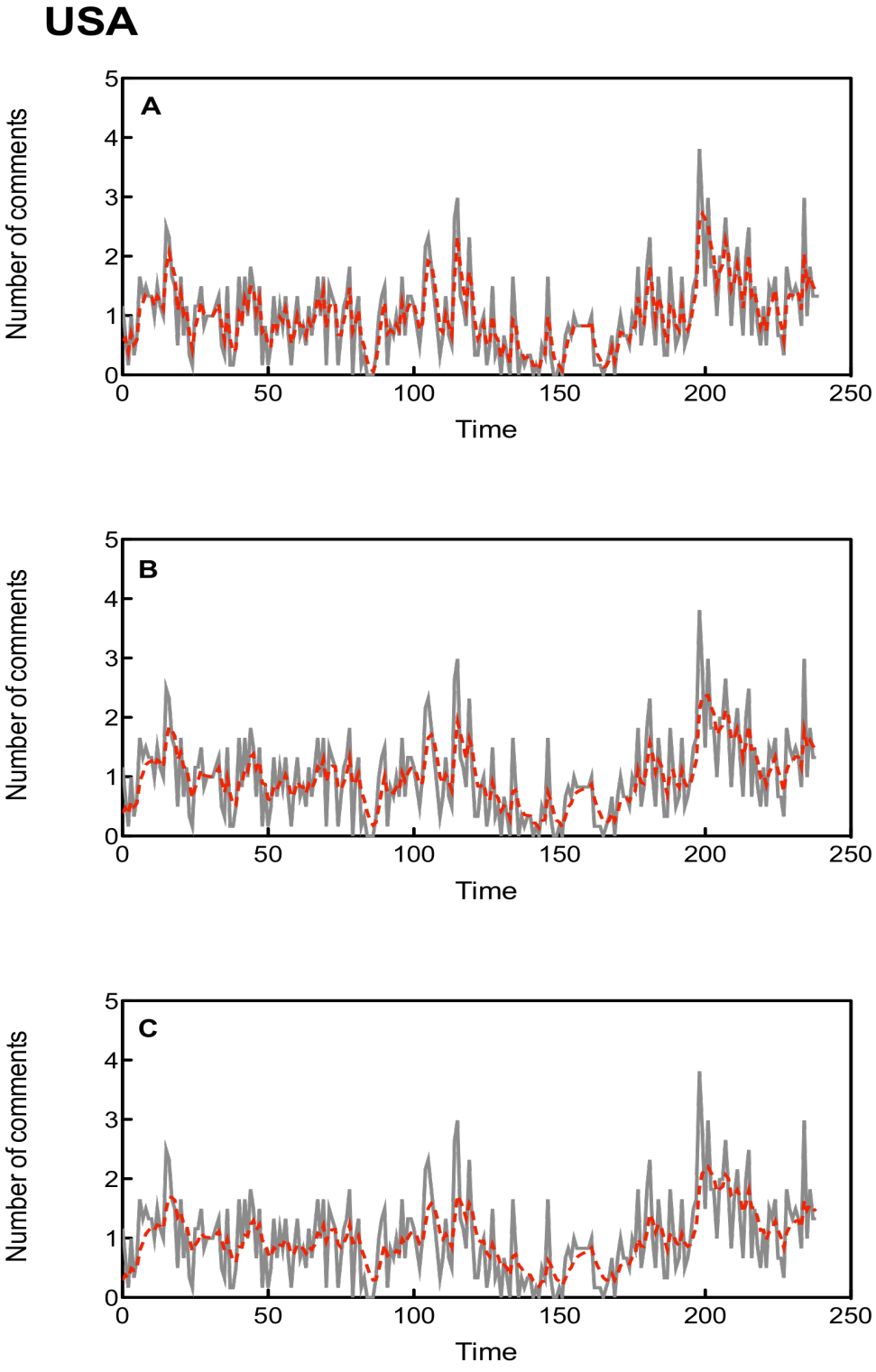

D
Number of comments
0
1
2
3
4
5
0
50
100
150
200
250
Time

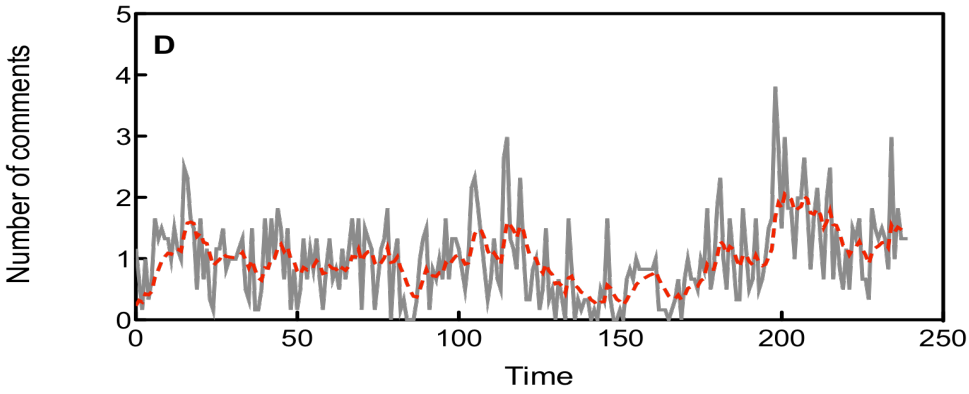

E
Number of comments
0
1
2
3
4
5
0
50
100
150
200
250
Time

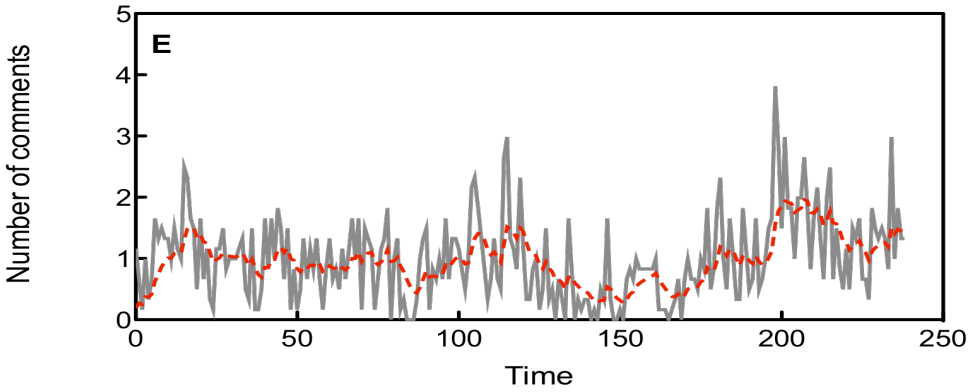

Cyberchat
A
B
C
Number of comments
Time
0
1
2
3
4
0
50
100
150
200
250

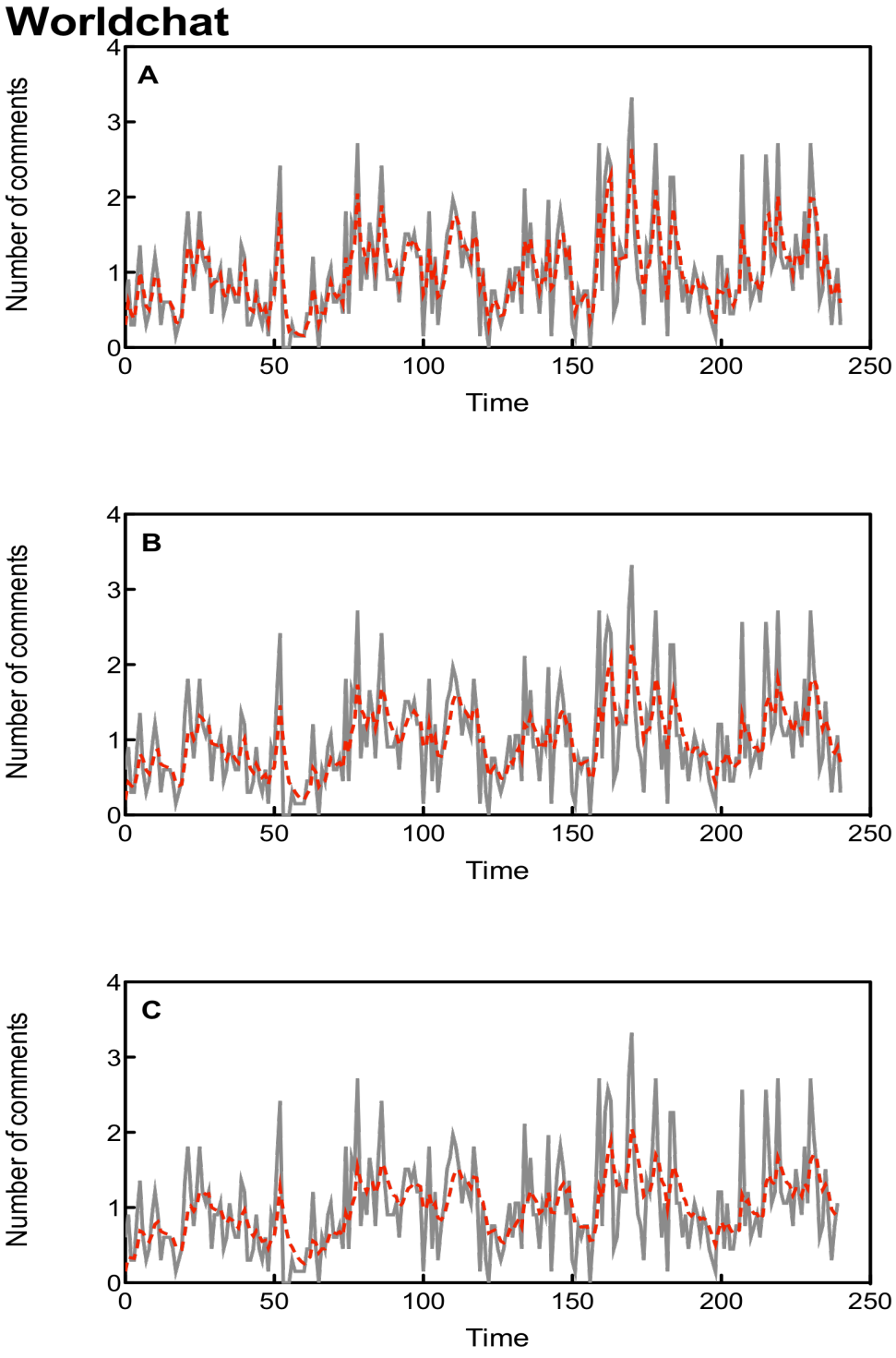

D
Number of comments
Time
0
1
2
3
4
0
50
100
150
200
250

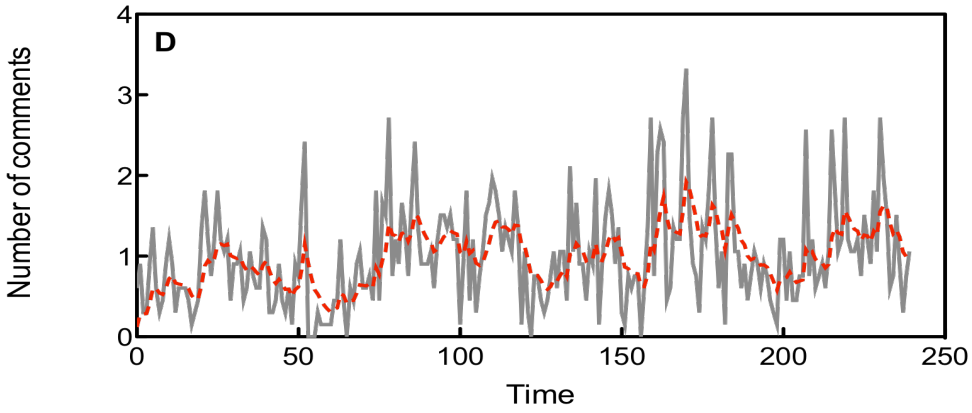

E
Number of comments
Time
0
1
2
3
4
0
50
100
150
200
250

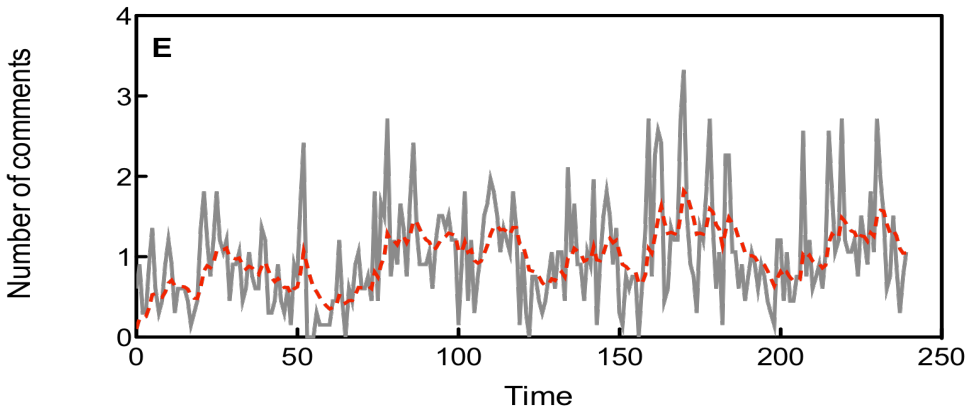

USA
A
B
C
Number of comments
Time
0
50
100
150
200
250
1
2
3
4
5


D
Number of comments
Time
0
1
2
3
4
5
0
50
100
150
200
250


E
Number of comments
Time
0
1
2
3
4
5
0
50
100
150
200
250


Worldchat
A
B
C
Number of comments
Time
0
1
2
3
4
0
50
100
150
200
250


D
Number of comments
Time
0
1
2
3
4
0
50
100
150
200
250


E
Number of comments
Time
0
1
2
3
4
0
50
100
150
200
250

Appendix 5: DMDX scripts

Stroop task

```
N160 <azk> <s 1> <cr> <fd 50> <vm 1024, 768, 768, 32, 75> <id keyboard> <nfb> <dbc 255255255> <dwc 0><vzk +1> <vzk +2> <vzk +3> <vzk +4>
$
0 <ln -3>"Welcome to the next experiment.", <ln -2> " On each of the screens to follow there will be between one and four words.", <ln -1> " Please type the number that corresponds to the number of words visible on screen.", <ln 1> "The words will only be visible for 1.5 seconds.";
0 <ln -2> "Please answer as quickly as possible, but do not sacrifice accuracy for speed", <ln 2> "Please do not blur your vision, keep the words in sharp focus.";
0 "Press SPACEBAR to start practice trials"; $
+250    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "bird", <XY 500,400> "bird"/;
+250    <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "cat", <XY 500,400> "cat", <XY 500,300> "cat"/;
+250    <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "cat", <XY 400,300> "cat", <XY 500,300> "cat"/;
+250    <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,400> "dog"/;
+250    <msfd 1500><umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 400,400> "bird", <XY 400,300> "bird", <XY 500,400> "bird", <XY 500,300> "bird"/;
+250    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY 400,400> "three", <XY 500,300> "three"/;
+250    <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4>  * <XY 500,300> "three"/;
+250    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY 400,400> "one", <XY 400,300> "one"/;
+250    <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4>  * <XY 400,400> "four", <XY 400,300> "four", <XY 500,400> "four"/;
+250    <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4>  * <XY 400,400> "three"/;
$0 “End of practice” <msfd 3000>/c;$
\
$0 “Press SPACEBAR to begin experiment”;$
+1      <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "dog", <XY 500,300> "dog", <XY 400,400>  "dog"/;
+2      <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,300> "cat"/;
+3      <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "bird", <XY 400,400> "bird"/;
+4      <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 400,300> "mouse", <XY 500,300> "mouse", <XY 400,400> "mouse", <XY 500,400> "mouse"/;
+5      <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,300> "dog"/;
+6      <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "dog"/;
+7      <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,400> "dog"/;
+8      <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
```

500,400> "dog"/;
+9 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
400,300> "cat"/;
+10 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
400,400> "cat"/;
+11 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
500,400> "cat"/;
+12 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
500,300> "bird"/;
+13 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
400,300> "bird"/;
+14 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
500,400> "bird"/;
+15 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
400,400> "bird"/;
+16 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
500,300> "mouse"/;
+17 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
400,300> "mouse"/;
+18 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
500,400> "mouse"/;
+19 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY
400,400> "mouse"/;
+20 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "dog", <XY 400,300> "dog"/;
+21 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "dog", <XY 500,400> "dog"/;
+22 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "dog", <XY 500,300> "dog"/;
+23 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,300> "dog", <XY 500,300> "dog"/;
+24 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,300> "dog", <XY 500,400> "dog"/;
+25 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
500,400> "dog", <XY 500,300> "dog"/;
+26 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "cat", <XY 400,300> "cat"/;
+27 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "cat", <XY 500,400> "cat"/;
+28 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "cat", <XY 500,300> "cat"/;
+29 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,300> "cat", <XY 500,400> "cat"/;
+30 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,300> "cat", <XY 500,300> "cat"/;
+31 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
500,400> "cat", <XY 500,300> "cat"/;
+32 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "bird", <XY 500,400> "bird"/;
+33 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,400> "bird", <XY 500,300> "bird"/;
+34 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,300> "bird", <XY 500,400> "bird"/;
+35 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY
400,300> "bird", <XY 500,300> "bird"/;
+36 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY

500,400> "bird", <XY 500,300> "bird"/;
+37 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "mouse", <XY 400,300> "mouse"/;
+38 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "mouse", <XY 500,400> "mouse"/;
+39 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "mouse", <XY 500,300> "mouse"/;
+40 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "mouse", <XY 500,400> "mouse"/;
+41 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "mouse", <XY 500,300> "mouse"/;
+42 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 500,400> "mouse", <XY 500,300> "mouse"/;
+43 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "dog", <XY 400,300> "dog", <XY 500,400> "dog"/;
+44 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "dog", <XY 500,400> "dog", <XY 500,300> "dog"/;
+45 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "dog", <XY 500,400> "dog", <XY 500,300> "dog"/;
+46 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "cat", <XY 400,300> "cat", <XY 500,400> "cat"/;
+47 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "cat", <XY 400,300> "cat", <XY 500,300> "cat"/;
+48 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "cat", <XY 500,400> "cat", <XY 500,300> "cat"/;
+49 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "cat", <XY 500,400> "cat", <XY 500,300> "cat"/;
+50 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "bird", <XY 400,300> "bird", <XY 500,400> "bird"/;
+51 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "bird", <XY 400,300> "bird", <XY 500,300> "bird"/;
+52 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "bird", <XY 500,400> "bird", <XY 500,300> "bird"/;
+53 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "bird", <XY 500,400> "bird", <XY 500,300> "bird"/;
+54 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "mouse", <XY 400,300> "mouse", <XY 500,400> "mouse"/;
+55 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "mouse", <XY 400,300> "mouse", <XY 500,300> "mouse"/;
+56 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "mouse", <XY 500,400> "mouse", <XY 500,300> "mouse"/;
+57 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "mouse", <XY 500,400> "mouse", <XY 500,300> "mouse"/;
+58 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 400,400> "dog", <XY 400,300> "dog", <XY 500,400> "dog", <XY 500,300> "dog"/;
+59 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 400,400> "cat", <XY 400,300> "cat", <XY 500,400> "cat", <XY 500,300> "cat"/;
+60 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 400,400> "bird", <XY 400,300> "bird", <XY 500,400> "bird", <XY 500,300> "bird"/;
+61 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "bird", <XY 400,400> "bird"/;
+62 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,300> "dog"/;
+63 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "dog"/;
+64 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY

400,400> "dog"/;
+65 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,400> "cat"/;
+66 <msfd 1500> <umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,400> "bird"/;
+67 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "dog", <XY 400,300> "dog"/;
+68 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "dog", <XY 500,400> "dog"/;
+69 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "bird", <XY 400,300> "bird", <XY 500,400> "bird"/;
+70 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "dog", <XY 500,300> "dog"/;
+71 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 500,400> "dog", <XY 500,300> "dog"/;
+72 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "mouse", <XY 500,400> "mouse"/;
+73 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "mouse", <XY 500,400> "mouse"/;
+74 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 500,400> "mouse", <XY 500,300> "mouse"/;
+75 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "dog", <XY 500,400> "dog", <XY 500,300> "dog"/;
+76 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "cat", <XY 500,400> "cat", <XY 500,300> "cat"/;
+77 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "cat", <XY 500,400> "cat", <XY 500,300> "cat"/;
+78 <msfd 1500> <umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "cat", <XY 500,300> "cat"/;
+79 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "bird", <XY 500,400> "bird", <XY 500,300> "bird"/;
+80 <msfd 1500> <umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "mouse", <XY 400,300> "mouse", <XY 500,300> "mouse"/;
+101 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "one", <XY 500,400> "one", <XY 400,300> "one"/;
+102 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,400> "three"/;
+103 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 500,300> "four", <XY 400,400> "four"/;
+104 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 500,400> "two", <XY 500,300> "two", <XY 400,400> "two", <XY 400,300> "two"/;
+105 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,400> "two"/;
+106 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "two"/;
+107 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,400> "two"/;
+108 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,300> "two"/;
+109 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,400> "three"/;
+110 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "three"/;
+111 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,300> "three"/;
+112 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY

400,400> "four"/;
+113 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "four"/;
+114 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,400> "four"/;
+115 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,300> "four"/;
+116 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "one", <XY 400,300> "one"/;
+117 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "one", <XY 500,400> "one"/;
+118 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "one", <XY 500,300> "one"/;
+119 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "one", <XY 500,400> "one"/;
+120 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "one", <XY 500,300> "one"/;
+121 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 500,400> "one", <XY 500,300> "one"/;
+122 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "three", <XY 400,300> "three"/;
+123 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "three", <XY 500,400> "three"/;
+124 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "three", <XY 500,300> "three"/;
+125 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "three", <XY 500,400> "three"/;
+126 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "three", <XY 500,300> "three"/;
+127 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 500,400> "three", <XY 500,300> "three"/;
+128 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "four", <XY 400,300> "four"/;
+129 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "four", <XY 500,400> "four"/;
+130 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "four", <XY 500,400> "four"/;
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+133 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "one", <XY 400,300> "one", <XY 500,300> "one"/;
+134 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "one", <XY 500,400> "one", <XY 500,300> "one"/;
+135 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "one", <XY 500,400> "one", <XY 500,300> "one"/;
+136 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "two", <XY 400,300> "two", <XY 500,400> "two"/;
+137 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "two", <XY 400,300> "two", <XY 500,300> "two"/;
+138 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "two", <XY 500,400> "two", <XY 500,300> "two"/;
+139 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "two", <XY 500,400> "two", <XY 500,300> "two"/;
+140 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY

400,400> "four", <XY 400,300> "four", <XY 500,400> "four"/;
+141 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "four", <XY 400,300> "four", <XY 500,300> "four"/;
+142 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "four", <XY 500,400> "four", <XY 500,300> "four"/;
+143 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "four", <XY 500,400> "four", <XY 500,300> "four"/;
+144 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 400,400> "one", <XY 400,300> "one", <XY 500,400> "one", <XY 500,300> "one"/;
+145 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "three", <XY 400,300> "three", <XY 500,400> "three", <XY 500,300> "three"/;
+146 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "one", <XY 500,400> "one", <XY 400,300> "one"/;
+147 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "one", <XY 400,300> "one"/;
+148 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "one", <XY 500,400> "one"/;
+149 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,400> "one", <XY 500,300> "one"/;
+150 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "one", <XY 500,400> "one"/;
+151 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 400,300> "one", <XY 500,300> "one"/;
+152 <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4> * <XY 500,400> "one", <XY 500,300> "one"/;
+153 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "one", <XY 500,400> "one", <XY 500,300> "one"/;
+154 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "one", <XY 500,400> "one", <XY 500,300> "one"/;
+155 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mnr +3><mpr +4> * <XY 500,400> "two", <XY 500,300> "two", <XY 400,400> "two", <XY 400,300> "two"/;
+156 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,400> "two"/;
+157 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "two"/;
+158 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,400> "two"/;
+159 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,300> "two"/;
+160 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "two", <XY 400,300> "two", <XY 500,400> "two"/;
+161 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "two", <XY 400,300> "two", <XY 500,300> "two"/;
+162 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,300> "two", <XY 500,400> "two", <XY 500,300> "two"/;
+163 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "two", <XY 500,400> "two", <XY 500,300> "two"/;
+164 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "two"/;
+165 <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4> * <XY 400,400> "two", <XY 400,300> "two", <XY 500,400> "two"/;
+166 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 500,400> "three"/;
+167 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY 400,300> "three"/;
+168 <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4> * <XY

```
500,300> "three"/;
+169    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
400,400> "three", <XY 400,300> "three"/;
+170    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
400,400> "three", <XY 500,400> "three"/;
+171    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
400,400> "three", <XY 500,300> "three"/;
+172    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
400,300> "three", <XY 500,400> "three"/;
+173    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
500,400> "three", <XY 500,300> "three"/;
+174    <msfd 1500><umnr><umpr><mnr +1><mnr +2><mpr +3><mnr +4>  * <XY
400,400> "three", <XY 400,300> "three", <XY 500,400> "three", <XY 500,300> "three"/;
+175    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
500,300> "four", <XY 400,400> "four"/;
+176    <msfd 1500><umnr><umpr><mpr +1><mnr +2><mnr +3><mnr +4>  * <XY
400,300> "four"/;
+177    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
400,400> "four", <XY 500,400> "four"/;
+178    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
400,300> "four", <XY 500,400> "four"/;
+179    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
500,400> "four", <XY 500,300> "four"/;
+180    <msfd 1500><umnr><umpr><mnr +1><mpr +2><mnr +3><mnr +4>  * <XY
400,300> "four", <XY 500,300> "four"/;
$
0 "Thankyou";
$
```

Remote Associates Task

```
N15 <cr> <s 1> <fd 50> <t 15000> <vm 1024, 768, 768, 32, 75> <id keyboard> <zil>
<ztr> <nfb> <dbc 255255255> <dwc 0>;
$
0 <ln -2> “Welcome to the next experiment”, <ln -1> "On each of the following screens
there will be three words", <ln 1> "Please type the word that connects all three";
0 <ln -1> "On some of these screens the words will be presented with words in italics", <ln
1> "These are examples of the kind of associates that are correct solutions";
0 <ln -1> "Each set of words will be presented for 15 seconds", <ln 1> "Please answer as
quickly and accurately as possible";
0 "Press SPACEBAR to start the practice trials"; $
+1 <msfd 12000> <ztr sore> * <ln -1> "loser/throat/spot"/, <msfd 3000> <ln -1>
"loser/throat/sore", <ln 1> "answer: spot";
+1 <msfd 12000> <ztr coat> * <ln -1> "fur/rack/tail"/, <msfd 3000> <ln -1>
"fur/rack/tail", <ln 1> "answer: coat";
+1 <msfd 12000> <ztr party> * <ln -1> "surprise (trick)/line (angle)/birthday (cake)"/,<msfd
3000> <ln -1> "surprise (trick)/line (angle)/birthday (cake)", <ln 1> "answer: party";
$0 "End of practice"<msfd 3000>/c;$
\
$0 "Please press SPACEBAR to begin the experiment";$

+21 <msfd 15000> <ztr cheese> * "cottage/cake/swiss"/;
+22 <msfd 15000> <ztr watch> * "night/wrist/stop"/;
+23 <msfd 15000> <ztr chair> * "rocking/wheel/high"/;
+24 <msfd 15000> <ztr ice> * "cream/skate/water"/;
+25 <msfd 15000> <ztr boat> * "show/life/row"/;
+31 <msfd 15000> <ztr sky> * "dive/light/rocket"/;
+32 <msfd 15000> <ztr false> * "teeth/arrest/start"/;
+33 <msfd 15000> <ztr battle> * "cry/front/ship"/;
+34 <msfd 15000> <ztr birth> * "control/place/rate"/;
+35 <msfd 15000> <ztr clock> * "wise/work/tower"/;
+41 <msfd 15000> <ztr chair> * “wheel (tyre)/electric (cord)/high (low)”/;
+42 <msfd 15000> <ztr dog> * "food (eat)/catcher (pitcher)/hot (cold)"/;
+43 <msfd 15000> <ztr writer> * "type (kind)/ghost (goblin)/story (tale)"/;
+44 <msfd 15000> <ztr glasses> * "dark (light)/shot (gun)/sun (moon)"/;
+45 <msfd 15000> <ztr pit> * "arm (leg)/coal (furnace)/peach (pear)"/;
$
0 "Thankyou";
$
```