Emotional Prosody Communication In Long-Term Abstained Alcoholics

Chelsea Harmsworth

A thesis submitted for the degree of Master of Science (by Dissertation)

Department of Psychology

University of Essex

Date: 11/01/16

Abstract

Emotional prosody difficulties have been found in recently detoxified alcoholics. Through three experiments, it was explored if these production and perception deficits per se continue even after a period of long-term abstinence. In Study one, 15 dry abstained alcoholics (AA) and 15 aged/educational matched healthy controls were asked to produce sentences in the six basic emotions plus neutral whilst being recorded. Results demonstrated that at an acoustic level pitch was a cue that AA struggled to modulate emotionally compared to healthy controls. The aim of Study 2 was to firstly explore on a perception level whether AA emotional utterances from Study 1 were perceived differently from those of healthy controls. A further goal was to explore how voice qualities of AA compared with healthy controls. To this aim, twenty-one naïve listeners heard randomly selected recordings from Study 1 and were asked to judge the emotion in a force-choice paradigm followed by a judgment of the speakers voice quality. Results showed naïve listeners find it more difficult to judge AA emotional utterances compared to those of healthy controls supporting acoustic results from Study 1. Listeners also rated AA voice quality as huskier, flat and less emotionally expressive than healthy controls. Finally in Study 3 abstained alcoholics perception of emotional prosody was investigated. Fifteen AA and 15 aged/educational matched healthy controls heard emotional utterances from Study 1 and were asked to identify the emotion heard in the tone of voice. Analyses showed that AA performed worse than healthy controls at judging emotional prosody. This applies to both stimuli uttered by AA or healthy controls. All these results combined demonstrate that abstained alcoholics show an emotional prosody

deficit at the production and perception level. Potential reasons for this deficit are further discussed in this thesis.

General introduction

In many of our social interactions we are faced with a large amount of emotional information that we seem to decode automatically and without any effort. In fact, emotions are of great importance to our daily life and play a crucial role in our communication and are a defining feature in managing our relationships (Burgoon, Buller & Woodall, 1996; Motley, 2008). Ekman (1992) claims that emotional communication is vital for survival. We never go a day without expressing our own internal feelings or analysing another's. While some emotional values are communicated through verbal cues (i.e. words), non-verbal cues such as voice, facial expressions and body posture also help us interpret and predict another's behaviour and affective state in the majority of our daily encounters (Juslin & Scherer, 2005). All kinds of interactions, such as interactions between husband and wife, parent and child, friendship groups and even professional relationships, require an amount of emotional communication. For example a wife expressing happiness when her husband brings her flowers home from work or an employer expressing anger at their employees lateness. Sometimes, feelings are stated explicitly in these settings (e.g. "Thank you, the flowers make me happy"). At other times, the tone of voice, also referred to as prosody, helps to de- and encode emotional meanings. For example, a parent might scream, "watch what you are doing" in a tone of voice that will allow the child to grasp that it has been putting him/herself in danger. Similarly, a boss might use a harsh tone of voice when uttering the words “you need to finish the job now” to his/her employee, leaving no doubt that the work needs to be finished in time to not aggravate the employer even more.

Emotional Prosody is thus an important nonverbal cue which is conveyed through acoustic features such pitch, loudness, tempo, and rhythm (Juslin & Scherer, 2005; Scherer, 1986). Prosody forms an essential part of spoken language and helps listeners gain more information about a speaker’s intended motive.

The importance of emotional prosody can be further understood by looking at self-report studies, where vocal cues have been identified as the most frequent way of understanding others’ emotional states (Planalp, 1998). Prosody offers a rich source of information that words alone cannot provide. In fact, it has been argued that successful acquisition of interpersonal skills includes developing the ability to successfully encode and decode non-verbal cues (Hargie, Saunders & Dickson, 1994). Failure to understand non-verbal cues means an individual is likely to be missing important information from their communicative partner. Just as important is the way we present non-verbal cues and communicate these to others in order to convey messages. Individuals could find themselves in an awkward or damaging situation if another person misinterpreted them. Failure in successful emotional communication (involving both the production and perception side) can lead to a reduced quality of life and may promote social isolation. Just imagine a situation in which an individual cannot “sense the tone” of their partner and thus fails to adequately grasp how their partner feels. Anger, sadness, and frustration will likely be the result of such a failure. However, most people do not truly understand nor appreciate the power of our vocal abilities until their ability to communicate effectively is disrupted and they indeed become restricted in social interactions.

There has been extensive research looking into healthy populations and emotional prosody (e.g., Banse & Scherer, 1996; Costanzo, Markel & Costanzo, 1969; Juslin & Scherer, 2005; Paulmann, 2015; Scherer, 2003). Similarly, many investigations have explored emotional prosody use in patients suffering from acquired brain damage (hemispheric insults) or neurodegenerative diseases (see e.g., Baum & Pell, 1999;Dara, Monetta, & Pell, 2008; Pell & Leonard, 2003; or for a review see Kotz & Paulmann, 2011). Far less focus has been put on emotional communication in populations that may suffer from damaging effects on the brain due to substance abuse problems. For instance, it has only recently been reported that alcohol abuse can cause emotional problems affecting non-verbal communication, particularly the ability to understand others (Kornreich et al., 2012; Monnot, Nixon, Lovallo & Ross, 2001; Monnot, Lovallo, Nixon & Ross, 2002; Maurage Campanella, Philippot, Martin & Timary, 2008; Uekermann, Daum, Schlebusch & Trenckmann, 2005). To help fill this gap in the literature, this thesis addresses the question whether alcohol abuse can have any long-term effects on individuals’ ability to successfully communicate and recognise emotional speech. Investigations on this timely topic are badly needed, as the next sections will outline in detail. To start with, a general overview of alcohol abuse and alcoholism will be provided.

Alcohol and Alcoholism

Alcohol is not a new phenomenon; people have been producing alcohol from plants for over 5000 years to effect changes within brain chemistry (Gibb, 2012). Much medical and scientific research has gone into the understanding and preventing of alcoholism over the last 50 years (Room, Babor & Rehm, 2005). As medical knowledge has grown, people have come to realise that alcohol has damaging effects if abused (Estes & Heinmann, 1986).

To identify the difference between a problem drinker and someone who is alcohol *dependent* can be hard. Both appear to suffer within areas of work, home and health at some point (Berger, 1993). The main theoretical distinction between the two is that an alcoholic has a strong physiological dependence on alcohol that problem/binge drinkers do not have (American Psychiatric Association, 2003; Berger, 1993; Kurtz, 2013). The current diagnoses for alcoholism in the UK relies on the Diagnostics and Statistical Manual of Mental Disorders (DSM) (American Psychiatric Association, 2003). The manual regards alcohol abuse, which is known as alcoholism, as the persistent and excessive drinking behaviour that causes repeated psychosocial problems within social, interpersonal and occupational areas. The problem also involves a physiological dependence that manifests itself as a tolerance and creates withdrawal symptoms to the drug. Alcoholism can affect individuals from all different races, sexes, social classes, and ages

(Estes & Heinemann, 1986). It is a worldwide issue and has been reported to be the most common diagnosed psychiatric issue (Harper & Matsumoto, 2005). The issue represents a serious problem for all those affected by alcoholism and society as a whole. In England in 2012-2013, 1,008,850 individuals with an alcohol related disease or injuries were admitted to hospital. Of these, 65% (651,010) admissions were due to chronic alcohol abuse (Health and Social Care Information Centre, 2014). Shockingly, 2012 saw a 19% increase to 6,490 people suffering from alcohol related deaths over the 5,476 found in 2001 (Health and Social Care Information Centre, 2014). While these numbers highlight how prevalent alcohol problems are in society, much of the research on alcohol seems to focus on drinking behaviour issues (e.g. do women drink more often than men, how many units per day should people drink, etc.), rather than the impact alcohol abuse can have on areas of life, including emotional communication. The little research available on this topic will be reviewed in the next section.

Alcoholism and emotional communication

As mentioned before, emotion is a central aspect to our lives and has a major impact on social communications and decision-making processes (Lane & Nadel, 2002). Alcoholics have been found to suffer from interpersonal problems and commonly these interpersonal problems are related to emotional situations (Duberstein, Conwell & Caine, 1993; Kornreich et al., 2002; Philippot, Feldman & Coats, 2003). Importantly, it has been found that a major contributor to relapse is difficulty coping with anger and frustration (Marlatt, 1979). This inability to cope with emotions may affect how alcoholics express or deal with others emotionally. Interestingly being experimentally restricted from being able to express ones emotions has been found to cause more alcohol consumption in heavy drinkers (Marlatt, Kosturn, & Lang, 1975). Marlatt, Kosturn and Lang (1975) assigned heavy drinkers to one of three groups. In one condition participants were provoked into anger by an insulting confederate and given no opportunity to express their emotions. In another condition they were provoked into anger and allowed to express their emotions. Finally in the third condition there was no-provocation and no-retaliation instead just neutral interaction with a confederate. Results from a follow-up drinking test indicated that the group that was not allowed to express their emotions but had received provocation had drunk significantly more alcohol by the retest than the other two groups. One may speculate that the inability to express emotions could cause more drinking behaviour and potentially de-crease the chances of withdrawals.

It has been suggested that alcoholics display poor communication skills within the family network, including parent-child relationships and husband-wife (Jacob & Seilhamer, 1987; Jacob, Leonard, & Randolph Haber, 2001; Jones & Houts, 1992; Rangarajan & Kelly, 2006). Moreover, the family unit has been argued to suffer from more conflict, avoidance and when alcoholism is apparent (Segrin & Menees, 1996). One study explored the parent-child relationship within alcoholic families and what effect this has on children’s social skills (Jones & Houts, 1992). Out of 338 students who took part in the study, participants who self-reported they came from an alcoholic family experienced negative perceptions of their families and felt as if they were denied their needs and feelings. It was also self-reported that children from alcoholic families struggle within social communication skills compared with children who did not grow up in families suffering from a history of alcohol abuse.

Dethier, Counerotte and Blairy (2011) asked 15 male alcoholics and their wife's and 15 control couples to fill out a marital and emotional state questionnaire. The emotional state questionnaire contained questions based on the emotional experiences of shame, joy, fear, guilt, affection, jealousy, sadness, anguish, and anger. The participant had to fill this out based on their feelings and then those of their partners. Interestingly, it was found an alcoholic husband's understanding of his wife's emotional state was less likely to match up with how the wife actually felt compared with the understanding of the controls. One of the ways the wife would have expressed these emotions to their husbands would have been through non-verbal cues such as tone of voice. The husband may have had low recognition of this causing a misinterpretation on his part. This suggests that alcoholics are less like to understand their partner's emotions than controls. Another study explored the quality of communication within alcoholic couples compared to control couples (Sferrazza et al., 2002). 25 couples where one was an alcoholic and 25 control couples where neither party suffered from alcohol dependency separately filled in two questionnaires. One questionnaire assessed the emotional experience within their relationship, which addressed the type of emotion, intensity and the ability to control that emotion. Participants had to fill it in from their perspective, how they thought their partner felt and what they believed their partner perceived their emotions to be. The other questionnaire assessed the quality of emotional communication and emotional reactions within their relationship. This questionnaire asked questions about a specific and recent event that both partners had experiences together. Results from both partners of the alcoholic couple indicated they felt intense feelings of anger, guilt, shame and disgust, which was different from the control couples who felt more positive emotions. Results also found that both partners within the alcoholic couples self reported they had difficulties expressing, and controlling their emotions and felt they were not understood compared to the controls. The quality of emotional communication questionnaire indicated that alcoholic couples felt more guilt, shame, and anxiety in their recent event than control couples. It was also found all of the control couple had spoken about the self-reported event to someone this usually being their partner. However, only 86% of the alcoholic couples had spoken about the event with someone and of those that did it was never to their partner. The study suggests that not only do alcoholic couples experience more negative emotions at a more intense level but they also face communication difficulties with their emotions.

In short, the research in this section has shown that alcoholism can generate a number of emotional and interpersonal difficulties and even the alcoholic’s family. More specifically it appears that in their social environment, alcoholics, experience more negative emotions than non-alcoholics and have difficulties in communicating their emotions.

While this short review clearly outlines the impact alcoholism can have on emotional communication in different settings, it is also apparent that studies have primarily focused on the immediate effects that alcohol can have on emotion processing. However, a growing number of individuals suffering from a history of alcohol abuse will stop drinking at some point in their life. The question that needs to be addressed in this context is whether years of emotional damage to the internal and emotional communication system and altered cognitive scripts can recover after the alcohol is removed. Anecdotal evidence on forums suggests that many abstained alcoholics still suffer in their ability to communicate their emotions and understand others even after years of abstinence (Fowler, 2012; Sober recovery, 2016). The next section will outline the literature investigating alcohol abuse and non-verbal communication.

Alcoholism and the communication of non-verbal cues

There is more to communication than words. The way we communicate through modalities such as our faces, voices and body language plays a big part in our social interactions. Disruption within this communication system can have damaging effects on ones social, work and home life. Below a review of the past literature on non-verbal communication and alcoholism is presented.

Emotional Facial Recognition and Alcoholism: The literature

Given the lack of research in the auditory domain, it is helpful to review the literature which has focused on alcoholics and another important non-verbal cue, namely emotional face processing. Like voices, facial expressions give rich information about a person, such as their gender, identity and emotional intention (Uekermann & Daum, 2008). Also, like voices, the ability to successfully judge the emotion expressed on a commutative partner's face allows for successful social interactions (Feldman, Philippot & Custrini, 1991; Patterson, 1999). Similarly, individuals who are found to be less capable of this have been found to have poorer social skills (Feldman, Philippot & Custrini, 1991; Feldman & Rimé, 1991; Philippot & Feldman, 2011). Social skills are the underlying skills that allow us to communicate effectively with others through verbal and non-verbal cues (Argyle, 2013). Alcoholics have been found to display deficits in their social skills (Erikson, Bjornstad & Gotestasm, 1986; Nixon, Tivis & Parsons, 1992) which could indicate a potential problem within the ability to recognise emotions through modalities such as faces and voices for this group, therefore having serious implications for them for example in all areas of life.

The recognition of emotional facial expressions in alcoholics has been studied to some extent in recently detoxified alcoholics (Philippot et al., 1999; Frigerio, Burt, Montagne, Murray & Perrett, 2002; Kornreich et al., 2003; Townshend & Duka, 2003; Uekermann, Daum, Schlebusch & Trenckmann, 2005). The majority of the literature involves alcoholics who were recently detoxified from alcohol. These are individuals who have abstained from alcohol for under 2 months or less. Given the lack of studies on long-term effects of alcohol abuse and its effect on facial recognition, some of the data available from recently detoxified alcoholics will be summarised below.

To establish whether recently detoxified alcoholics did display a difficulty in recognising others' emotional facial expressions compared to healthy controls, Philippot and colleagues (1999) gave participants a wide set of real life facial expressions that differed in emotional intensity. Their task was to judge the facial expressions from eight emotion categories (anger, disgust, contempt, fear, happiness, sadness, surprise and shame) and to rate these stimuli on a seven-point scale based on the intensity of the emotion judged. The authors found that not only did recently detoxified alcoholics suffer in accurately identifying the emotion from facial expressions compared to healthy controls but they tended to overestimate the intensity expressed and judged weak or low intensity emotions as displaying neutral expressions, which, the authors argue, could in turn cause them to overreact in some social situations (Philippot et al., 1999). Philippott et al., (1999) also pointed out that alcoholics had a systematic bias in judging the emotions expressed on facial expressions as displaying anger and contempt. Supporting this emotional bias, Frigerio, Burt, Montagne, Murray & Perrett, (2002) found that alcoholics in detoxification tend to mistake faces expressing sadness as angry or disgusted. Both these studies illustrate how recently detoxified alcoholics could misjudge emotional cues in social situations and perhaps face difficulties or conflict.

As mentioned above, what has received less attention in the phenomenon of emotional facial recognition is what happens to this ability after long-term abstinence from alcohol. The studies mentioned above that involve recently detoxified alcoholics typically use individuals with under two months of abstinence. Kornreich et al., (2001) attempted to investigate this by testing recently detoxified alcoholics, AA who ranged from two months to nine years abstinence and healthy controls. Participants were shown photographs of faces expressing anger, disgust, fear, happiness and sadness in neutral, mild, moderate and strong intensities. Their task was to first judge the emotion of each photo and then to decide the intensity of the expression on a 7-point scale. As a result of this study Kornreich et al., (2001) found that emotional facial recognition and overestimating the intensity of the emotions does improve in general with a longer detoxification period i.e. two months onwards compared with recently detoxified alcoholics. However, authors did note that a deficit for the recognition of anger and disgust was still found within the mid-long term abstained group. In addition, Foisey et al., (2007) in a longitudinal study found, when testing alcoholics after three months abstinence, an emotional facial recognition problem with a bias towards negative emotions and overestimation of the intensity was still evident. In this study recently detoxified alcoholics, three weeks into their treatment, and healthy controls were required to judge the emotions and intensity of 16 facial expressions displaying emotions of anger, disgust, happiness and sadness from two intensity levels (30% or 70%). The participants were then retested on the same task 2 months after (i.e. alcoholics were now 3 months into their abstinence). The researchers also tested individuals who dropped out from the abstinence treatment. It was found that alcoholics who had abstained preformed worse than healthy controls but preformed significantly better than those who dropped out of treatment. This could suggest that the treatment process aids the ability to correctly identify emotional from facial expressions.

Further, Fein, Kay and Szymanski, (2010) found early processing deficits in long-term abstained alcoholics (> 6 Years) whilst carrying out an EEG experiment on emotional facial expressions. Long-term abstained alcoholics had slower reaction times than aged match controls and delayed early processing of emotional facial expression.

In sum, it has been observed that recently detoxified alcoholics appear to have a problem in the decoding and labelling of emotional facial expressions and also tend to over judge the intensity of emotions suggesting they perceive emotions as more intense with a bias towards negative emotions (Philippot et al., 1999; Frigerio et al., 2002). Recently detoxified alcoholics also need more intensity of the emotion on the face to be expressed in order to perceive an emotion as being present (Frigerio et al., 2002). Interestingly, the problem has been found to persist further into abstinence although performance seems to increase with time of abstinence (Konreich et al., 2001; Foisey et al., 2007).

Although the evidence suggests that alcoholics and AA display impairments in the modality of faces it cannot automatically be assumed they will display similar impairments in the vocal modality. Emotional vocal recognition is a different modality that has not yet been tested properly amongst this patient group and although face and voice processing have been argued to recruit some of the same brain networks (see e.g., Kotz & Paulmann, 2011, for a review), the two modalities have also been shown to differ in their processing. For instance, emotional facial expressions have been found to obtain higher recognition rates overall than that of voices (Scherer, 2003). Also, how accurately a specific emotion is recognised tends to depend on whether the emotion is presented through faces or voices. For example, disgust is easily recognised from facial expression whereas listeners' find it hard to distinguish disgust through voices (Scherer, 2003). This could be the result of facial stimuli being presented in static manor and observers can process emotional features instantly (Paulmann & Pell, 2011; Scherer, 2003). In contrast, vocal stimuli are more dynamic and the emotion becomes clearer to the listener as more of the utterance is heard (Paulmann & Pell, 2011; Scherer, 2003). However, if impairment is also found within vocal recognition it could suggest that this patient group have a more modality unspecific deficit. What is clear is a slight impairment of recognition of any of the modalities can have serious implications on social interactions.

Emotional Prosody Recognition and Alcoholism: The literature

A far less studied nonverbal cue in this population and the one of interest here is the recognition of emotional prosody. There have been a selective few studies looking into recently detoxified alcoholics and emotional prosody recognition and this literature will be summarised below (Oscar-Berman, Hancock, Mildwolf, Hunter & Weber, 1990; Monnot, Nixon, Lovallo & Ross, 2001; Uekermann, Daum, Schlebusch & Trenckmann, 2005). An early study found minor impairments in recognition rates between alcoholics and healthy controls when they were assessed separately on two modalities (faces and voices) (Oscar-Berman et al., 1990). Within their study Korsakoff patients (a neurological disorder often caused by extreme alcohol consumption), recently detoxified alcoholics and controls were firstly presented with a range of visual tasks that involved a male face displaying emotions of angry, happiness, neutral and sadness expressed through different intensities. Secondly they were asked to complete auditory tasks. Here the participants were presented with sentences produced by one male speaker that were intoned in the same emotions shown for the visual task and were either congruent or incongruent to the semantic meaning of the sentence (e.g. “I am happy” spoken in a happy tone of voice (congruent) or “I am happy” spoken in an angry tone of voice (incongruent)). Results revealed that Korsakoff patients, performed worst in both visual and auditory tasks (Oscar-Berman et el., 1990). Alcoholic patients performed better than Korsakoff patients, but still worse than controls for most tasks. Finally, both alcoholics and Korsakoff patients overestimated the intensity of the emotion portrayed through facial expressions. Authors speculated the results were due to brain functioning problems specifically in the limbic system. They suggest that differences found between the alcoholic and Korsakoff patients are because although both are found to have cortical atrophy, the extent of the damage is far serious in Korsokoff patients.

Building on the facial recognition studies, Maurage, Campanella, Philipott, Charest, Martain and Timary, (2008) generalized the impairments found in modality of faces to be present in decoding emotional prosody and body postures. In their study, the authors asked recently detoxified alcoholics and age-matched controls to judge emotional stimuli from a range of modalities (faces, voices, body postures and written scenarios) in a variety of emotions (anger, happiness, fear and sadness). They then had to rate the intensity of the emotion on a seven-point scale. Results indicated alcoholics did not display impairment when decoding happiness for any of the modalities presented. Data also showed alcoholics tended to underestimate intensity of both fear and sadness compared to healthy controls. However, in line with previous research they were found to overestimate in the intensity of anger expressed (Frigerio et al., 2002; Philippot et al. 1999). No problem with written scenarios was found suggesting that damage to the emotional perception system is not partly due to linguistic impairments i.e. labelling difficulties (Maurage, Campanella, Philippot, Charest, Martin & de Timary, 2009). The authors from the study suggest the global impairment of found could highlight a deficit in cerebral areas such as the amygdala because this area has been found to be active whilst healthy control participants process emotional stimuli regardless of modality of stimulus type. Kornreich et al., (2012) later supported this claim by reporting that recently detoxified alcoholics performed worse than controls in identifying the emotions from faces, voices and music. Both studies propose that alcoholics who have recently abstained from alcohol exhibit an emotional decoding deficit that is more generalized rather than in one specific modality. Kornreich et al., (2012) suggests that problems alcoholics' face in recognising emotional stimuli (from faces, voices and music), alexithymia (problems identifying emotions internally), theory of mind and emotional empathy could stem from a deficit in the fronto-parietal mirror neurone system.

Monnot et al. (2001) tested recently detoxified alcoholics and individuals who had been exposed to alcohol in the womb (foetal alcohol syndrome) on the

Aprosodia battery test. The Aprosodia battery test is used to measure aphasia in brain-damaged patients by accessing them on tasks relating to emotional and linguistic prosody (Monnot et al., 2001). Authors found that both the alcoholic and foetal exposed group displayed significant impairments in correctly identifying emotions from speech that was predicted by four variables (age at first drunken episode, alcohol abuse duration, age abuse started and alcohol use by mother). It must be noted that within the foetal exposed group nine out of 11 had a history of alcohol abuse themselves which could have contributed to the overall group effect rather than the mother’s drinking habits whilst in the womb. In a later study Monnot, Lovallo, Nixon and Ross, (2002) investigated how the performance of 32 recently detoxified alcoholics and 11 fetal alcohol exposed individuals compared with nine right and 10 left hemisphere brain damaged patients on the Aprosodia battery task. Results indicated that alcoholics were significantly different from the right hemisphere patients for the word subtest. No difference was found between alcoholics and left brain damage for the monosyllabic, Asyllabic and Discrimination subtests. The fetal exposed group were found to have patterns comparable scores to the right brain damage for the Word, Monosylabic and Asyllabic subtests. However, they significantly differed from the left hemisphere brain damaged group from the discrimination subtests. The researchers collapsed the brain group and found that the patterns for the left and right hemisphere group, alcohol dependents and fetal exposed were here statistically identical. This led the authors to conclude deficits found in alcohol dependents and the fetal alcohol exposed group on the Aprosodia battery task share a combination of left and right hemisphere brain damage deficits.

This, they argued could mean that emotional prosodic comprehension in both alcohol groups is related to impairments or damage to the corpus callosum (found in left hemisphere brain damage) and right cortical areas.

Uekermann, Daum, Schlebusch and Trenckmann, (2005) investigated how incongruent prosody and semantic cues would affect recognition for depressed and non-depressed alcoholics. Alcoholic patients, regardless of whether they were depressed or not, were found to struggle in distinguishing emotional prosody from semantically neutral utterances, misjudging the prosody from semantically incongruent utterances and matching facial expressions to the incorrect emotional prosody, supporting the claim that alcoholics display a deficit in processing emotional prosodic cues.

Uekermann and Daum (2008) reviewed behavioral experiments exploring alcoholism and social cognition. They highlighted that Alcoholics lack skills in humor processing (Uekermann, Channon & Daum, 2007), theory- of-mind (Uekermann, Channon, Winkel, Schlebusch, & Daum, 2007), emotional prosody (Monnot et al., 2002; Maurage et al., 2008) and facial expression (Philippot et al., 1999; Frigerio et al., 2002) processing.

In summary, the majority of the literature suggests that recently detoxified alcoholics appear to struggle with recognising emotions from speech (Kornreich et al., 2012; Monnot et al., 2001; Monnot et al., 2002; Maurage et al., 2008; Uekermann et al., 2005). What remains to be seen is whether the difficulties found remain no matter the length of sobriety?

While work for this thesis was underway, a study by Valmas, Ruiz, Gansler, Sawyer & Oscar-Berman (2014) investigated deficits in social cognition within long-term abstained alcoholics (of about 6 years) and age/educational matched controls. Participants were tested on their performance on the ACS Social Cognition task (more specific two out of the three subsets were tested here: Social Perception and Faces) and subsets of the Wechsler Adult Intelligence Scale (Valmas et al., 2014). The Social Perception component tests individuals' understanding of social communication and contains three tasks: Prosody-Face Matching, Prosody-Pair Matching and Affect Naming. In the Prosody-Face matching task, participants were asked to match the corresponding facial expression with the emotional prosody they were presented with. In the Prosody-Pair Matching task, participants were instructed to match the correct emotional prosody with photos of two people interacting; they then had to decide whether the semantics of the utterance matched the emotional prosody it was spoken in. Finally the Affect Naming task assessed the participants' ability to select the correct emotion from photographs of facial expressions they are presented with. In the Faces component, participants' were assessed on performance in decoding different emotional facial expressions and facial memory tasks. The authors also explored whether there was any difference between abstained males and females and if factors such as length of drinking and time abstained correlated with participants' scores. Results showed that overall, abstained alcoholics preformed worse than controls on Affect Naming and Faces Content. When looking at gender separately, results indicated that abstained males performed worse on the Prosody-Face Matching and Faces Content tasks when compared with abstained alcoholic women. Also alcoholic men performed worse on the face content task when compared to non-alcoholic men. When looking at drinking factors compared to recognition scores: more years of heavy drinking was associated with impairments in identifying emotions from facial expressions. Also the more alcohol that was consumed each day was linked to worse performance in matching the emotional prosody to the correct facial expression. Interestingly alcoholic women were found to improve with labeling facial expressions with abstinence. Authors concluded that some areas of social cognition remain affected even with abstinence and impairments manifest themselves differently in men and women.

Brain networks engaged in the production and recognition of emotional prosody and how these brain areas might relate to alcoholism

Below is offered a brief discussion of how alcoholism can affect the brain and how these areas may be related to emotional recognition and production problems.

Over the past decades, much research has focused on highlighting brain networks underlying emotional prosody processing (Kotz, Meyer & Paulmann, 2006; Kotz & Paulmann, 2011; Sidtis & Van Lancker Sidtis, 2003). Specifically, it has been argued that emotional speech perception is mediated by diverse brain structures (e.g. Schirmer & Kotz, 2006; Kotz & Paulmann, 2011): Bilateral auditory processing areas are involved in extracting acoustic cues from speech. Next, to infer emotional significance, these cues are integrated, a process that arguably involves projections from superior temporal gyrus to anterior superior temporal sulcus. Later, more emotional evaluative processes seem to recruit frontal cortex areas bilaterally (e.g. inferior frontal gyrus, orbito-frontal cortex). In other words, emotional prosody processing involves a bilateral temporo-frontal brain network, with some studies describing activation of subcortical structures, too (see e.g., Paulmann, 2015 for a review). Similarly, research has demonstrated that patients suffering from lesions to fronto-temporal and fronto-parietal cortex, as well as the basal ganglia, internal capsule, or thalamus often suffer from emotional expression impairments (e.g. Ross, 1981; Cancelliere & Kertesz, 1990; Baum & Pell, 1997), thus implying some of the same brain areas in the production process that have already been linked to the perception of emotional prosody. Interestingly, it is well established that chronic alcoholism is also associated with neurological changes (Oscar-Berman & Marinkovic, 2003), though the degree to which the brain becomes impaired from long-term alcohol abuse seems to vary from person to person (Oscar-Berman & Schendan, 2002). However, often, grey matter shrinkage in frontal and dorso-lateral cortices as well as reduction of cerebellum and thalamus is reported (Ritz et al., 2015). Thus, some of the brain areas implicated in emotional processing are affected by alcohol abuse (see sections below). The extent of brain abnormalities is affected by many factors such as extent of abstinence; duration of drinking; number of withdrawals; how often and how much alcohol was consumed (Oscar-Berman et al., 2014; Petrakis, Gonzalez, Rosenheck & Krystal, 2002). Again, not surprisingly, it has been shown that the effect alcohol abuse leaves on the brain can lead to problems in cognitive processing (Andrade & Andrade,1992; Goldman, 1983; Tamkin & Dolenz, 1990; Theotoka, 2006), emotion processing (Foisey et al., 2007; Konreich et al., 2001; Uekermann, Daum, Schlebusch & Trenckmann, 2005) and social interaction (Nixon, Travis & Parsons, 1992; Segrin & Menees, 1996).

Interestingly, available data on neuropsychological deficits mostly involves early abstainers, in other words individuals who have abstained from alcohol for less than a year. The long-term effects abuse may have on individuals is thus less certain, though some research suggests that brain plasticity (i.e. the brain's ability to reorganize itself) helps to improve cognitive behavior in some instances. That is, some compensation may occur in some in cognitive tasks (Chanraud & Guillermo, 2009; Oscar-Berman et al., 2014).

The paragraphs of the following section will review some of the findings that may link long-term alcohol effects on the brain and emotional prosody processing.

Right-Hemisphere Hypothesis

Some researchers have suggested that the right hemisphere is more susceptible to damage provided from alcoholism than the left hemisphere (Oscar- Berman, 2003). Interestingly, early clinical as well as experimental evidence on emotional prosody perception and production has also revealed an important role for the right hemisphere in emotional prosody (Borod, 1993; Ross & Mesulam, 1979). For instance, Heilman, Scholes and Watson (1975) tested six patients who had right temporo-parietal lesions and six patients with left temporo-parietal lesions. Participants were instructed for half of the trials to judge the emotion (happy, sad, angry, indifferent) of the speaker from recorded sentences played through a Dictaphone. For the other half of the trials they were asked to select the content of the sentences they heard. Each patient indicated their answer by selecting a line drawing of facial expressions for the emotion task and line drawing corresponding to the content in the content task. Results indicated both groups were able to achieve maximum scores for the contents trials. In the emotion trials patients with lesions in right temporo-parietal brain areas performed significantly worse than patients with lesions in let temporo-parietal regions, suggesting patients with right hemispheric dysfunction have impairments in the ability to distinguish emotions from speech. Additionally, Bowers, Coslett, Bauer, Speedie and Heilman's results (1987) indicated that the right hemisphere was responsible for identifying emotional prosody. In this study nine right hemisphere-damaged, eight left hemisphere-damaged and eight healthy control participants were asked to judge the emotional prosody from sentences where the semantic meanings were congruent or incongruent with the prosody and sentences that had been filtered (i.e. containing only the prosodic information, no linguistic) and unfiltered. Right-hemisphere patients were found to perform significantly worse than left hemisphere-damaged patients and controls.

Further, emotional prosody is recognised more accurately by the left ear compared to the right (Erhan, Borod, Tenke & Bruder, 1998). Thus, the above research suggests that damage to the right-hemisphere can alter an individual's emotional prosody perception ability. Similar results were found for emotional prosody production. An early study by Borod, Koff, Lorch and Nicholas (1985) analysed controls, left-hemisphere and right-hemisphere damaged patients' speech output after they had watched laden slides. Right-hemisphere patients were found to produce less emotional outputs than those of the left-hemisphere and controls. This led the authors to conclude the right-hemisphere played a vital role in emotional prosody production.

Taken together, results revealed that patients with right-hemisphere brain damage have difficulties with emotional prosody. Similarly, alcoholic patients have been reported to suffer from emotional prosody problems (Monnot et al., 2001, Monnet et al., 2003; Oscar-Berman et al., 1990; Uekermann, Daum, Schlebusch & Trenckmann, 2005), leading to the hypothesis that the behavior of the two groups might be comparable (Oscar-Berman & Bowirrat, 2005). In other words, emotional processing difficulties found in alcoholism might be due to the right-hemisphere being more sensitive to damage caused by heavy alcohol abuse (Oscar-Berman & Marinkovic, 2003). As this hemisphere is also heavily implicated in emotional prosody, it would come as no surprise that alcoholics can suffer from emotional communication problems.

<u>Prefrontal cortex</u>

It has also been proposed that impairments in emotional perception seen in alcoholism could be due to a vulnerability of the prefrontal cortex known as the 'frontal lobe hypothesis' (Oscar-Berman & Bowirrat, 2005; Moselhy, Georgiou & Kahn, 2001; Uekarmann & Daum, 2008). The pre-frontal cortex is linked to planning and regulating behavior, decision-making and controlling social actions such as inhibiting certain behaviors and emotional responses (Fuster, 1988; Koechlin, Basso, Pietrini, Panzer & Grafman 1999). Several studies have implicated the OFC in emotional prosody. For instance, patients with uni- or bilateral damage to the OFC have been found to show impairments in identifying emotional prosody (Hornak et al., 2003). Similarly, patient evidence using event-related brain potentials (ERP) suggests that the OFC is responsible for evaluating the emotional significance of a vocal expression (Paulmann, Seifert, & Kotz, 2010).

Looking at alcoholics and the prefrontal cortex, a study by Krill, Halliday, Svoboda, and Cartwright (1997) reports reduced cortical neurons in the frontal association cortex in alcoholics' brains. This might suggest that the frontal cortex is damaged by heavy drinking. Further, chronic alcoholism has been associated with decreased cerebral blood flow (Dally et al., 1988; Melgaard et al.,1990; Nicolas et al., 1993), though blood flow has also been found to increase again with longer periods of abstinence (over four years) (Gansler et al., 2000). This would suggest that abstinence could lead to brain damage recovery, questioning whether emotional communication abilities should be affected in AA in a similar way to what has been found in alcoholics. Finally, fMRI data have also found that chronic alcoholics display abnormalities in the prefrontal cortex (Marinkovic et al., 2009; O'Daly et al, 2012). In one study O'Daly et al (2012) carried out fMRI on two groups of alcoholic patients and controls who drunk socially. Of the alcoholic patients one group had detoxed with medical support only once and the other group had multiple medical detoxifications. All groups carried out an emotional facial perception task, which used fearful, neutral and fearful-neutral morphed facial expressions. In one part of the task participants had to state the gender of the face. In another part of the task participants had to decide whether the faces displayed fearful or neutral expressions. Both groups of alcoholics were found to struggle with recognising fearful faces and showed less activation within prefrontal areas such as the OFC and the insula when compared with controls. Interestingly the multiple detoxification group displayed the most problems and least activation. The study shows that it may not just be alcoholism or detoxification that can affect the brain but also that multiple detoxifications can be an important factor. On a final note, although there is strong evidence that frontal lobe damage could contribute to emotional processing difficulties found in alcoholism, the frontal lobes do not work alone and have very strong connections with cortical and subcortical areas that are also important in emotional speech processing (Moselhy, Georgiou & Kahn, 2001).

To summarise the research in this chapter has highlighted that alcoholism can cause widespread damage to the brain that could potentially cause emotional processing abnormalities. These neurological changes are not uniform and appear to depend on factors such as age, gender, number of detoxifications, length of time drinking, how often and how much alcohol is consumed. The areas of the brain that have been found to be vulnerable to damage caused by alcoholism include: cortical regions such as the frontal lobes, subcortical areas such as the limbic system, basal forebrain and the thalamus (for a review see Oscar-Berman & Marinkovic, 2003). Some research has also pointed towards the right-hemisphere being more susceptible to alcohol related damage than the left (Oscar-Berman & Marinkovic, 2003). Finally it has also been found that alcoholics are vulnerable to cerebral atrophy of the whole brain. Given that these areas are important in emotional prosody production and perception it is not surprising that alcoholics have been found to have difficulties in this area (Oscar-Berman et al., 1990; Monnot et al., 2001; Monnet et al., 2003; Uekermann et al., 2005). What is less understood is how the brain reacts after a lengthy time of abstinence period, this will be briefly discussed in the next section.

What happens after abstinence?

Alone or in combination, the brain alterations seen in alcoholics could potentially cause emotional perception and production problems in alcoholics. Specifically, as some of the same brain structures that are implicated in emotional prosody processing are also affected by alcohol abuse, it is likely that emotional prosody deficits of alcoholics are a result of brain damage cause by drinking. However, as some “compensation” has also been observed in individuals with longer abstinent duration (e.g. blood flow increase, brain reorganization), it is unclear what long-term effects previous alcohol abuse can have on emotional communication (Chanraud, Pitel, Müller-Oehring, Pfefferbaum, & Sullivan, 2012; Oscar-Berman & Marinkovic, 2007; Oscar-Berman, Valmas, Sawyer, Ruiz, Luhar, & Gravitz, 2014; Sullivan & Pfefferbaum, 2005). It has been highlighted that different neuropsychological abilities (i.e memory, emotional skills and executive function) have different patterns of impairments, compensation and recovery within the brain networks associated (Oscar-Berman, et al., 2014). However, research within the domain of emotional skills and abstinence is sparse and is often related to relapse rates (Berking, 2011; Oscar-Berman, et al., 2014). It is beyond the scope of the present thesis to link specific brain damage caused by alcoholism and emotional communication abilities per se. Instead, the links previously hypothesised (see section above) were taken as motivation to explore this issue further. Specifically, this thesis will concentrate on identifying *if* and *how* long-term alcohol abuse can impact on emotional communication abilities in the auditory domain. This is an underexplored area; however, some anecdotal evidence exists that even AA still display difficulties in social settings that require emotional communication abilities.

So far this thesis has explained that the ability to express and understand emotions through the voice is essential to social communication and disruption within this modality may cause problems within daily relationships. Some research suggests that emotional prosody processing is impaired in recently detoxified alcoholics while next to nothing is known about after alcoholics abstain long-term. The goal of the thesis is to shed light on emotional prosody perception and production abilities of abstained alcoholics. To this aim, three studies were conducted. In Study 1, the main interest was to see whether long-term abstained alcoholics produce emotional prosody differently than individuals with no alcohol abuse history. Study 2 aimed to see if emotional utterances produced by abstained alcoholics would be perceived similarly to utterances made by healthy controls. In other words, this study assessed the impact of potentially altered emotional communication abilities in abstained alcoholics. Finally in Study 3, it was investigated if abstained alcoholics can recognise emotional prosody similarly to healthy controls. The novelty of latter study was further enhanced by using emotional stimuli materials expressed by individuals with no training in acting.

Study 1: The production of emotions

Introduction

The skill of understanding and expressing (vocal) emotions is vital for successful social interaction (Banse & Scherer, 1996; Pittam & Scherer, 1993; Scherer, 2003). Thus, if either the production or the perception of emotion is hampered, for example through alcohol abuse, it is likely to have severe detrimental effects on someone's social and personal life (Mitchell, 2007). It is well documented that long-term abstained alcoholics continue to exhibit a wide range of cognitive deficits; for example, they exhibit difficulties with problem solving, memory, perceptual tasks and learning (Nixon & Phillips, 1999; Parsons, 1987). The present study sought to investigate whether these deficits expand to emotional speech production. After all, a high proportion of social interaction is conveyed through nonverbal signals, which underlines how imperative nonverbal communication skills are. People make inferences about a person's identity and wellbeing simply from hearing their voice. Based on someone's tone of voice alone we can make an informed guess about the speaker's gender, age, nationality, social class or internal state (e.g. whether the speaker feels stressed or not). All this can be done without seeing the person or paying attention to what they are saying (lexical-semantic meanings of sentences; see Kreiman & Sidtis, 2013).

Hence, one important cue that listeners rely on when assessing how someone feels is emotional prosody, or the expression of emotion through tone of voice. Changes in pitch, loudness, tempo, rhythm, and voice quality can help infer how someone feels (e.g., Banse & Scherer, 1996; Paulmann, Pell & Kotz, 2008). Prosody conveys essential parts of speech, different from pure linguistic elements like lexical meaning, which can be used to verbally express feelings. Not surprisingly, research shows that listeners accurately identify emotions from vocal cues better than chance would predict (Pittam & Scherer, 1993) and it has been self-reported that prosody is the most common method of distinguishing emotions in real life situations (Planalp, 1998). A voice with no expressions has been highlighted to represent a mental health disorder (Russell, Bachorowski, & Fernández-Dols, 2003).

Physiology of speech production

To fully understand how (emotionally relevant) acoustic cues are produced it is helpful to provide some physiological background. There are three systems that assist speech production: the respiratory system, the phonation system and the resonance (articulation) system (Aronson & Bless, 2011). The respiratory system is the starting point for vocal expressions and consists of the lungs, trachea, thoracic cage and the diaphragm. The system provides a supply of air pressure that drives the phonation system. The phonation system includes the larynx (vocal folds and glottis) and the pharynx. This system produces the sounds we hear but the type of sound depends on how air is passed through the glottis.

In phonation, the vocal folds are brought close together by a number of laryngeal muscles which then causes air pressure to build up below the vocal folds, resulting in them parting. When air begins to flow through the glottis, air pressure causes the vocal folds to close and then reopen this is known as the Bernoulli effect (Juslin & Scherer, 2005). The frequencies produced by the air pressure correspond to the fundamental frequency (f0), which is what listeners perceive as pitch. The vocal folds are an important part of this structure as the length and thickness of them will determine the output of the F0. For example, if the vocal chords are large and thick the vibrations will occur less frequently therefore lower F0 (Juslin & Scherer, 2005). Also, the more tight the larynx is, and narrow the vocal chords are, the higher in intensity sounds will be, which is what is perceived by the listener as loudness.

Lastly the articulation system consists of the tongue, lips and teeth and make up the shape of the pharynx, which produces voiced and unvoiced sounds (Juslin & Scherer, 2005). The whole system is very sensitive and any physiological changes can have massive effects on an individual's acoustic pattern (Scherer, 1989).

Emotions and acoustic cues

Shouting semantically neutral phrases, such as 'What are you doing?' in a loud tone of voice alerts the listener to be wary of what is going to happen next. Uttering the same sentence in a quiet, slow voice might tell the listener that the speaker feels tender. Heightening or lowering of pitch are important characteristics of emotional speech; such acoustical parameters provide the listener with important information about the speaker's intentions and feelings.

Consistently researched acoustical cues of emotional speech - frequency (perceived as pitch), intensity (perceived as loudness) and duration (perceived as speech rate/tempo) (Banse & Scherer, 1996; Pittam & Scherer, 1993) - are fundamental to communication.

A small number of studies have tried to assign vocal patterns to emotions expressed through speech (Banse & Scherer, 1996; Sobin & Alpert, 1999). The majority of them have looked at the six basic emotions identified by Ekman (1992), which will also be investigated in the current study of voice production. The six basic emotions most commonly studied are anger, sadness, fear, surprise, disgust and happiness. Within research of vocal emotion expression, anger has been found to have an increased mean F0, mean intensity & utterance duration in comparison to neutrally spoken sentences (Wallbott & Scherer, 1986; Scherer, 1989; Scherer, 1991; Banse & Scherer, 1996). Acoustic cues associated with sadness have been found to be very consistent, too. Sad stimuli often show decreases in mean F0, F0 range, intensity and utterance duration compared to neutral stimuli (Banse & Scherer, 1996; Scherer, 1991; Murray & Arnott, 1993). Fear, on the other hand, shows an increase in mean F0, F0 range, mean intensity and faster speech rate (Scherer, 1989). Happiness is frequently linked to an increase in mean F0, F0 range, mean intensity and utterance duration (Juslin, 2013). However, some emotions are less reliably linked to distinct vocal profiles. For instance, expressions of disgust tend to reveal less consistent patterns. Some studies find an increase in mean F0 whereas others find a decrease (Juslin & Scherer, 2005) and Scherer (1989) suggests this could be due to the way emotions are induced. Looking at the emotional recognition literature highlights that disgust also tends to be poorly recognised, possibly due to the variability between speakers when expressing disgust (Johnston & Scherer, 2000). Lastly, emotions expressed in a surprised prosody have been found to produce a higher F0 mean compared neutrally spoken sentences and a decrease in the utterance duration (Juslin, 2013).

Past research

Research into the effects of alcohol abuse and emotional prosody production has been neglected despite the knowledge of persistent long-term cognitive problems in this group and importance of social interaction in this group. To our knowledge only one paper to date has investigated the emotional production of recently detoxified alcoholics (Monnet, Orbelo & Ross, 2001; cited in: Monnet, Orbello, Riccardo, Sikka & Ross, 2003). Monnet and colleagues (2003) asked both recently detoxified alcoholics and healthy controls to repeat sentences in one of the six basic emotions. Four judges were then asked to identify which emotion the speaker tried to express. In addition, pitch and intensity measurements were extracted to explore if acoustic cues could predict correctly identified emotions (Monnet, Orbello, Riccardo, Sikka & Ross, 2003). Results showed that pitch accounted for 50% of the variance of accurately identifying the emotions expressed by detoxified alcoholics, implying that judges used pitch to infer emotions from detoxified alcoholics' speech. This result further suggests that those speakers who do not vary their pitch properly might find it hard to communicate emotions accurately to others. The study highlights that pitch appears to be an important acoustic cue in utterances produced by recently detoxified alcoholics; however, the authors did not investigate other acoustic cues such as intensity and utterance duration that have been linked to emotional vocal expressions (see above). They also did not look at acoustic measurements in healthy controls utterance as a comparison. This makes it difficult to assess whether emotional expressions of recently detoxified alcoholics are comparable to utterances expressed by healthy participants.

Motivation for the study

As outlined in the general introduction, attempts to map out a neural network of prosody production has focused on patients suffering from damage to either cortical (e.g, frontotemporal and frontoparietal cortex) or subcortical brain areas (e.g, basal ganglia, internal capsule, thalamus). Both patient groups have been reported to suffer from problems with expressing emotions in their speech (Baum and Pell, 1999; Cancelliere & Kertesz, 1990; Kell, Morris, Scott & Dolan, 1998; Pichon, 2013). Interestingly, it has been found that very regular excessive consumption of alcohol can affect these same areas of the brain used in speech production, i.e the frontal cortex and subcortical areas (Chanraud et al., 2007; Moselhy, Georgiou & Kahn, 2001; Oscar–Berman, 2000; Oscar-Berman & Marinkovic, 2003). Moreover, as outlined in detail earlier, it is long known that long-term alcoholism can impact on a variety of cognitive and emotional functions (Oscar-Berman et al., 2014; Sullivan & Pfefferbaum, 2013). Even when an individual discontinues alcohol use, some long-term effects are still apparent. However, what is less certain, is exactly which brain regions remain damaged after abstinence and what structures become reorganised (Oscar-Berman et al., 2014). Therefore research and existing knowledge of how alcohol can affect brain structures long-term (Harper, 1998; Gazdzinski, Durazzo & Meyerhoff, 2005), raises the question whether the problem of expressing emotions through speech is apparent in individuals who have desisted from alcohol.

An additional motivator for the current study comes from anecdotal evidence. Listening to family members of alcoholics and reading about their stories, it seems that, even when an alcoholic is dry, they have difficulties in communicating emotion through speech. Surprisingly, these subjective impressions reported are not yet substantiated by empirical data, i.e. it is unknown whether differences in emotional prosody production are indeed found between AA and those who have never suffered from alcohol (or other substance) abuse. Lack of research in this area could be due to the tedious and time consuming methods involved with recording and cutting a large amount of stimuli. Given the importance of emotion expression, it is, however, a phenomenon worth investigating. Thus, the current study aimed to investigate whether AA display a similar vocal pattern to that of age and education matched healthy controls. In other words, the study set out to explore if years of alcohol abuse have detrimental long-term effects on how emotions are conveyed through speech.

To this aim, specific emotions were first induced in participants. Next, both AA and healthy controls were asked to produce sentences in the six basic emotions plus neutral whilst being recorded. The goal of this study was to then establish acoustic profiles uttered by AA and to compare them to profiles of healthy adult controls healthy controls. As this study was explorative in nature, no clear predictions could be made; however, if true that AA suffer from emotional prosody production difficulties, it can be assumed that their acoustic profile will differ from that of healthy controls. Direction of effects (pitch, duration, intensity alterations) could not be predicted with certainty due to lack of previous evidence.

Method

Participants

In total, 30 participants were tested. 15 (10 male, 5 female) AA participants (age range from 33-76 years) participated in the study. They were recruited via newspaper, radio adverts and leafleting in Alcohol Anonymous and other self-help groups. Each participant had been abstained from alcohol for at least one year (abstinence ranged from 1-32 years). The self-reported number of years for alcohol dependence ranged from 3-27 years. All participants had a past medical diagnosis of alcohol dependence and met the criteria for alcohol dependence according to the DSM-IV (Patient information can be found in Table 1). In addition, 15 healthy control participants (8 females and 7 males) matched for age and education as closely as possible took part in the study. None of them reported having a drinking problem or any other addiction in the past (full participant information can be found in Table 1).

All participants self reported they were not currently suffering from any mental health condition such as depression or anxiety; were free from any neurological problems and were not taking any psychotropic medication. The number of years of education for each group was worked out from the number of completed years in education from primary school. Both groups were assessed using a number of control measures that are thought to influence emotional processing. Each of the following measures used a self-completion questionnaire method: Depression (Patient health questionnaire (PHQ-9), Kroenke, Spitzer & Willams, 2001); Anxiety disorder (GAD-7, Spitzer, Kroenke, Williams & Lowe, 2006); Optimism and pessimism (Revised life orientation test (LOT-R), Herzberg, Glaesmer, & Hoyer, 2006).

Table 1: Demographic and patient information for participants (Mean, *SD*)

Variable	Abstained Alcoholics	Healthy Controls
Sex (F/M)	5/10	8/7
Age *NS*	51.87 (12.98)	51.27 (13.32)
Education *NS*	13.91 (3.42)	15.8 (3.56)
Duration of the disease	13.7 (7.55)	N/A
Years of abstinence	9 (9.10)	N/A
Number of alcoholic drinks per week	N/A	2.33 (3.2)
GAD-7 **	6.73 (4.53)**	2.6 (3.6)**
PHQ-9 *NS*	4.93 (3.61)	3.07 (2.66)
LOT-R *NS*	13.33 (5.01)	15.07 (4.25)

N/A means not applicable, **= The difference was significant to the value of p<.05. Scores 0-5 for the GAD-7 represent mild anxiety, 6-10 moderate, 11-15 moderately severe anxiety, 16-21 severe anxiety. For PHQ-9 scores from 0-5 represents mild depression, 6-10 moderate depression, 11-15 moderately severe depression, 16-21 severe depression. A score of over 7 on the GAD-7 represents clinical anxiety and over 9 on the PHQ-9 clinical depression. For the LOT-R higher scores represent higher optimism.

Materials

20 semantically neutral sentences (four to six words long) were used as stimuli. For example, sentences such as “The book was green” and “It was a heavy car” were used as stimuli. The complete list of sentences can be found in Appendix 1.

Procedure

Participants were asked to intone 20 semantically neutral sentences in one of six emotions or neutral while being recorded. The procedure was fully explained to participants and each gave full consent before the start of the session. Participants were paid £5 for their time. The study was approved by the ethical committee of the University of Essex. Participants were tested individually in either laboratory booths at the Department of Psychology at the University of Essex, or in a quiet room in the participant’s own home. Each testing session lasted approximately 40 minutes. Before testing began, participants were asked to complete several questionnaires: background questionnaires, LOT-R, GAD-7 and PHQ-9.

Before intoning the sentences in each emotion participants were provided with a short scenario that depicted the emotion in question as part of a minor emotion induction procedure. Following the scenarios they were also asked to describe a time when they had felt that emotion to further help them feel the emotion before expressing it. Responses to these induction procedures were not recorded. All participants were then asked to intone the 20 sentences repeating each sentence three times in each of the six emotions plus neutral. All 20 sentences were recorded in the given emotion before moving onto the next. In total, each participant thus produced 420 utterances (6 emotions plus neutral x 20 sentences x 3 repeats of each sentence). Participants were instructed to start with neutral. Then, they were given the opportunity to indicate their preference for the emotion they had to intone next. No exemplars were given for the prosody that should be used. Sentences were recorded with the program Audacity, using a high-quality clip-on microphone, using a mono channel 16 bit 44,100 HZ sampling rate. The recording session lasted approximately 30 minutes.

Design

The study employed a 2 x 7 mixed design including the between-subjects factor speaker group (AA, healthy controls) and the within-subjects factor emotional tone of voice (neutral, fear, anger, disgust, sadness, surprise and happiness). Mean acoustical variables (pitch, duration, intensity) served as the dependent variables.

Results

All recordings produced by AA & healthy controls were acoustically analysed using Praat (Boersma & Weenink, 2012). Means and standard deviations were computed for each acoustic variable from the raw data. Table 2, shows that all emotions were expressed with different pitch, pitch range, amplitude, amplitude range and speech duration. For instance, angry sentences were expressed with high pitch and high intensity when compared to neutral. Sad sentences were expressed using slower speech rate and slightly lower intensity when compared to neutral.

Psychological Measures

As represented in Table 1, AA and healthy controls were similar in age ($t(14)=.12$, p=.903) and years of education ($t(14)=1.50$, $p=.154$). The two groups did not differ on scores for depression ($t(14)=1.59$, $p=.134$). However, the two groups significantly differed in scores for general anxiety disorder ($t(14)=-3.65$, $p=.003$). Showing that the alcoholic group presented higher anxiety levels than healthy controls.

To investigate the potential influence of anxiety scores on acoustic measures Person's correlations were calculated within each group. No significant correlations were found within the alcoholic group (all *P*'s>.05). Within the healthy control group there was a significant correlation for the acoustic cue mean amplitude for the emotion sad (*r*(15)=5.76,*p*=0.25). All other correlations non significant (all *p*'s>.05).

Table 2: Means (SD) for each acoustic variable per group (AA: Abstained alcoholic, HC: Healthy control). Pitch was measured in Hz, duration in seconds and amplitude in dB.

Group	Emotion	Mean pitch (SD)	Pitch range (SD)	Mean amplitude (SD)	Amplitude range (SD)	Utterance duration
AA	**Anger**	166.72 (13.70)	160.84 (11.57)	68.55 (1.38)	34.27 (1.05)	1.46 (.05)
	Disgust	152.24 (10.95)	162.07 (14.58)	61.68 (1.12)	33.10 (.85)	1.46 (.07)
	Fear	150.94 (14.05)	122.88 (11.75)	62.28 (1.34)	31.18 (.94)	1.35 (.04)
	Happiness	166.91 (13.60)	151.47 (11.85)	64.40 (1.09)	33.25 (.89)	1.46 (.05)
	Neutral	141.39 (8.51)	140.64 (11.38)	59.40 (.88)	31.04 (.82)	1.37 (.05)
	Sadness	140.36 (9.25)	141.72 (12.29)	57.98 (.96)	30.66 (.95)	1.46 (.04)
	Surprise	180.79 (18.74)	155.4 (14.31)	65.71 (1.27)	32.91 (1.05)	1.38 (.06)
HC	**Anger**	188.97 (13.70)	189 (11.57)	66.49 (1.38)	36.67 (1.05)	1.47 (.05)
	Disgust	176.28 (10.95)	207.76 (14.58)	60.83 (1.12)	36.35 (.85)	1.55 (.07)
	Fear	197.70 (14.05)	153.2 (11.75)	64.26 (1.33)	32.58 (.94)	1.34 (.04)
	Happiness	183.14 (13.60)	168.16 (11.85)	62.66 (1.09)	34.37 (.89)	1.47 (.05)
	Neutral	151.61 (8.51)	155.35 (11.38)	58.09 (.88)	33.47 (.82)	1.47 (.05)
	Sadness	153.78 (9.25)	165.13 (12.28)	56.83 (.96)	31.94 (.95)	1.45 (.04)
	Surprise	237.88 (18.74)	223.82 (14.31)	66.15 (1.27)	33.90 (1.05)	1.43 (.06)

Experimental results

Analysis of variance (ANOVA)

To explore differences in emotion production between healthy controls (HC) and AA, five separate 2 (speaker group: HC & AA) by 7 (emotion: angry, disgust, fear, happy, neutral, sad and surprise) ANOVAs were calculated with each acoustic variable serving as dependent variable. Effect size was measured using omega-square (Ω), which is an estimate of the variance accounted for by the independent variable. Effect sizes can be interpreted in the following way values between 0.0009 – 0.048 are small effects, between 0.048 and 0.138 medium and values above 0.138 are seen to be large effects (for more information see, Olejnik & Algina, 2003).

<u>Mean pitch</u>

Results indicated a significant main effect of emotion, (F(6,168)=26.382, *p<..001,* Ω=.69) showing that surprise (209.33 Hz) had the highest mean pitch followed by anger (177.84 Hz), happiness (175.02 Hz), fear (175.32 Hz), disgust (164.26 Hz), sadness (147.07 Hz) and lastly neutral (146.50 Hz). To investigate whether emotional prosody differs from neutral prosody, pairwise comparisons between each emotion and neutral were conducted. Results showed that all emotions were significantly different from neutral (p<.001), apart from sadness (p=.804).

Crucially, there was a significant speaker group x emotion interaction, (F(6,168)=4.560, p<.001, Ω=.39). The interaction was followed up by emotion using pairwise comparisons. This revealed that healthy controls used higher pitch when expressing fear (p=.026) and surprise (p=.040) compared to AA. Looking at the effects by group, pairwise comparisons revealed that AA mean pitch use for neutral speech differs from their mean pitch use when expressing angry (p=.008), disgust (p=.044), happy (p=.002) and surprised (p=.010) prosody. In contrast, healthy controls use of mean pitch for neutral speech differed significantly from their mean pitch when expressing angry, disgust, fearful, happy and surprised prosody (all *p*s<.001).

Pitch range

Results indicated a significant main effect of emotion ($F(6,168)=10.807$, $p<.001$, Ω=.69) showing that surprise was expressed with the largest pitch range (189.61 Hz), followed by disgust (184.91 Hz), angry (174.92 Hz), happy (159.81 Hz), sad (153.42 Hz), neutral (148 Hz) and lastly fear (138.04 Hz). Follow up tests were conducted and revealed that pitch range used for angry (p=0.11), disgust (p=.002) and surprise (p=.001) speech differed significantly from pitch range for neutral speech. A significant main effect of speaker group ($F(1,28)=5.355$, $p=.028$, Ω=.09), showing that healthy controls used a wider pitch range (180.35 Hz) than AA (147.86 Hz).

Main effects were qualified by a significant emotion x speaker interaction ($F(6,168)=2.542$, $p=.022$, Ω=.16). Pairwise comparisons revealed that healthy controls had a significantly higher pitch range than AA for disgust (p=.035) and surprise (p<.001). Follow up tests by group showed that AA did not significantly differ in pitch range for any emotional utterances compared to neutral. In contrast, healthy controls used a different pitch range for angry (p=.035), disgust, (p=.002) and surprise (p<.001) utterances when compared to neutral.

Mean amplitude

The main effect of emotion was significant (*F*(6,168)=50.631*, p*<.001, Ω= .64), indicating angry utterances had the highest mean amplitude (M=67.52 Hz), followed by surprise (M= 65.93 Hz), happy (M=63.53 Hz), fear (M=63.27 Hz), disgust (M=61.25 Hz), neutral (M=58.75 Hz,) and lastly sad (M=57.41 Hz). All emotional utterances were significantly different to neutral (all *p*s<.001).

No other effects were found for mean amplitude suggesting both groups appear to be intoning emotions with similar intensities (Speaker: *p*=.621; Speaker*emotion interaction: *p*=.465).

Amplitude range

The main effect of emotion was significant *(F*(6,168)=50.631*, p*<.001, Ω=.69), revealing angry had the largest amplitude range (35.47 Hz,), followed by disgust (34.72 Hz,), happy (M=33.81 Hz), surprise (33.40 Hz), neutral (32.26 Hz), fear (31.89 Hz) and lastly surprise (31.30Hz). Follow up tests found angry (*p*<.001), disgust (*p*<.001) and happy (*p*=.002) utterances differed significantly in amplitude range from neutral speech.

No other effects were found (Speaker*emotion interaction: *p*=.340). The main effect of speaker approached significance (*p*=.093, Ω=.10). Comparisons of the means displays that Healthy controls used a wider amplitude range than AA.

Utterance duration

A significant main effect of emotion (F(6,168)=5.583, p<.001, Ω=.75) was yielded by the analysis, showing that disgust utterances were longest (1.51 MS), followed by angry and happy (1.46 MS), sad (1.45 MS), neutral (1.42 MS,), surprise (1.4 MS) and fear (1.34 MS). Follow up tests revealed that disgust and fear significantly differed in duration to neutral (both *p*s<.05).

No other effects were found for utterance duration suggesting that both groups expressed emotional and neutral prosody with a similar speech rate (Speaker: *p*=.554; Speaker*emotion interaction: *p*=.316).

In sum, these data suggest that emotional utterances were produced with varying acoustic profiles. For all parameters investigated, we found that neutral prosody differed significantly from emotional prosody. Speaker group differences when expressing emotions were found for mean pitch and pitch range. Amplitude range was also slightly wider for healthy controls.

Drinking Behavior variables

Persons correlations were computed between length of time abstained (LOA), duration of abuse (DOA) and each acoustic variable. Results showed there was a significant positive relationship between LOA and mean amplitude for the emotion disgust (*r*(15)=.57, *p*=.028). No other significant results were found for LOA (all *p*'s<.05). A significant negative relationship was found between DOA and utterance duration for angry ($r(15)=-.63$, $p=.012$), mean amplitude for disgust utterances ($r(15)=-.61$, $p=.015$) and amplitude range for sad ($r(15)=-.60$, $p=.019$). No other correlations reached significance (all *p*'s<.05).

Discussion

This study investigated how alcohol abuse can influence emotional speech production when an individual has abstained from alcohol for over a year at least. As mentioned previously, anecdotal evidence from family members suggests even after an alcoholic has abstained long-term they have difficulties in expressing emotions through speech prosody in a typical manner. The current data support this assumption, as it revealed pitch differences between healthy controls and AA. In particular, results showed that AA seem to modulate their pitch less to express emotions when compared to healthy controls who seem to differentiate their pitch more between emotions. Abstained alcoholics and healthy controls use speech rate in a similar manner and while both groups also seem to use mean intensity similarly, marginal differences between the two groups were found for the parameter amplitude range. In particular, healthy controls seemed to use a wider amplitude range than AA.

Emotions and acoustic patterns compared to past research

The results of the present study are in line with past research in that acoustic cues for emotional utterances are produced differently compared to neutrally spoken utterances (Banse & Scherer, 1996; Sobin & Alpert, 1999). However, acoustic profiles found in the present study were slightly different to those previously reported. The present study found healthy controls spoke with an increased pitch when producing sadness compared to neutrally spoken sentences; past research has consistently found a decrease in these acoustic cues. Interestingly, sadness has been found as one of the emotions to be more recognised when produced by non-actors compare to trained actors (Jürgens, Grass, Drolet, & Fischer, 2015). Fear produced by healthy controls in this study also showed a decreased F0 range and speech utterance whereas it was previously found to have an increase in both of these acoustic cues (Scherer, 1989). Inconsistency could be due to the way emotions are induced as suggested by Scherer (1989). This study attempted to induce emotions in order to produce a more natural speech. Emotions were induced by reading a scenario, participants were then asked to imagine a scenario where they have felt that emotion and explain it to the researcher. Differences in the acoustic cues they produced could have evolved from the way the emotion was imagined. To support this, Scherer (1986) suggests that pitch as an acoustic cue maybe represented in the way the emotion was aroused. Also, here, the researcher did not specify the exact emotion category they intended the participant to express. For example there are lots of ways anger is expressed and there are key vocal differences between hot explosive anger and cold anger (Scherer, 1986). Future research will need to pay attention to specifying the exact emotion in order to build and compare reliable and testable data. Juslin and Scherer (2005) suggest using manipulation checks such as emotion scales could be one way to control for any difference of experienced emotions between participants. Inconsistency in the data here compared to past research could also be highlighting the differences between real life speakers' production compared to actors that have been previously used. Some researchers have suggested that trained actors produce more intense and over exaggerated versions of the emotion intended (Barrett, 2011

Douglas-Cowie et al. 2003; Jürgens, Grass, Drolet, & Fischer, 2015). In fact trained actors have been found to articulate expressions differently to non-actors including producing higher pitch (Jürgens, Hammerschmidt & Fischer, 2011; Jürgens, Grass, Drolet, & Fischer, 2015).

Effects of alcohol abuse on acoustic cues used in emotional prosody production

The results from this study suggest that AA do vary relevant acoustic cues (e.g. amplitude and duration) similarly to healthy controls when expressing emotions through sentence prosody. However, results also highlight that they modulate their pitch less than healthy controls. Monnet et al., (2003) found, when investigating the effects pitch has on accuracy identifying emotions, pitch was positively correlated with the responses and accounted for 50% of the effects found. The results from this study are important as they, for the first time, support the claim that AA may struggle to use pitch appropriately when expressing emotions. Further, an unreported explorative discriminant analysis was run on the data and found sentences from AA were less accurately identified by this discriminant analysis than those from healthy controls. Together, this highlights that the pitch differences observed between the two groups can be considered meaningful (i.e. have an impact on the way their speech is perceived). Difficulties in fine-tuning the vocal apparatus can ultimately lead to a breakdown in social communication.

Pitch has been identified as a major predictor of prosody recognition (Pell & Baum, 1997; Scherer, 2003) and one that is universally (i.e. across cultures) used (Pell, Monetta, Paulmann & Kotz, 2009). Being unable to accurately produce different pitches that help differentiate between emotions, for example neutral and sadness or neutral and angry, makes it difficult for others to recognise the intended emotion. Pitch as an acoustic cue of emotional speech has also been correlated higher ratings of speaker skills (Strangert & Gustafson, 2008). The results here could suggest that limited modulation of pitch leads to lower recognition of emotions. As it has already been highlighted the ability to communicate emotions is an important and necessary aspect of social relationships. Given that Social support has been found to be important in the recovery process (Booth, Russell, Soucek & Laughlin, 1992; Groh, Jason, Davis, Olson, & Ferrari, 2007). This disruption demonstrated within the dry alcoholic group could make abstaining harder than it already is for the individual. For example imagine a situation where a dry alcoholic utters ‘I am OK’ in what they believe to be an angry sarcastic tone of voice but rather it is expressed more neutral to the listener. This could lead their social partner into believing they really are ok and not offer support or assistance.

This study’s participants had abstained from alcohol between 1-32 years. We found that length of abstinence did not correlate with pitch use, suggesting that emotional pitch production is affected similarly in all alcoholic participants. It is worth highlighting that this study had a large range of number of years in the abstinence group. Future research should look at larger controlled groups of abstinence for example 1-5 years, 5-10 and 10+ long-term abstained groups in order to establish detail to the recovery process and production of emotional prosody.

Difficulty in using pitch appropriately could be due to either the speech production system being affected or the brain areas modulating the cues. As outlined above, the speech production system is complex and long-term alcohol abuse could cause damage to this system. The vocal folds are an important part of pitch output and it has been shown that excessive use of alcohol can damage them or the muscles surrounding them (Aronson & Bless, 2009; Schiel, Heinrich, Barfüsser & Gilg, 2008). However, it bears noting that, there is a strong link between smoking and alcoholism (Difranza and Gurrera, 1990), and smoking has a known impact on voice mechanisms (Aronson & Bless, 2009). However, researchers did not control for this factor and therefore cannot comment on it.

The present study cannot comment directly on whether lasting damage to the brain (or the vocal folds) caused by alcohol abuse could have contributed to the results found here. Future research investigating the underlying cause for the differences in pitch would be needed. Specific brain parts' known vulnerability to alcohol includes brain areas used in prosody production such as frontal lobes, anterior temporal lobes, and subcortical brain structures (Chanraud et al., 2007; Moselhy, Georgiou & Kahn, 2001; Oscar–Berman, 2000; Oscar-Berman & Marinkovic, 2003). It is also well documented that alcohol abuse can cause brain shrinkage and damage to tissues such as brain lesions (Oscar-Berman, 2014). However, the question still arises whether these brain areas remain affected after long-term abstinence or whether other brain areas pick up functions that may have been impaired.

It bears noting the anecdotal evidence that comes from family members indicates that, even when an individual has abstained from alcohol, they find it difficult to express emotions through speech. This in turn leaves the family member finding it difficult to interpret the intended emotional meaning. Therefore, it is clear there are differences in the way AA produce emotional utterances compared to healthy controls. This study found pitch could account for some of these differences; however, there must be other cues that contribute towards these difficulties. Future studies would benefit from investigating further acoustic cues and voice qualities to build a better picture of what combination of factors contribute towards difficulties observed by family members.

Conclusions

In summary, the present study indicates that some of the difficulties that family members may face in recognising intended emotional meanings of their alcoholics might derive from their inability to moderate pitch. There is a lack of research in the field of alcohol abuse and emotional prosody production and the present study provided some experimental insight into this phenomenon.

Study 2: Perceptions of Abstained Alcoholic's and Healthy Control's emotional speech.

Introduction

As mentioned previously, anecdotal evidence from family members suggests that, even when their loved ones have abstained from alcohol long-term they are still faced with difficulties in understanding the intended emotional meanings AA are attempting to communicate (Al-anon, 2015). Study 1 indeed reports differences between healthy controls and AA when expressing emotions. In particular, AA were less likely to modulate their pitch cues like healthy controls. This inability to fine-tune pitch appropriately might mean that AA could sound rather flat, or mono-pitch, to listeners.

While it is important to quantify differences between AA and healthy controls with regard to acoustic cue use, it is also important to assess whether the speech that they produce is actually *perceived* as different. In other words, the question is if the inability to use cues appropriately affects judgments of their speech samples. The goal of the present study was to assess whether people would perceive emotional sentences spoken by AA differently to that of healthy controls. Patient studies involving neurodegenerative diseases such as Parkinson's disease (PD) found that participants who are unable to vary pitch, intensity and speech rate in different emotions compared to healthy controls (Pell, Cheang & Leonard, 2006) are judged as sounding more 'negative'. For instance, Jaywant and Pell (2010) asked listeners to rate the speech of both Parkinson's disease and healthy control participants who were asked to describe a picture of either a cake or a fire. Listeners were firstly asked to rate the speaker's personality from the recordings heard and then they were asked to rate the content. Results showed that Parkinson's disease patients were perceived to be less involved, less friendly and less happy than healthy control speakers, although linguistically they were perceived as coherent and well organized (Jaywant & Pell, 2010). The authors also found that some of the acoustic cues used by the Parkinson's disease patients correlated with the impressions of the listeners. Evidence from neurological patients such as stroke patients has also demonstrated difficulties in producing emotional prosody (House, Rowe & Standen, 1987). In one such study right-hemisphere and left-hemisphere stroke patients (non-depressed), depressed patients and healthy controls were required to read a sad, neutral and excited passage in the correct tone of voice. First they read it to themselves and then to a tape recorder. The recordings were then collected and then presented to 12 medical students who rated the emotional tone of voice in each of the random recording they heard. They had to rate each recording based on seven point scale where 1 was sad and 7 was excited and then decide if the speaker sounded depressed or not. Results indicated that listener ratings for both right-hemisphere and left-hemisphere stroke speakers were similar to ratings of depressed speakers. All three groups of speakers were rated as sounding depressed and both struggled with intoning the excited passage compared with healthy controls. Authors concluded that both right-hemisphere and left hemisphere demonstrate emotional prosodic voice quality similar to speakers who suffer from depression (House, Rowe & Standen, 1987). Research in long-term abstinence from alcohol and emotional prosody production would benefit from gaining listeners' impressions such as the studies presented above.

The motivation of the present study was to build a clearer picture of families' views that AA still use prosodic cues inappropriately. The present study used individuals who were completely unaware of the speaker's disease and asked them to rate the emotion they perceived in the utterance. Listeners were then asked to rate each utterance based on three voice qualities identified by the researcher. The voice qualities selected were husky, flat and emotion expressed. The voice quality flat/monotone was selected partly because an inability to produce or combine the correct acoustic cues effectively could make the perception of monotone/flat speech. It is also one that has been widely used to describe Parkinson disorders speech and as alcoholism has been associated with displaying Parkinsonian symptoms (Neiman, Lang, Fornazzari & Carlen, 1990) it is one worth investigating. Secondly husky was selected because it is a voice quality that could have an impact on the way emotions are produce and then perceived (Gray, 1943; Kreiman, Vanlancker-Sidtis, & Gerratt, 2008). It is also one you often hear people using to describe alcoholics and AA speech, but this has not been experimentally tested. Lastly, it was investigated how emotionally expressive the speaker sounds. The assumption was made that listeners would be less accurate at recognising emotions from the speech of AA and a plausible suggestion to this could be they feel AA did not truly feel the emotions they were expressing and so this was investigated here.

Based on the anecdotal evidence and results found in Study 1, it is predicted not only that AA emotional utterances will be perceived less accurately compared to healthy controls, but that there will also be a difference between the two groups in the voice qualities used in that AA will be rated more husky and flat in emotional utterances but less emotionally expressive.

Method

Participants

10 females and 11 males were recruited through campus and online advertisement. The participant's age ranged from 20-51 years (*M*= 30.8 years, *SD*= 7.9) and mean number of years in education was 16.52 years (*SD*= 2.7). All participants were native speakers of English, reported normal or corrected-to-normal vision, and no hearing impairments. Participants were excluded from the study if they self-reported any history of mental health (e.g. depression), neurological problems (e.g. stroke), or a history of alcohol or substance abuse. None of the participants self reported any biological family members who had a known history of alcohol abuse, but one participant self reported that their stepfather had a history of alcohol abuse. Participants were reimbursed a small fee (£5) for their time.

Materials

105 AA utterances (15 sentences x 7 emotions) and 105 healthy control's utterances were selected randomly from the recordings produced in Study 1. The speakers were all participants who took part in Study 1: 15 AA speakers (5 female & 10 male) and 15 healthy control speakers (8 female and 7 male). Materials were acoustically analysed and results can be found in Table 3.

Neutral	F0 Mean	F0 Range	Utterance Duration	Intensity Mean	Intensity Range
Abstained Alcoholics	153.69 (31.55)	160.09 (106.72)	1.41 (0.22)	58.85 (7.41)	30.01 (2.13)
Abstained Controls	159.13 (36.31)	147.85 (126.52)	1.57 (0.27)	58.29 (8.32)	36.89 (7.17)
Happy					
Abstained Alcoholics	147.76 (30.26)	125.80 (83.81)	1.49 (0.33)	66.03 (7.83)	31.51 (6.54)
Abstained Controls	179.51 (42.77)	164.81 (120.05)	1.52 (0.31)	63.92 (7.75)	34.57 (5.76)
Sad					
Abstained Alcoholics	149.24 (39.27)	162.29 (140.75)	1.48 (0.46)	59.46 (7.95)	31.58 (4.62)
Abstained Controls	142.21 (41.55)	183.38 (98.44)	1.43 (0.20)	58.28 (7.16)	31.37 (4.98)
Angry					
Abstained Alcoholics	179.24 (32.95)	131.09 (83.32)	1.52 (0.28)	65.02 (8.13)	35.51 (5.44)
Abstained Controls	177.63 (47.21)	189.63 (130.63)	1.34	67.03 (8.79)	38.01 (8.34)

Surprise					
Abstained Alcoholics	170.96 (36.82)	136.75 (104.67)	1.24 (0.21)	64.69 (7.38)	30.07 (4.24)
Abstained Controls	211.44 (43.61)	170.02 (93.50)	1.41 (0.26)	68.12 (7.63)	32.76 (8.93)
Disgust					
Abstained Alcoholics	147.58 (39.72)	150.15 (115.92)	1.60 (0.46)	62.67 (8.87)	35.04 (7.54)
Abstained Controls	171.61 (46.91)	173.07 (109.70)	1.43 (0.26)	62 (8.55)	36.53 (6.97)
Fear					
Abstained Alcoholics	157.56 (34.78)	126.28 (100.13)	1.35 (0.39)	62.4 (7.28)	30.27 (5.21)
Healthy Controls	213.04 (38.04)	167.78 (139.67)	1.28 (0.39)	63.27 (7.43)	34.65 (8.68)

Table 3: Acoustic parameters for both *abstained alcoholics* and healthy controls from the randomly selected files from Study 1. Mean (SD).

<u>*Design:*</u>

This study employed a 2x7 within subjects design with speaker (AA & healthy control) and emotional tone of voice (happiness, sadness, disgust, surprise, fear, anger & neutral) as independent variables and recognition accuracy as dependent variable. In addition to assessing emotion recognition accuracy, participants were also asked to rate the voice quality of all stimuli (see below for details). Results of these ratings were analysed in separate ANOVAs with speaker (AA & healthy controls) and emotional prosody (happiness, sadness, disgust, surprise, fear, anger, and neutral) as independent variables and rating results as dependent variables.

Procedure:

All participants gave informed consent and the study was ethically approved by the Ethics Committee of the University. Each participant was tested individually in laboratory booths at the Department of Psychology. Testing lasted approximately one hour.

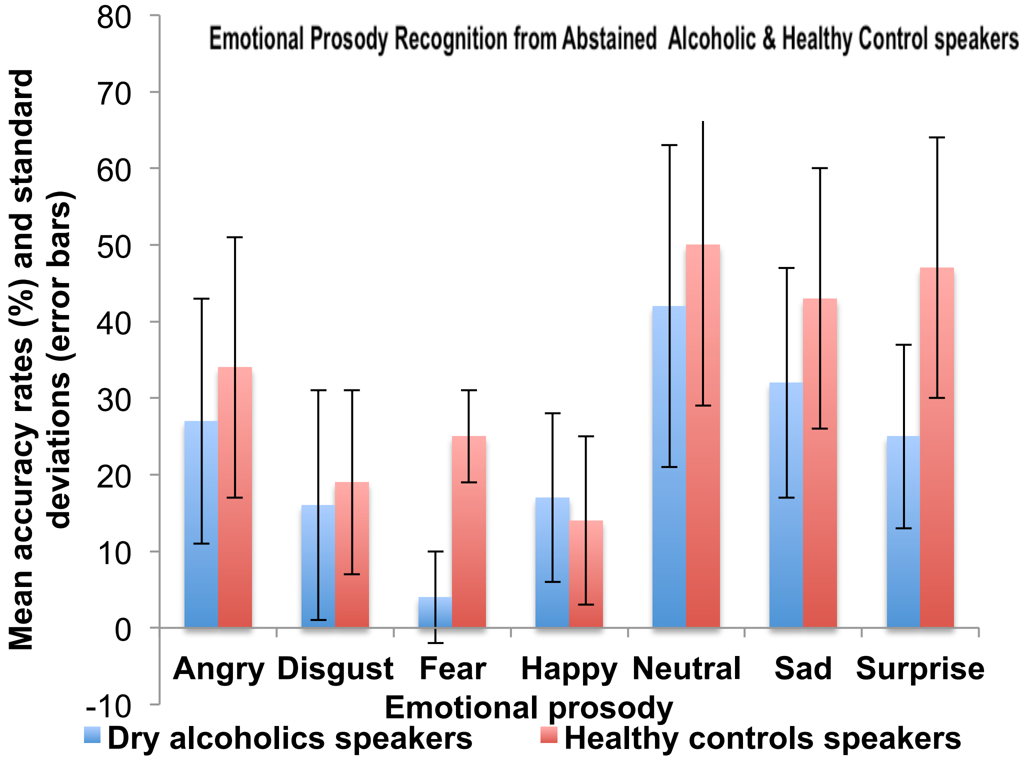
210 emotional utterances were presented by means of Superlab software. Materials were presented through loudspeakers located to the left and right of a computer monitor. Participants were instructed to first listen to the utterance and then to make four independent judgments about these utterances. First, participants were asked to decide which emotional tone of voice they believed the speaker was using. In order to make their response, a response screen was presented with buttons for each one of the seven target emotions (buttons were labeled as happy, sad, disgust, surprise, fear, angry & neutral). Next, a seven-point rating scale appeared on screen (where 1 represented ‘Not at all’ and 7 presented ‘very much’) and participants had to make a decision about the speakers’ voice quality. First, they were asked ‘‘How flat does the speaker sound?’’ followed by ‘’Did the speaker sound as if they really felt the emotion?’’ and finally ‘‘How rough/husky did the speaker sound?’’ A trial sequence was thus as follows: a fixation cross was presented

for 200ms followed by the presentation of the sentences (max duration: 10 ms), followed by a seven choice response screen. After participants provided their emotional assessment, they were presented with three rating scale screens, which also contained the question at hand. A blank screen was presented for 500 ms as an inter-stimulus interval. No time limit was imposed for responses, but participants were instructed to answer as quickly and accurately as possible. After five practice trials, participants had the chance to ask the experimenter for help. The main experiment was divided into 7 blocks that consisted of 30 trials each. Each block was followed by a short break.

Results

Emotion recognition accuracy

The raw data were pooled and means and standard deviations for recognition accuracy rates for both Abstained alcoholic & healthy control speakers in each emotion category were calculated (Refer to Graph 1 below).



Graph 1: Accuracy (%) of mean emotional recognition responses for each speaker group (AA & healthy controls). Bars show correct responses for each emotion and the error bars represent standard deviations.

To examine whether there was a difference between the way listeners recognised AA speakers compared to healthy controls, a 2 (speaker: AA & healthy controls) by 7 (emotion: angry, disgust, fear, happy, neutral, sad and surprise) fully within ANOVA was conducted. The analysis revealed a main effect of speaker ($F(1,20)= 72.825$, $p<.001$) indicating that listeners were more accurate at identifying materials spoken by healthy controls (M=34%)

compared to materials spoken by AA (*M*=23%). Results also showed a significant main effect of emotion (F (6,120)=19.431, p<.001) revealing that neutral prosody was best recognised (45%), followed by utterances intended to express anger (32%), sadness (39%), pleasant surprise (36%), disgust (18%), happiness (15%) and lastly fear (14%). Pairwise comparisons revealed a significant difference between recognition rates for neutral stimuli compared to stimuli spoken in a disgusted, fearful & happy tone of voice (all *p*s<.05).

Crucially, a significant two-way interaction between speaker and emotion was also found (F(6,120) =9.270, p<.001). The interaction was followed up for each emotion using pairwise comparisons. These analyses revealed that listeners were significantly better at recognising emotions expressed from healthy control speakers compared to AA when sentences were intoned in an angry (37% vs 27 %, p=.013), fearful (24% vs 4%, p<.001), neutral (50% vs 40%, p=.011), sad (44% vs 34%, p=.001), or surprised (48% vs 24%, p<.001) tone of voice.

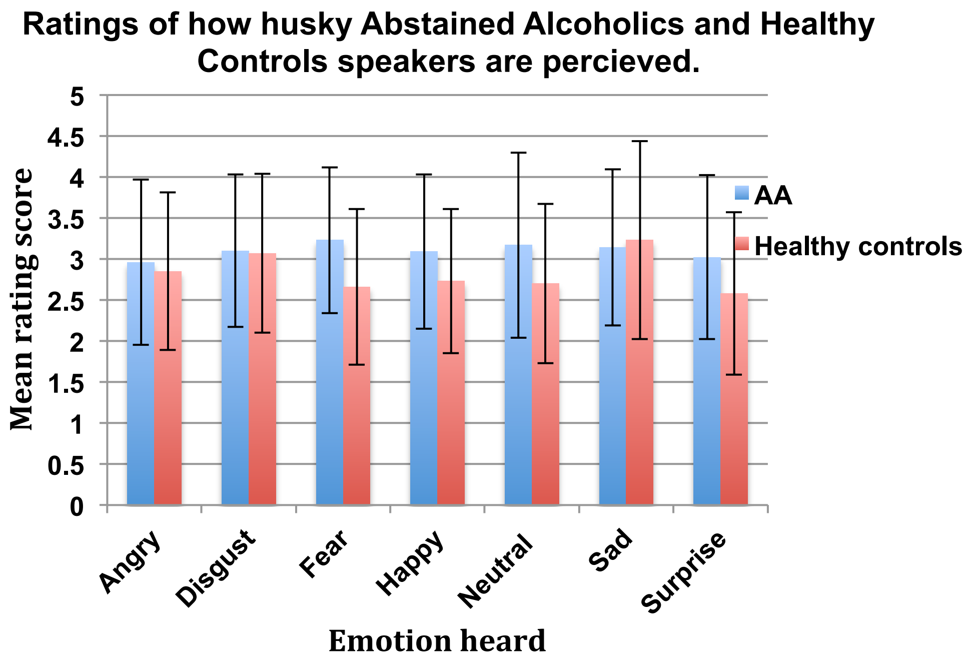
Voice quality analysis

To examine whether listeners could detect voice quality differences between the two groups when speakers were expressing emotions, three separate two-way ANOVAs were computed. In the analyses, the seven basic emotions (anger, disgust, fear, happiness, sadness, surprise, and neutral) and speaker group (AA & healthy controls) served as independent variables, while each voice quality attribute (Flat, husky & how much the speaker felt the emotion) served as dependent variable. Each voice quality attribute was rated on a scale from 1 to 7. Responses were averaged for each participant and emotion before carrying out the analyses.

<u>Husky scale</u>

The ANOVA revealed a significant main effect of speaker ($F(1,20)=5.463$, $p=.030$), showing that listeners found utterances spoken by AA (M=3.10) sounded more husky than utterances spoken by healthy controls (M=2.83). Results also showed a significant main effect of emotion ($F(6,120)=3.176$, $p=.006$), indicating that listeners found that sad prosody (M=3.19) sounded most husky, followed by disgust (M=3.08), fear (M=2.94), neutral (M=2.93), happy (M=2.91), angry (M=2.90) and lastly surprise (M=2.80) utterances. Pairwise comparisons revealed a significant difference between husky recognition responses for neutral stimuli compared to stimuli spoken in a sad tone of voice ($p=.003$).

These main effects were qualified by a significant two-way interaction between speaker and emotion, ($F(6,120)= 4.046$, $p=.001$). The interaction was followed up for each emotion using pairwise comparisons. These analyses revealed that sentences produced in a surprised, fear, neutral or happy prosody by AA were rated as significantly more husky than those uttered by healthy controls ($p<.05$) (refer to Graph 2).

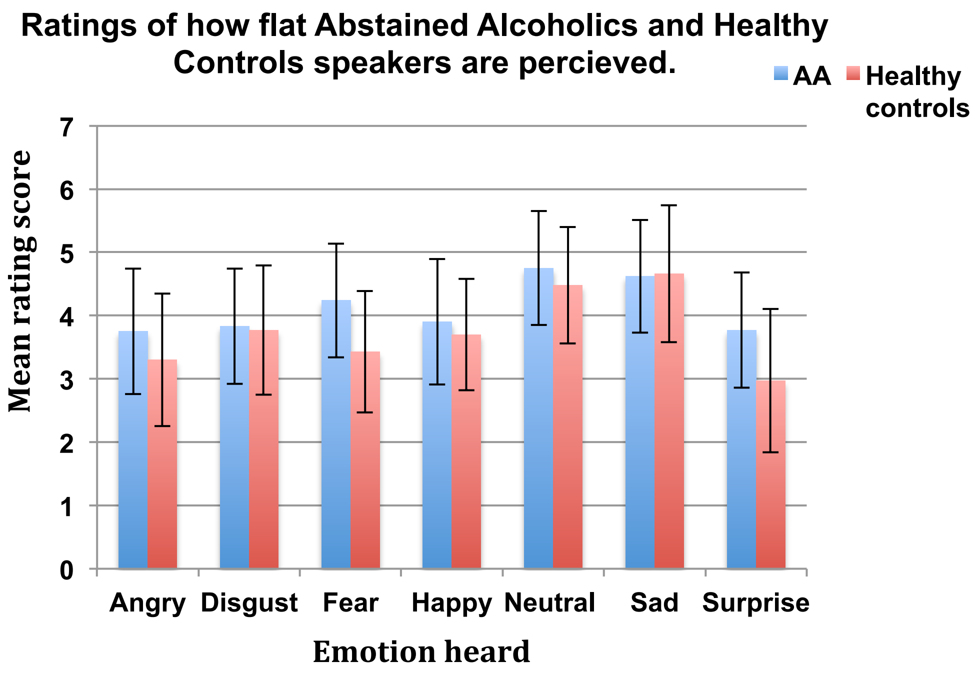


Graph 2: Mean ratings for the voice quality husky for both AA & healthy controls in each emotion category. Standard deviations represented in the error bars.

<u>Flatness scale</u>

The analysis revealed a significant main effect of speaker *(F(1,20)*= 17.030*, p*=.001*)* showing that AA (M=4.12) emotional prosody production was rated as sounding more flat than healthy control's (M=3.76). Results also showed a significant main effect of emotion *(F(6,120)*=24.713*, P*<.001*)* indicating that sad prosody (M=4.64) was rated as sounding most flat, closely followed by neutral (M=4.61) and then fear (M=3.84), disgust (M=3.8), happy (M=3.8), angry (M=3.53) and lastly surprise (M=3.37). Pairwise comparisons revealed a significant difference between flatness recognition responses for neutral stimuli compared to stimuli spoken in a angry, disgust, fearful, happy and surprised tone of voice (all *p*s<.01).

Crucially, results also indicated a significant two-way interaction between speaker and emotion *(F(*6,120)=6.900*, p<.001).* Pairwise comparisons for each emotion revealed that sentences produced in an angry, fearful, neutral or surprised prosody by AA were rated as significantly more flat than utterances produced by healthy controls (p<.05) (refer to Graph 3).

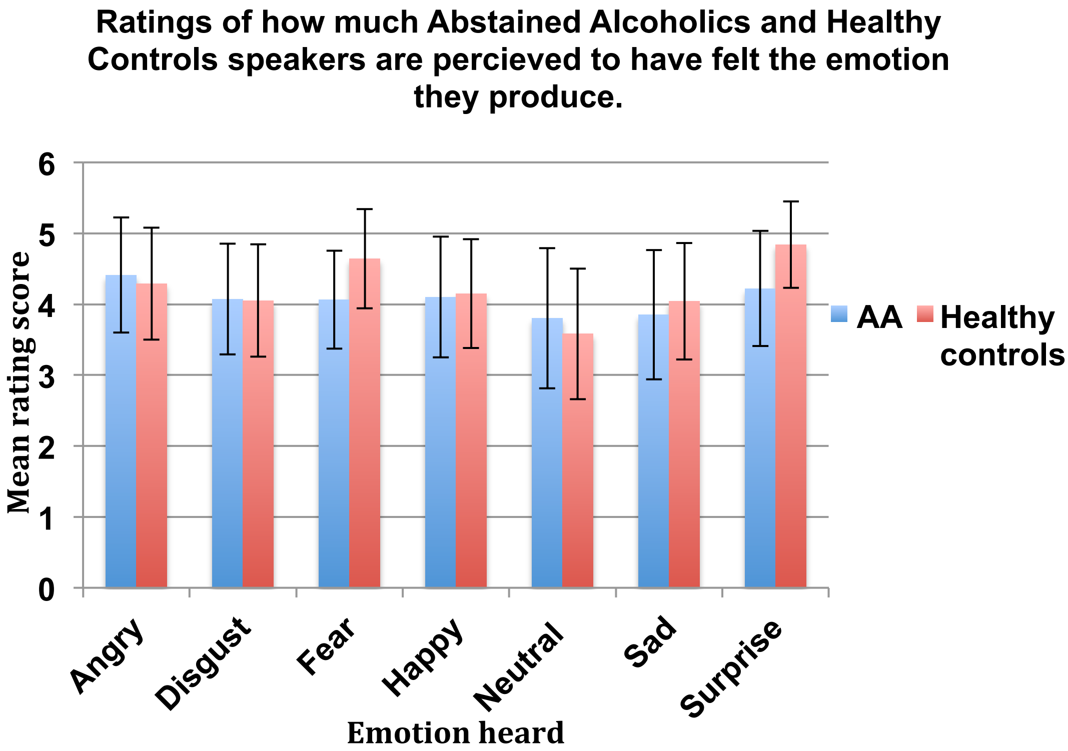


Graph 3: Mean ratings for the voice quality flat for both AA and healthy controls in each emotion category. Standard deviations represented in the error bars.

<u>How much the speaker felt the emotion</u>

The analysis revealed a significant main effect of emotion *(F(6,12)=14.263, p<.001)* indicating that listeners perceived utterances spoken in a surprised tone of voice (M=4.53) felt most expressive. Fearful (M=4.35) angry (M=4.35) and happy (M=4.12) utterances followed, with disgust (M=4.06), sad (M=3.95) and neutral (M=3.69) utterances being rated as less expressive. Pairwise comparisons revealed a significant difference between emotional expressive recognition responses for neutral stimuli compared to stimuli spoken in a angry, disgusted, fearful, happy, sad and surprised tone of voice (all *p*s<.01).

Results also revealed a significant emotion x speaker interaction, (F(6,12)=9.379, p<.001). Pairwise comparisons indicated that utterances spoken by healthy controls in a fearful or surprised prosody were perceived as more intense than the same emotions expressed by AA (p<.001) (see Graph 4).



Graph 4: Mean ratings for the voice quality emotion felt for both AA & healthy controls in each emotion category. Standard deviations represented in the error bars.

Combined these results suggest that not only are AA emotional utterances less recognisable than healthy controls, but also they are rated more husky, flat and less emotional expressive. Results also show a difference within these voice qualities amongst different emotions.

Discussion

The goal of the present study was first to investigate whether the emotional expression of AA were recognised on a perceptual level less accurately than those of healthy controls. Another goal of the study was to build a more coherent picture of listeners' perceptions of AA emotional utterances in comparison to healthy controls based on three voice quality measures. Overall findings show AA are indeed recognised less accurately and their speech is rated more huskier, flatter and less emotionally expressive by listeners. This is in line with the predictions made based on anecdotal evidence and results from Experiment 1.

Acoustic cues are a good measure of emotion but do not provide complete information on people's voices. It is known that speakers raise their voices whilst speaking in a happy tone of voice but similarly they also raise their voices when angry. However, listeners recognise a vital difference between the two emotional tones of voice, therefore there must be other important differences between emotional utterances (Juslin & Scherer, 2005). The present study investigated a small proportion of the voice qualities that could be involved in the differences found between AA and healthy controls.

The effects of alcoholism on emotional recognition

The recognition rates for the study were below chance for some emotions for both groups. It is worth noting that the stimuli used in Study 2 were randomly selected from Study 1 so the quality of the exemplars could have been poor (this applies to both groups, it would not have affected the voice quality ratings and the perceptual differences found for the two speaker groups).

Overall listeners found it more difficult to identify the emotion in speech of AA compared to healthy controls for most emotions, which support the idea that AA struggle to successfully convey their emotional meanings through speech. This further adds to the acoustic data found in Study 1, which found that AA show an inability to vary their pitch cues for emotions compared to healthy controls. However, no difference was found between the two groups for utterances intoned in a disgusted and a happy tone of voice. This lends further support to Study 1 and the idea that pitch plays an important role in listeners' ability to distinguish emotion through speech as AA were able to use pitch cues for these emotions. Disgust is one of the more controversial emotions studied and produces less consistent results amongst acoustic cues (Johnston & Scherer, 2000; Scherer, 1989). It may have been that both groups found it relatively hard to express disgust and this was evident in recognition task results. More deliberate selection of samples might have produced more typical examples or it may be that lay people expressing happiness produce different sounds to actors aiming to convey a particular emotion.

Voice quality variables

Researchers picked husky as a voice quality variable here because people often refer to heavy drinkers/alcoholics as sounding husky. However, this has not been experimentally tested until now. The results of the present study indicate that AA are indeed perceived as sounding huskier (at least when expressing some emotions) than healthy controls by naïve listeners. This could be due to the potential damage alcohol can have on voice mechanisms such as the vocal chords (Hirabayashi et al., 1990; Peron, Graffino & Zenker, 1988; Sataloff, 1991) which might also be a contributing factor to the differences found between AA and healthy control's emotional speech as the huskiness of AA voices may mask some of the vital acoustic cues such as pitch.

Secondly, the flatness of the speakers voice was investigated; i.e. how monotone they sound to perceivers. Results found that emotional utterances produced by AA are perceived as sounding more flat/monotone than those of healthy control speakers. This further supports evidence from Experiment 1 as inability to express pitch in the correct manner could make AA voice sound more flat to listeners. This in turn can affect communication, as listeners will find it hard to interpret the intended emotional meaning of AA speakers.

Lastly, how emotionally expressive the speaker sounded was investigated. Results in the current study found AA speech was rated less emotional expressive than healthy controls. More specifically that utterances spoken in a fearful and surprised prosody were rated more intense when spoken by healthy controls compared to AA. This once more supports the assumption that AA emotional speech production is altered when compared to healthy controls.

Future directions

All together the results of this experiment indicate naïve listeners find crucial differences in emotional utterances spoken by AA compared with healthy controls. Not only do they find it more difficult to correctly identify the emotion AA are expressing but also AA speech is judged more huskier, flat and less emotionally expressive compared to healthy controls.

Further research could investigate whether acoustic effects on prosody also affect the linguistic part of prosody communication. Prosody in both aspects is an important part of communication. A breakdown in the ability to convey emotions, make statements or raise questions could have damaging effects on social interactions. Pell et al., (2006) found Parkinson disorder patients displayed a deficit in linguistic prosody production. The authors point out the importance of F0 cues in linguistic prosody production. The AA were found to deliver poor pitch production in Study 1 and research shows pitch to be a significant co-occurring element in linguistic prosody (Cutler, Dahan &

Donselaar, 1997). It might be predicted that AA have difficulty in using linguistic prosody effectively, further adding to communication difficulties.

In Study 1 participants were emotionally induced, by being read a scenario for each emotion. They then had to tell the researcher a time when they had felt this particular emotion. To gain further understanding of social impressions made of AA in comparison to healthy controls it would be a good idea to record and play these stories from both groups to naïve listeners and have them rated. For example Pitcairn, Clemie, Gray and Pentland (1990) found when presenting interview recordings to naïve listeners' Parkinson patients were rated as more cold, anxious and withdrawn than control speakers. It would be interesting to gain listener ratings of AA speech in this way.

The present study provides the first important steps in building a data set of listeners' perceptions of speakers who have abstained from alcohol for more than one year.

Study 3: Abstained Alcoholic's perception of emotional utterances compared with Healthy Controls.

Introduction

Communication of emotions through speech involves the production of emotional utterances and the ability on the part of the listener to recognise the produced speech. While Study 1 explored AA ability to *produce* emotions through speech and Study 2 explored the way these produced utterances were perceived the present study sought to investigate the ability of AA to *perceive* the emotional speech of others.

The ability to recognise and interpret the emotional state of others is an important social skill that enables individuals to communicate effectively (Oatley & Johnson-Laird, 1987). It can allow the listener to engage appropriately with another's behaviour. It has been shown that being able to correctly identify emotional expression from others enables and maintains healthy social relationships (Feldman, Philippott & Custrini, 1991; Carton, Kessler & Pape, 1999). If abstained alcoholics were to suffer from difficulties in recognising emotions from speech it could cause them to misunderstand others intentions or feelings and leave them socially isolated. In fact, alcoholics have previously been found to exhibit difficulties with interpersonal relationships even when abstained from alcohol (Dubertstein et al., 1993; Nixon et al., 1992; Kornreich et al., 2002). However, research has found social training, a type of therapy that teaches alcoholics' how to interact with others, empathy and understanding of non-verbal cues, helps to maintain abstinence and prevent relapse (Eriksen, Bjornsted & Gotestam, 1986; Rohsenow et al., 1991). Problems with emotional facial recognition (another important non-verbal cue) have also been linked to interpersonal problems encountered in alcoholism (Korneich et al, 2002).

Alcoholics have been found to demonstrate difficulties in processing emotional signals. In particular, recently detoxified alcoholics (under 3 month abstinence) show difficulty in perceiving emotions through prosody (Kornreich et al., 2012; Monnot et al., 2001; Monnot et al., 2002; Maurage et al., 2008; Uekermann et al., 2005), emotional facial expressions (Frigerio et al., 2002; Philippot et al., 1999) and body postures (Maurage et al., 2009). Recently detoxified alcoholics have been found to show a bias towards negative facial stimuli (Philippot et al., 1999; Frigerio et al., 2002). Difficulties in the perception of emotions have been found to persist through to mid and long-term abstinence (Foisey et al., 2007; Kornreich et al., 2001; Valmas et al., 2014). However, more evidence is needed to build a clearer picture of problems within emotional prosody recognition with a different population and materials. Therefore, the primary focus of this thesis is to highlight whether abstained alcoholics have a problem in the area of emotional communication. If more scientific data can build a clearer picture of the emotional problems that exist within alcoholism, future work investigating how to repair communication and whether this is something that can be recovered/learnt in the recovery process can be carried out.

<u>Motivation for the study</u>

Research on alcoholism and emotional prosody recognition is sparse but the research that is available indicates that (recently detoxified) alcoholics tend to show difficulties in recognising emotions successfully from their social partners' voices (Monnot et al., 2001; Uekermann et al., 2005; Maurage et al., 2008; Kornreich et al., 2012). Therefore the goal of the present study was to investigate whether this deficit persists even after a more prolonged abstinence. Based on past data involving recently detoxified alcoholics and mid-term abstainers, it is predicted that the ability to recognise emotions through speech would decline in abstained alcoholics when compared with age/education healthy controls. Also, it is predicted that abstained alcoholics will display a bias towards negative emotions therefore often misinterpreting positive emotions for negative. The results will help in building a fuller picture of the long-term effects of alcohol abuse and emotional prosody recognition. It is important to investigate this area as deficits may cause problems to recovering alcoholics in home, work and social relationships therefore having serious negative implications.

The present investigation uniquely used lay peoples' emotional utterances as stimuli in this recognition task to diverge from the use of trained actors. Traditionally trained actors have been used to intone stimulus materials, a process which has proven to be very useful. The current study wanted to diverge from the use of trained actors not only to create a more realistic approach and therefore increasing the ecological validity (Scherer, 2003) but also to fully understand the production and recognition patterns of AA. Little attention has been placed on lay people and how they acoustically produce emotions therefore highlighting the importance of this study. Abstained alcoholics with at least one year's abstinence and age/educational matched healthy controls heard the emotionally intoned neutral sentences from Study 1. Participants were asked to judge the emotional prosody of these sentences in a forced choice paradigm.

Method

Participants

15 abstained alcoholics (age range from 30-70 years, M = 49.87, SD= 13.81) participated in the study. 11 of them had already participated in Study 1, the remaining were recruited via newspaper, radio adverts and leafleting in Alcohol Anonymous and other self-help groups. Each participant had been abstained from alcohol for at least 1 year (abstinence ranging from 1 year 1 month – 33 years, M= 7.12, SD= 8.02). The self-reported number of years for alcohol dependence ranged from 5 - 46 years (M= 16.86, SD= 11.15). All participants had a past medical diagnosis of alcohol dependence and met the criteria for alcohol dependence according to the DSM-IV.

In addition, 15 healthy control participants (matched for age and education as closely as possible, age range= 32-76 years old) took part in the study. None of them reported having a drinking problem or any other addiction in the past. None of the participants self reported any biological family members who had a known history of alcohol abuse, but one participant reported her adopted daughter suffered from the disease. Six of the participants had previously participated in Study 1 and were contacted again, while the remaining was recruited via leafleting and the University emailing system. A summary of participant characteristics can be found in Table 4.

All participants were native speakers of English and reported normal or corrected-to-normal vision, and no hearing impairments. Participants were excluded from the study if they had any self-reported mental health problems (e.g. depression), neurological problems (e.g. stroke) or taking any psychotropic medication. The number of years of education for each group was worked out from the number of completed years in education starting from primary school. Both groups were assessed using a number of control measures. Each of the following measures used a self-completion questionnaire method: Depression (Patient health questionnaire (PHQ-9), Kroenke & Spitzer, 2002): Anxiety disorder (GAD-7, Spitzer, Kroenke, Williams &Lowe, 2006): Optimism & pessimism (Revised life orientation test (LOT-R), Scheier, Carver & Bridges, 1994). Scoring from the screening process can be found in Table 4.

Table 4:
Demographic and clinical information from AA and healthy control participants (mean (SD)).

Variable	Abstained Alcoholics	Healthy Controls
Sex (F/M)	6/9	9/6
Age *NS*	49.87 (13.81)	50.4 (14.88)
Education *NS*	14.53 (3.42)	14.93 (2.69)
Duration of the disease	16.87 (11.15)	N/A
Years of abstinence	7.12 (8.02)	N/A
Number of alcoholic drinks per week	N/A	1.6 (1.84)
GAD *NS*	6.53 (4.67)	4.07 (3.56)
PHQ-9 *NS*	6.6 (5.33)	4.93 (3.79)
LOT-R *NS*	14.4 (4.58)	14.07 (3.95)

N/A means not applicable. *NS* states the means are not statistically different. Scores 0-5 for the GAD-7 represent mild anxiety, 6-10 moderate, 11-15 moderately severe anxiety, 16-21 severe anxiety. For PHQ-9 scores from 0-5 represents mild depression, 6-10 moderate depression, 11-15 moderately severe depression,16-21 severe depression. A score of over 7 on the GAD-7 represents clinical anxiety and over 9 on the PHQ-9 clinical depression. For the LOT-R higher scores represent higher optimism.

Materials

The stimuli were selected from materials produced in Study 1. In order to avoid experimenter biases when selecting good emotional prosody exemplars, the selection was based upon the results of a discriminant analysis. In the analysis, mean pitch, intensity, duration, and range of pitch and intensity of the stimuli served as predictor variables and the intended emotional category (anger, disgust, fear, happiness, sadness, surprise, and neutral) served as dependent variable. Discriminant analyses were carried out separately for materials spoken by AA and healthy control speakers. Out of the correctly identified sentences, 20 sentences spoken by AA speakers and 20 sentences spoken by healthy control speakers were selected for each emotion. This resulted in 280 sentences in total (40 x 7 basic emotions).

Design

This study employed a 2 (speaker group) x 2 (listener group) x 7 (anger, disgust, fear, happiness, sadness, surprise, neutral) mixed design to investigate differences between abstained alcoholics and healthy controls in recognising emotional prosody expressed by abstained alcoholics and healthy control speakers.

Procedure

All participants gave informed consent and the study was ethically approved by the Ethics Committee of the University. Each participant was then tested individually in either laboratory booths at the Department of Psychology, or a convenient quite location for the participant. Testing lasted approximately 45 minutes.

280 emotional utterances were presented by means of Superlab software divided into seven presentation blocks. Each block was followed by a short break. Before the start of the main study, participants received five practice trials to familiarise themselves with the task. After the five practice trials, participants had the chance to ask the experimenter for help if anything remained unclear. Each block began with task instructions asking the participant to identify the emotional tone of voice used by the speakers and to ignore the content of the presented sentence. A trial in the experiment worked as follows: First, a fixation cross was presented for 250ms. Next, participants heard a sentence presented via speakers, which was immediately followed by a screen that showed seven response boxes (labeled happy, sad, angry, disgust, fear, surprise and neutral). No time limit was imposed for responses; however participants were instructed to respond as quickly and accurately as possible. Responses were made by using a mouse to click on the corresponding response box. A blank screen was presented for 500 ms as an inter-stimulus interval. Run time of the experiment was 35 minutes.

Results

Means and standard deviations for recognition accuracy rates for both listener groups were pooled from the raw data (refer to Figure 1). Recognition rates for healthy control listeners were above chance level (14%) when rating both healthy control & AA speakers for all emotions. However AA listeners were below chance when rating utterances spoken by AA individuals intoned in a fearful and disgusted prosody. A visual inspection of the data suggests that angry and sad emotional utterances were best recognised while fear was the least.

Psychological Measures

As represented in Table 4, abstained alcoholics and healthy controls were similar in age ($t(14)=-.09$, $p=.933$) and years of education ($t(14)=-.37$, $p=.716$). Moreover, the two groups did not differ on scores for anxiety ($t(14)=1.945$, $p=.072$) or depression ($t(14)=1.387$, $p=.187$).

To further investigate the potential influence of anxiety scores on recognition scores Person's correlations were calculated within each group. No significant correlations were found within the alcoholic group ($p=.717$). Within the healthy control group there was a significant moderate correlation between anxiety scores and recognition rates ($r(15)=.54$, $p=.04$).

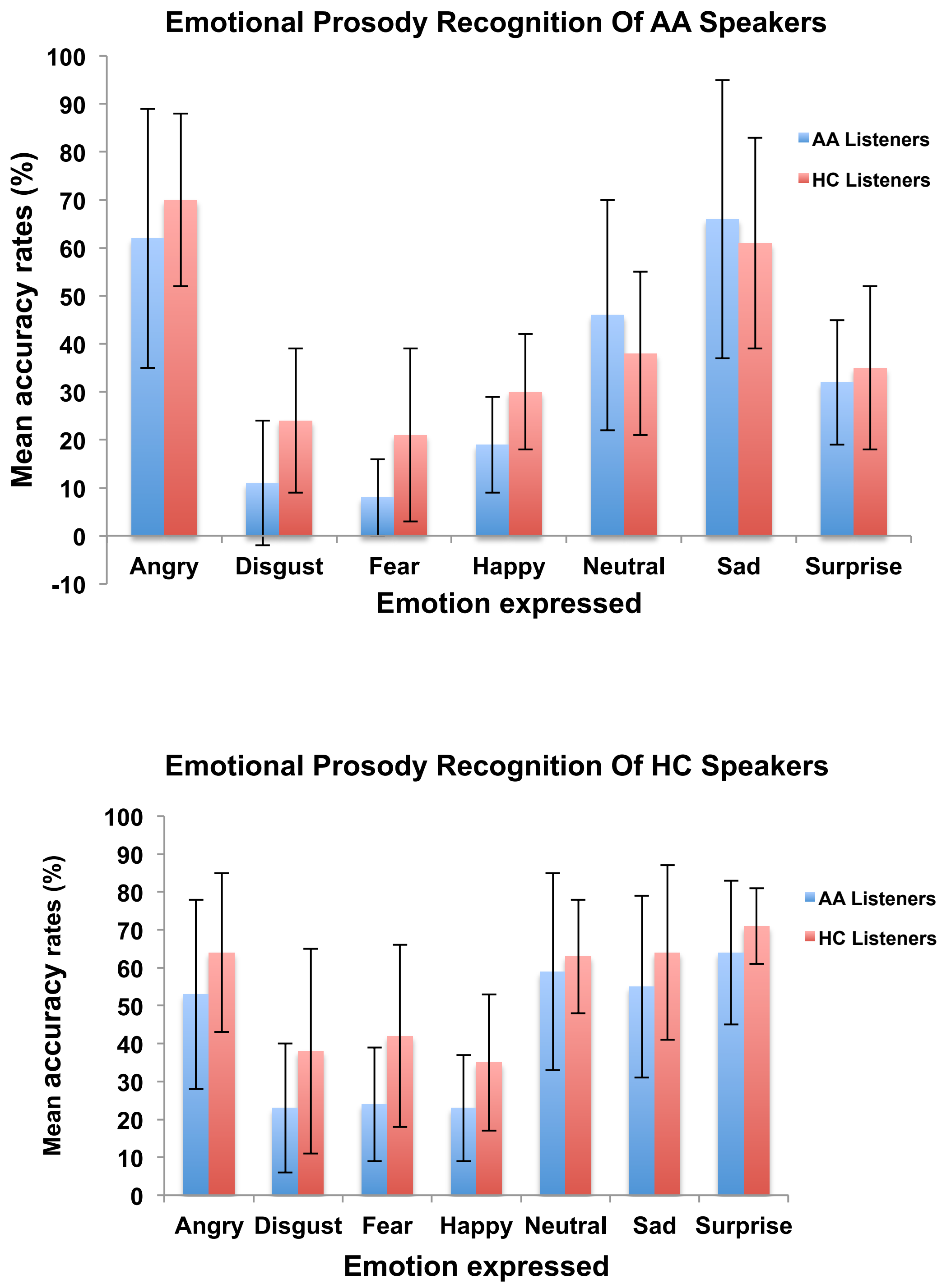


Figure 1: Graphs of Accuracy (%) of mean emotional recognition responses from both groups of listeners for each speaker group (Abstained *alcoholics (AA) [top panel] and healthy controls (HC) [bottom panel]). Bars show correct responses for each emotion and the error bars represent standard deviation.*

Experimental results

Analysis of variance (ANOVA)

To assess whether abstained alcoholics recognise emotions through speech differently to healthy controls a 2 (listener group) x 2 (speaker group) x 7 (emotion) repeated measures ANOVA was computed. Effect size was measured using omega-square (Ω2), which is an estimate of the variance accounted for by the independent variable. Effect sizes can be interpreted in the following way: values between 0.0009 – 0.048 are small effects, between 0.048 and 0.138 medium and values above 0.138 are seen to be large effects (for more information see Olejnik & Algina, 2003).

The main effect of listener was significant ($F(1,28)=4.354$, $p=.046$, $\Omega=.14$) which was explained by healthy control listeners (47%) achieving a slightly higher recognition rate to that of abstained alcoholic listeners (39%). The main effect of emotion was also significant ($F(6,168)=39.306$, $p<.001$, $\Omega=.58$) indicating angry and sad prosody (62%) were best recognised followed by utterances intended to express neutral (51%), pleasant surprise (50%), happiness (27%), disgust and fear (24%) . Pairwise comparisons revealed utterances intoned in an angry, disgusted, fearful and happy prosody were recognised significantly different from neutral (all *p*s<.05). A significant main effect for speaker emerged ($F(1,28)=65.297$, $p<001$, $\Omega=.70$) showing utterances spoken by healthy control speakers (48%) were better recognised than utterances spoken by AA speakers (37%).

A significant emotion x speaker interaction ($F(6,168)=23.617$, $p<.001$, $\Omega=.46$) was found. The interaction was followed up for each emotion using pairwise comparisons. These analyses revealed that listener's recognised emotions intoned in a disgusted, fearful and happy prosody significantly better when spoken by a health control speakers compared to abstained alcoholics. Interestingly, results also found a significant interaction between speaker x listener ($F(1,28)=4.593$, $p=.041$, $\Omega=.14$). Pairwise comparisons revealed both healthy control and abstained alcoholic listeners found it easier to rate utterances when spoken by healthy control speakers than when spoken by abstained alcoholics. No other interactions were significant in this analysis.

Error patterns

The confusions patterns for both AA and healthy controls are shown below in Table 5. This has been presented as Juslin and Scherer (2005) suggest this is the most efficient way of presenting data from forced-choice procedures. As can been seen AA individuals and healthy controls show similar patterns of confusion. Disgust is often misinterpreted for neutral and sad. Fear as neutral and sad. Happy as neutral and surprise; sad as neutral and surprise with happy and neutral.

Table 5: Confusion matrices of errors for each emotion in the prosody recognition task split by group. (AA: Abstained alcoholics and HC: healthy controls).

		Intended Emotion						
Listener Group		Angry	Disgust	Fear	Happy	Neutral	Sad	Surprise
AA	Angry	62.17	4.00	3.00	2.33	2.83	0.50	8.17
	Disgust	11.00	19.00	3.17	4.17	5.17	2.00	3.17
	Fear	0.67	6.67	17.50	3.33	2.33	8.00	1.67
	Happy	3.33	3.00	7.17	22.00	3.50	1.00	17.67
	Neutral	13.17	32.83	38.67	33.33	53.67	23.17	17.17
	Sad	0.50	27.17	15.83	3.17	30.33	64.17	2.67
	Surprise	9.17	7.33	14.67	31.67	2.17	1.17	49.50
		Angry	Disgust	Fear	Happy	Neutral	Sad	Surprise
HC	Angry	67.17	7.50	2.33	1.83	2.50	0.50	3.83
	Disgust	12.67	31.00	4.50	3.17	7.17	2.67	3.50
	Fear	0.67	7.17	31.50	4.83	3.83	12.33	2.50
	Happy	3.50	4.17	8.50	32.50	5.00	1.17	22.67
	Neutral	7.17	25.67	28.00	27.50	50.50	19.33	14.00
	Sad	0.17	19.00	15.33	4.83	28.33	62.33	0.67
	Surprise	8.67	5.50	9.83	25.33	2.67	1.67	52.83

In sum, healthy control listeners recognise emotions from speech more accurately than abstained alcoholics. Healthy control speakers are best recognised by both abstained alcoholics and healthy control listeners.

Drinking behavior variables

To assess if length of time abstained (LOA) and duration of abuse (DOA) were related to recognition scores Person's correlations were computed. Neither LOA (*p*=.436) or DOA (*p*=.179) were significantly related to accuracy scores.

Discussion

The study set out to investigate whether impairments in emotional speech recognition that had previously been found in recently detoxified alcoholics persisted after long-term abstinence. It was expected that AA indivuals would have difficulties recognising emotion from speech compared to age/education matched healthy controls.

The results of the current study support the hypothesis: overall AA individuals demonstrated impairments in emotional decoding accuracy when compared with healthy controls.

How alcohol affects emotional prosody recognition

The issue that was addressed here is that long-term sober alcoholics may have a persisting emotional decoding impairment even when sober for at least one year. Results here revealed healthy controls did obtain higher recognition scores overall when compared with AA, suggesting alcoholics who have abstained over a long-term period continue to display problems in decoding emotional utterances of their social partners.

Recognition rates for the healthy control listeners were all above chance level (14%) with surprise being recognised five times above chance level. Recognition rates from the literature show that generally listeners can decode emotions five times better than chance (Scherer, 2003). The AA listeners obtained lower recognition rates than healthy control listeners for all emotions. Fearful, happy and disgusted emotional utterances spoken by healthy controls were recognised by AA as low as two times above chance level. It is not surprising that disgust and happiness utterances received low recognition rates as this is commonly reported within the literature for recognition tasks (Scherer, 2003), however, healthy controls were more accurate than AA.

Overall the recognition rates in this study are generally lower than are usually obtained in recognition studies (Paulmann, Pell & Kotz, 2008; Pittam and Scherer, 1993). It is important to point out these low recognition rates are probably due to using non-trained actors as speakers. Wilting, Krahmer and Swerts (2006) found, when comparing speech from actors and real life speakers, actors' emotions were better recognised by listeners, as they tend to over-emphasise the emotion. The authors concluded this was because actors aim to communicate simulated emotion and this needs to be taken into consideration with drawing comparisons with studies investigating genuinely expressed emotions. Using actors might give very high, unrealistic recognition rates compared to the recognition of real life speech.

Our data established that both AA and healthy control listeners recognised emotional utterances more accurately when spoken by healthy control speakers. Study 1 found that AA struggled to produce differing emotional utterances and results from Study 2 and 3 support this. The data here suggests that there is no in-group advantage within this patient group. An in-group advantage is where people within the same culture, ethnic or religious group are more able to correctly identify the emotions being expressed from one another as compared to an out group (Elfenbein & Ambady, 2002;

Jürgens, Drolet, Pirow, Scheiner & Fischer, 2013; Pell, Monetta, Paulmann & Kotz, 2009). However, these results are more than likely because the AA group does not share a culture and although they do exhibit some similar behaviours the disease manifests itself in different ways (Estes & Heinemann, 1977). Also, just because someone is an ex/alcoholic we cannot assume they socialise with other ex/alcoholics. What is interesting is that inspection of the means finds that AA do discriminate anger and sadness slightly more accurately from AA speakers than healthy control speakers. As the difference is not significant one can only highlight this as an interesting difference that both the negative emotions are best recognised by speakers of their group. The finding that both groups significantly recognise utterances spoken by healthy controls compared to AA lends support to the data from Study 1, which suggests that AA are not using vocal attributes in the same way others do.

Interestingly, from looking at the confusion matrices it is clear that although AA make more wrong responses, the patterns of errors are very similar in both groups. Importantly, in contrast to past research, our results do not support a bias towards negative emotions that was found in the literature of facial recognition regarding recently detoxified alcoholics and mid-term abstainers (Frigerio et al., 2002; Foisey et al., 2007; Philippot et al., 1999). One difference that can be pointed out between the two groups is that healthy controls never made more errors in identifying another emotion than they gave accurate responses to the intended emotion. However, AA highly confused disgusted utterances with neutral and sad; fearful with neutral; and happy with surprise. This could suggest AA perceived a large amount of the emotional utterances as flat/montone, i.e. non expressional. The reason AA commonly misinterpret happy as surprise, could be because both share similar patterns of acoustic cues as suggested by Scherer (2003), and this makes the two emotions even harder for AA to disentangle.

<u>Past research in emotional recognition and alcoholism</u>

The literature suggests that alcoholics continue to err when decoding emotional facial expressions even when abstaining from alcohol long-term (Foisey et al., 2007). Here problems within the auditory domain have also been found to persist through long-term abstinence. The data here adds value to the idea that alcohol abuse affects the modalities globally therefore creating an unspecific modality deficit. Additionally the present study builds on the data for this under- researched area of long-term abstaining alcoholics and emotional prosody recognition (Valmas et al., 2014).

As previously stated, a person's characteristics and their drinking habits have been suggested to have an impact on impairments (Oscar-Berman & and Marinkovic, 2007; Oscar-Berman et al., 2014). Therefore it was predicted that after longer duration of abstinence AA scores would improve and the more years the drinking that had taken place were assumed to dampen the recognition scores. Results found that AA demonstrated poor accuracy in emotional prosody recognition regardless of abstinence length as no correlation was found between length of time abstained and AA total scores. This is inconsistent with past research (Korneich et al., 2001; Valmas et al., 2014). Duration of drinking was also not correlated with accuracy scores here. Our correlation results are in line with Foisey et al., (2007) who also found no correlation in their facial recognition task and these factors with mid- and long-term abstained alcoholics. This study is an important start; however, future studies with larger samples need to look at the discrepancies found between the current and previous work more closely. For now, the possibility that small sample sizes affected results cannot be fully excluded.

An important opportunity for future study to investigate would be the number of withdrawals AA had. This factor has been found to have an impact on recovery rate of cognitive functions (Loeber et al., 2010).

Our data suggest that long-term clean alcoholics still experience difficulties in decoding emotional meanings from speech. The findings cannot directly inform us on the causes of the impairment as the study only examined AA and whether they had any issues with emotional prosody perception. They do, however, highlight that there remains impairment in this group and provide us with the first steps to investigating this more in depth. In the general introduction some explanations are offered as to why alcoholism could affect emotional communication. The differences between the two groups found here could suggest that the neuropsychological changes that occurred during alcoholism have not been compensated for (Moselhy, Georgiou & Kahn, 2001; Oscar-Berman, 2014).

One suggestion for the poor decoding skills found within this group could be that they have not reached emotional sobriety/maturity. During their duration of drinking they dampened their emotional system: maybe they drank to suppress emotions and therefore rarely identified and managed them (Wilson, 1958). Within the literature it is suggested a big part of the recovery process is emotional sobriety. Reaching emotional sobriety is where individuals have become independent of alcohol and are able to control and experience their emotions, good or bad (Mathieu, 2013). If the individual has not achieved this, they have managed to stop the drinking but their mental and emotional processes remain the same; the chaotic thinking remains part of them (Mathieu, 2013; Wilson, 1958). Abstained alcoholics are sometimes thought to believe that, because they have achieved recovery, this equates to some kind of emotional equilibrium (Wilson, 1958). However, the route to recovery comes with different emotional problems (Wilson, 1958). Perception of emotions is influenced by the perceiver's own experiences of that emotion. Therefore, if someone is struggling with acknowledging their own emotions, the way they perceive other people's emotions could be distorted (Juslin & Scherer, 2005). Further research could look into whether emotional sobriety is a factor that inhibits emotional communication within this group. A careful comprehensive questionnaire would need to be developed assessing emotional sobriety/maturity. This questionnaire could then be delivered AA to before completely the recognition task. Accuracy scores from emotionally sober AA could then be compared with AA who have not gained emotional sobriety and controls.

Some have suggested that observed impairments may have been characteristic of AA before the drinking began (potentially causing a predisposition to alcoholism exacerbated by the difficulties in communicating with others) (Foisey et al., 2007; Uekermann & Daum, 2008). Nonetheless, whether the deficit was present before or after the onset of alcohol abuse, more research should be conducted into how to improve communication. Consistent treatment concentrating on the improvement of non-verbal cues could improve social skills amongst alcoholics. More research looking into social skills training and how it can be applied to the recovery process is essential here (Eriksen, Bjornsted & Gotestam, 1986; Rohsenow et al., 1991). Future research looking into different intensities of the utterance presented, similar to what is investigated with facial expressions, may be worth looking into first (Frigerio et al., 2002; Philippot et al., 1999). This will alert clinicians to the areas most needing investigation.

It is hard to collect data for patient studies and this study has contributed to the growing data in this field (which will help with meta-analyses). Data here has found emotional processing deficits at the behavioral level in AA. The next step would be to explore brain correlates with emotional prosody recognition and AA using event-related potentials (ERP). ERPs would allow us to determine which stage of the processing system is impaired. Fein, Kay and Szymanski, (2010) concluded that difficulties found in discriminating emotional facial expressions were reflected in the earlier stages of processing. Therefore building on this data with emotional prosody recognition stimuli and AA would provide us with a better understanding of the recovery process.

Misinterpreting emotions can severely affect social communications and this in turn can have impact upon the recovery process in alcoholism. The present study demonstrates abstained alcoholics persistently display deficits in this area of communication. The results go to show that abstinence is not enough. Therefore further research should especially look into a programme to enhance these core skills.

General discussion

This thesis has uniquely contributed to the underdeveloped field of abstained alcoholics and emotional prosody communication. It is a basic social need to be able to understand others emotionally and to be understood and having problems within this area can greatly affect our social interactions (Adolphs, 2003; Riggio, 1986). The present three studies in this thesis have found that alcoholics who have abstained from alcohol for at least one year, that is long-term abstainers, display deficits in their abilities to effectively express and decode emotional prosody.

More specifically, in Study 1 it was found that at an acoustic level there were remarkable differences in the way AA and healthy controls use their pitch cues. As pitch has been highlighted as a major contributor in the transmission of emotions through speech the importance of not being able to use this acoustic cue properly could cause significant problems in transmitting the emotion correctly through utterances (Frick, 1985; Scherer, Koivumaki & Rosenthal, 1972; Vroomen, Collier & Mozziconacci, 1993). The results of the production task take the first step into highlighting that there is a potential barrier for AA in communicating their emotions in social interactions.

Overall the production study showed that others could be missing vital information from AA speech and either misinterpreting their intentions and feelings or even perceiving them as speaking flat and non expressive. In fact this was demonstrated in Study 2 where naïve judges rated AA emotional utterances as more flat than those of healthy controls. Judgments of AA and healthy control’s emotional utterances back these findings up, revealing at the perception level naïve listeners find it more difficult decoding emotions in dry alcoholic’s speech compared to healthy controls. While acoustic variables are strong indicators that help differentiating between the basic emotions studied in this thesis, other qualitative differences between healthy controls and AA were also looked at. Specifically, it was shown that naïve listeners judged AA voice quality as huskier, more flat and less emotionally expressive than speech produced by healthy controls. The findings from both these studies really lend support to the idea that long-term abstained alcoholics struggle in expressing their emotions through speech meaning others may misinterpret important points. Misinterpretation of intended emotions could lead to difficulties in successful social interactions.

Finally, in Study 3, it was found that long-term abstinence from alcohol impacts on the ability to decode emotional prosody. Abstained alcoholics seem to suffer from an inability to decode emotional utterances when compared to healthy controls. This difficulty found within AA listeners was regardless of whether the utterance was spoken by a AA or a healthy control.

Taken together, the data collected for this thesis suggests that alcoholism can have damaging effects on one’s use of communicating and understanding emotions through speech. Deficits in long-term abstinence that manifest at the production and perception level are in line with previous findings from recently detoxified alcoholics and emotional recognition and emotional facial recognition studies (Frigerio et al., 2002; Kornreich et al., 2012; Maurage et al., 2008; Monnot et al., 2001; Philippot et al., 1999; Uekermann et al., 2005; Valmas, Ruiz, Gansler, Sawyer & Oscar-Berman, 2014). This thesis is the first of its kind to fully investigate solely emotional prosody in long-term clean alcoholics. Results obtained add to the growing idea that AA struggle with processing stimuli that contain emotional content. In the general introduction, research was summarised that suggests that this emotional impairment might be due to brain alterations caused by alcohol abuse in these individuals. In fact, comparisons between patient studies (such as damage to frontal cortex areas bilaterally, right-hemisphere patients and subcortical structures) and the data here suggests they display a deficit in producing and perceiving emotional stimuli. Therefore it could be speculated that brain areas involved in emotional communication (production and perception) have become impaired at some point of the alcoholics' drinking career and appear to remain impaired for this task. It has been implied that for some tasks the rewiring of brain networks has taken place i.e. other brain areas have compensated (Evert & Oscar-Berman, 1995; Oscar-Berman, et al., 2014). For this task at least this was not demonstrated. However, for the present investigation, brain scans from tested individuals were not obtained. Thus, no direct support can be provided for the claim that brain damage of long-term alcoholics leads to emotional communication problems. Still, the results add to the pool of data supporting such an idea. As suggested previously, it is encouraged future work looks into the neural processes underlying speech production and perception in AA through means of EEG to see how they differ from those of healthy controls. It will also give a better understanding of the time course behind recognising emotional utterances and if there are any differences between healthy controls and AA processing systems.

Future studies would benefit from investigating the cause behind these persistent problems further. While it is clear that alcohol damages the emotion communication system and ruins key communication skills, it is unknown why after lengthy abstinence these communication skills still remain difficult for this group. It might indeed be that affected brain areas involved in these tasks do not fully recover. However, it might also be speculated that these emotional communication problems existed before the alcoholism began. In fact, perhaps individuals are more predisposed to alcohol abuse because of their inability to deal with emotions appropriately?

Research into the vocal channel of expression has been limited compared to that of research on facial expressions. New technologies for collecting good quality auditory data, storing the data and editing it have improved (Juslin & Scherer, 2005). However, data collection and analysis is still a time-consuming task. Sharing stimulus materials across different research groups might help to speed up research in this underexplored domain. In addition, patient access is often limited and it is difficult to collect data from relatively homogeneous groups. Increasing awareness about the difficulties AA seem to suffer from might help recruit more participants in future studies. Again, sharing access to data should lead to more meaningful research; similarly, in a field suffering from limited sample sizes, meta-analyses will become increasingly important.

In conclusion, investigations into the long-term affects of alcoholism on emotional prosody communication is very much still in its infancy. The results of all three of these studies in this thesis demonstrate that AA display problems in the area of emotional prosody communication, specifically when encoding and decoding emotions through prosody. Problems found in emotional communication here may affect social interactions and interpersonal skills and therefore could cause difficulties in the recovery process and more so long-term difficulties for the individual. The results from these three studies highlight that abstinence programs may benefit from including a social skills element in which alcoholics learn to express and interpret others emotions from nonverbal cues such as emotional prosody. For instance AA may miss out on social support that they would benefit from in their continual recovery process. This research is vital to the recovery process of alcoholism and hopes to encourage further research into improving emotional non-verbal communication.

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Appendix 1: Semantically neutral sentences used in the Thesis

There was a pear tree	It was a heavy car	The water bottle was full	The bird flew over the house	The top was made of cotton
The fence is painted brown	The bush has orange flowers	The shop sells many things	There was a cupboard in the corner	She was driving a car
The dog has two owners	The zebra had black stripes	The boxes contain many items	There was food in the fridge	A women crossed the street
The book is green	The cat had night vision	The horse was eating an apple	This is a yellow blanket	He was writing a book

Appendix 2: Stories used to induce emotions in Study 1

I am going to read out some short scenarios to you in the 6 different emotions after I have read each scenario I am going to ask you to briefly tell me about an experience you have had with this emotion.

Happiness

Imagine winning the lottery, you took all your family on the most amazing holiday. You all had such a good time spending yours days in each others company whilst experiencing the hot weather.

Can you tell me a time when you felt really happy?

Anger

Can you imagine going shopping and whilst in the supermarket someone hits into your car. When you get out of the supermarket you find your car completely smashed up. The person who done is still at the scene so you confront them and they start shouting at you and telling you it's your fault. You know this is not true

Can you tell me about a time where you have felt angry?

Sadness

Can you imagine you left the house one day, when you returned your house was burnt down? Everything you owned, all your memories photos etc were gone. Most of your stuff you will never be able to replace

Can you tell me a time where you have felt really sad?

Fear

Imagine you were at home alone one night and heard tapping on the windows. You got up but no-one was there, when you sat back down you heard scratching on the windows. So you looked again and no-one was there, there was a big smash and a brick came through the window, a cold chill went down your spine.

Can you tell me a time when you have been in fear?

Surprise
Imagine, It's your birthday and everyone at home seems to of forgotten. You go to work and No one there has remembered either. You feel slightly disappointed that no one has remembered. After a long day at work you head off home feeling upset that everyone has forgotten about you, when you walk

through the door your family, friends and work colleagues jump out and shout surprise.

Can you tell me a time where you have felt surprised?

Disgust

Imagine sitting on the bus and the person next to you is sick on your lap. The smell is really strong.

Can you tell me a time where you felt disgusted?