# Acknowledgements

My gratitude goes to my supervisor Dawn Behne who has let me follow my own ideas. I would also like to thank everyone in the Speech Lab for interesting discussions and their valuable help and input.

My gratitude also goes to all the participants in the study.

I would like to thank my family and friends, for their constant support and motivation throughout. And finally, Torgeir Sundvor Solvin. He is always there for me, being patient and supporting, providing both comfort and valuable advice.

Trondheim, May 2013

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Cerebral lateralization and gender differences in dichotic audiovisual asynchrony perception

## Abstract

Both behavioral and neuroimaging studies on temporal processing have found a left cerebral hemisphere advantage for amodal auditory and visual stimuli. The current study investigated if this left hemisphere advantage also occurs for bimodal audiovisual asynchrony perception and possible gender differences in lateralization and temporal processing. To investigate this, 30 women and 30 men were tested using an audiovisual simultaneity judgment task with a binocular visual and dichotic auditory presentation. Results from the current study indicate that audiovisual synchrony perception has a left hemisphere advantage which is most evident in men. The results also revealed that men perceived more incidents of asynchrony in audiovisual speech, than women. The gender differences are concluded to most likely be due to a spatiotemporal advantage in men compared to women, maybe because of increased lateralization in men. Both the right ear advantage and the gender differences are most apparent when the video precedes the audio than vice versa, probably because the hemisphere receiving the second of the two inputs is more decisive when making the temporal judgment than the hemisphere receiving the first input. The findings show that gender differences might contribute to the large individual differences found in synchrony research and adds to a growing body of research giving insight into lateralization and gender differences in temporal perception and multisensory integration.

# Introduction

Even though perception usually is experienced as an effortless process, several factors need to work together in a complex way in order to construct an appropriate representation of the environment. A network of sensory systems continually receives information that the brain needs to integrate in order to provide a unified perception of the environment, as well as for focusing attention and controlling movement (e.g., Sanabria, Soto-Faraco, Chan, & Spence, 2005). Multimodal information enhances perceptual accuracy compared to unimodal information and thereby gives a perceptual advantage (Lewkowicz & Ghazanfar, 2009). Seeing the facial and lip movement of someone speaking, for example, aids in perceiving what is being said, especially under unfavorable listening conditions (Erber, 1969; Ma, Zhou, Ross, Foxe, & Parra, 2009). One of the vital factors needed for the brain to integrate information from the different modalities is temporal synchrony (Levitin, MacLean, Mathews, & Chu, 2000). In a natural environment, audiovisual information from a common object or event will usually be temporally aligned. When an audiovisual source is at a distance, information from different modalities may be perceived as being separated in time due to different propagation speed of light and sound, such as when lightning hits far away from the perceiver time (Vroomen & Keetels, 2010).

Temporal synchrony is crucial for audiovisual binding (Vroomen & Keetels, 2010) which is beneficial in speech identification (e.g., Shannon, Zeng, Kamath, Wygonski, & Ekelid, 1995; Sumby & Pollack, 1954). Also, auditory temporal processing is essential for noticing formant transitions signaling place of articulation and voice onset time, needed for consonant identifications (Kempe, Thoresen, Kirk, Schaeffler, & Brooks, 2012). For most of the right-handed population, processing analytic speech information, such as phonemes and words, is left-hemisphere lateralized (e.g., Kimura, 1964; Studdert-Kennedy & Shankweiler, 1970; Toga & Thompson, 2003). Cerebral lateralization is also known for other cognitive functions, such as musical structure processing, which is right lateralized (e.g., Hoch & Tillmann, 2010). Research on temporal processing has shown that unimodal tactile (e.g., Nicholls & Lindell, 2000), visual (e.g., Matthews, Vawter, & Kelly, 2012) and auditory stimuli (e.g., Schönwiesner, Rübsamen, & von Cramon, 2005) are usually left lateralized. However, to our knowledge, no research has yet addressed lateralization of bimodal audiovisual temporal processing.

## Temporal perception and cross modal simultaneity

Temporal perception includes different temporal dimensions. According to Pöppel (1999) at least four subjective temporal experiences exist: the experience of simultaneity vs. non-simultaneity, succession or temporal order, a subjective present and subjective duration. Cross-modal simultaneity occurs when input arriving from different sensory channels is perceived as a single event (Levitin et al., 2000).

Previous intermodal asynchrony experiments have focused on audiovisual asynchrony (e.g., Alm & Behne, 2013). Results suggest that the window of synchrony is a few hundred milliseconds wide (Conrey & Pisoni, 2006) and varies a great deal across individuals (Stone et. al., 2001), content type (van Eijk, Kohlrausch, Juola, & van der Par, 2008) and content complexity (Arrighi, Alias, & Burr, 2006). The audiovisual synchrony window also appears to be asymmetric, with participants being more likely to perceive events as asynchronous when an auditory input precedes a visual input than vice versa (e.g., Conrey & Pisoni, 2006; Dixon & Spitz, 1980). The audio lead advantage is usually attributed to the perceptual system’s adaptation to transmission speed differences of sound and light (Baskent & Bazo, 2011). Where light (300 000 000 m/s) travels faster than sound (330 m/s), the transduction and neural transmission time for visual input (50 ms) is longer than for auditory input (10 ms) (Vroomen & Keetels, 2010). Arrival and processing time differences cause a naturally occurring lag for the different information streams to the brain (Vroomen & Keetels, 2010). The differences in arrival and processing time between sound and light cancel each other out when the audiovisual source is at a distance of approximately 10 meters from the perceiver, the so-called horizon of simultaneity (Pöppel, Schill, & von Steinbüchel, 1990; Spence & Squire, 2003). Thus, while naturally occurring visual leads occur when the source is further than 10 meters from the perceiver and continue to increase the further the distance is increased from this threshold, naturally occurring audio leads will only be perceived within the 10 meters threshold and can never exceed 40 ms (Alm & Behne, 2013; Vroomen & Keetels, 2010). Therefore, naturally occurring visual lead asynchronies vary with the observer’s distance to the audiovisual source, while naturally occurring audio lead asynchronies are limited by neural processing time of sound and light (Alm & Behne, 2013).

A perceptual system where visual input prepares us for, and helps us to predict auditory input, may be another reason for more conservative audio lead thresholds compared to visual lead thresholds (Grant, Greenberg, Poeppel, & van Wassenhove, 2004). When speaking, the facial movements from the articulators start ten to a few hundred milliseconds before the onset of the auditory signal (Smeele, 1994), which might prepare the perceiver and help predicting the auditory signal and assist in the audiovisual binding (Grant et al., 2004).

## Brain hemisphere lateralization and dichotic listening

The cerebral cortex is anatomically divided in two hemispheres. Although the hemispheres are more or less symmetrical in anatomical appearance, many hemispheric processing asymmetries have been demonstrated (Chiron et al., 1997). However, although hemispheric dominance, like language lateralization (Studdert-Kennedy & Shankweiler, 1970), is measurable, both the left and right hemispheres contribute to most types of processes (e.g., Nicholls & Lindell, 2000).

Dichotic listening is a non-invasive test to measure lateralization in the auditory modality (Bethmann, Tempelmann, De Bleser, Scheich, & Brechmann, 2007; Broadbent, 1954; Kimura, 1964). In dichotic listening studies, two competing auditory inputs are delivered to the left and right ears, to assess cerebral dominance (Toga & Thompson, 2003). Cerebral dominance is reflected in an unequal perception of the stimuli presented to the different ears, with a contralateral ear advantage (e.g., Kimura, 1967). Language lateralization was one of the earliest brain hemisphere asymmetries to be studied (Toga & Thompson, 2003). Over 96 percent of right-handed people have a left hemisphere dominance for speech processing (Pujol, Deus, Losilla, & Capdevila, 1999), which results in a right ear advantage for speech stimuli presented dichotically to both ears (Studdert-Kennedy, & Shankweiler, 1970).

**Interpretations of ear asymmetries in dichotic listening.** Two different models attempt to explain how hemisphere lateralization results in a contralateral ear advantage that can be measured using dichotic listening. The structural model suggests that the contralateral pathways from the ear to the auditory cortex supresses impulses arriving along the ipsilateral pathway (Kimura, 1967). The attentional model explains the ear asymmetries by an attention bias directed to the contralateral ear (Kinsbourne, 1970). According to the attentional model, the anticipation of a stimulus, for example speech or music, primes the corresponding hemisphere for processing the stimulus. Because each hemisphere controls the contralateral side, a bias resulting in better performance for the processing of objects located in the contralateral half of space is created (de Bode, Sininger, Healy, Mathern, & Zaidel, 2007). Studies using modern imaging techniques support both the structural model (Bayazit, Oniz, Hahn, Güntürkün, & Ozgören, 2008; Brancucci, et al., 2004; Penna, et al., 2007) and the attentional model (Alho et al. 2012). Notably, attentional biases may be a byproduct of structural aspects of laterality, for example that the right ear bias for auditory speech stimuli is due to the contralateral hemisphere being hardwired to processing speech information and thus the attention will be shifted to the right ear (e.g., Voyer, 2003). Therefore, some authors argue that dichotic measurements of laterality reflect an interaction of structural and attentional factors (e.g., Bryden & Mondor, 1991; Jäncke, Buchanan, Lutz, & Shah 2001; Voyer, 2003; Voyer & Ingram, 2005).

**Critique of the use of dichotic listening in measuring laterality.** Dichotic listening is known to be influenced by attention instructions (Jäncke et al., 2001), stimulus features (Bedoin, Ferragne, & Marsico, 2010), gender (Gur et al., 2000), handedness (Pujol et al., 1999) and background noise (Dos Santos Sequeira, Specht, Moosmann, Westerhausen, & Hugdahl, 2010), which suggests that the method may be vulnerable to perceptual and cognitive factors. Also, when testing left hemisphere dominance for speech, different dichotic tests have revealed different results, with low or non-existent intertest correlations (Jäncke, Steinmetz, & Volkmann, 1992). This has led some authors to argue that dichotic listening is not the best test to measure laterality, and should not be used to determine laterality for individual subjects (e.g., Bethmann et al., 2007; Jäncke et al., 1992). However, Van der Haegen, Westerhausen, Hugdahl and Brysbaert (2013) argue that even though the method show some variability for individual subjects, dichotic listening is a valid procedure when determining laterality in a group.

## Temporal processing

For temporal processing, an advantage for stimuli presented so that it target the left hemisphere (e.g., to the right ear or right visual field) was first shown in a simultaneity detection experiment using unimodal tactile and unimodal visual stimuli (Efron, 1963). The interpretation of these results suggested that temporal order and simultaneity detection was left lateralized. Later studies have shown temporal processing to be lateralized to the left hemisphere with tactile (Nicholls & Lindell, 2000; Nicholls & Whelan, 1998), visual (Elias, Bulman-Fleming, & McManus, 1999; Grondin, Voyer, & Bissona, 2011; Matthews et al., 2012) and auditory stimuli (Mills & Rollman, 1980). However, some studies have not been able to replicate these findings (e.g., for visual stimuli: Brown & Sainsbury, 2002; for tactile stimuli: Clark & Geffen, 1990) and some findings have even been contradictory with a left ear advantage for temporal processing (e.g., for auditory stimuli: Murphy & Venables, 1970).

For visual and auditory stimuli, a left hemisphere advantage for temporal processing has also been shown with neuroanatomical measurements. Nicholls, Gora and Stough (2002) used EEG and a gap detection task with unimodal auditory and unimodal visual stimuli. The auditory stimuli consisted of bursts of white noise presented to both ears, half of which contained a gap lasting four or six seconds. The visual stimuli consisted of flashes of light presented bilaterally to both visual fields, half of which contained a gap lasting six or eight seconds. Topographic maps of the waveforms showed that the left hemisphere was dominant for temporal processing. Zatorre and Belin (2001) studied temporal lateralization using positron emission tomography (PET) and auditory sequences of two pure tones separated by one octave. The results showed that that the auditory cortex in both hemispheres responded to temporal variation, but the left hemisphere had a greater response compared to the right hemisphere, indicating a left hemisphere specialization for rapid auditory temporal processing (Zatorre & Belin, 2001). Schönwiesner et al. (2005) used novel noise-like auditory stimuli with different temporal complexity, to measure lateralization in temporal processing in a functional magnetic resonance imaging (fMRI) study. They found that rapid auditory temporal processing was most prominent in the left superior temporal gyrus. The range of stimuli and methodologies used to measure temporal processing that shows a left hemisphere advantage has even lead some to believe that the left hemisphere has a general temporal advantage (e.g., Mills & Rollman, 1980; Nicholls, 1996).

## Gender differences in laterality and temporal perception

**Laterality.** Studies broadly report laterality differences between the genders, with women having less lateralization than men, for example for language (Gur et al., 2000), for spatial processing (Koles, Lind, & Flor-Henry, 2010), for speech (Pujol et al., 1999) and for temporal processing (Nicholls & Lindell, 2000). However, laterality differences between the genders are controversial (e.g., Summer, Aleman, Bouma, & Kahn, 2004), which have led to several meta-analyses on the topic (e.g., Voyer, 1996; Voyer 2011). Meta-analyses have looked at studies using both verbal and non-verbal stimuli, fMRI with unimodal auditory, visual and tactile presentation (e.g., Voyer, 1996) and auditory dichotic listening studies (Voyer, 2011), and found a small and homogeneous effect showing that women have less lateralization than men (Voyer, 1996; Voyer, 2011). Thus, small lateralization differences between the genders might exist on a population level. Voyer (2011) claims that when using dichotic listening to measure gender differences in laterality, the differences are so small that 2688 participants would be required to get statistically significant results at the .05 level with 80 percent power for an effect size of 0.054. Because of the small effect size, Voyer (2011) argued that the effect has little implications for an individual experiment. Even though these meta-analyses did not look specifically at temporal processing, they looked at a range of verbal and non-verbal stimuli which might imply that women have a more bilateral processing in general compared to men.

**Temporal perception.** Studies have found gender differences in temporal perception such as auditory discrimination of amplitude onset rise times (Kempe et al., 2012), temporal discrimination tasks (Rammsayer & Troche, 2010), duration judgment (Hancock & Rausch, 2010) and auditory temporal order judgments (e.g., Wittmann & Szelag, 2003). For example, women experience a longer subjective duration and exhibit a greater variance in their duration judgments, compared to men (see Block, Hancock & Zakay, 2000 for review).

Gender differences have also been found in studies using synchrony judgment (SJ) tasks (Geffen, Rosa, & Luciano, 2000a, 2000b) and temporal order judgment (TOJ) tasks (Lotze, Wittann, von Steinbüchel, Pöppel, & Rosenneberg, 1999; Wittmann & Szelag, 2003). However, some studies have not been able to replicate these findings (e.g., van Kersteren & Wiersinga-Post, 2007). Geffen et al. (2000a, 2000b) used a tactile SJ task where participants judged if pairs of unimanually or bimanually tactile stimuli were presented simultaneous.  No gender differences were found in the unimanual conditions, however, in the bimanual conditions, women had a wider simultaneity window than men. Lotze et al. (1999) and Wittmann & Szelag (2003) both used an auditory TOJ task with pairs of clicks presented binaurally, where the participants judged which of two clicks was presented first. In both studies women had higher temporal order thresholds compared to men.

Rammsayer and Troche (2010) used, among other temporal tasks, an audiovisual TOJ task to look at gender differences in temporal processing. A red light was presented in a black viewer box and square-wave tones were presented binaurally via headphones. Presentation of both stimuli was terminated 200 milliseconds after the onset of the first stimulus, and the participants had to decide if the onset of the auditory or the visual stimulus occurred first. The initial stimulus onset asynchrony between the visual and auditory input was 70 milliseconds, with an increase of 18 milliseconds after each incorrect response and a decrease of 6 milliseconds after each correct response. Although their results for the TOJ task failed to reach the five percent level of statistical significance, a tendency ($p$ = .06) showed that women had a higher temporal order threshold than men. These results and a positive correlation between the TOJ task and the other temporal tasks used in the study, caused Rammsayer and

Troche (2010) to conclude that, in general, men process temporal information slightly more efficiently than women.

## Current study

The bipartite nature of the brain has encouraged many researchers to study differences in the functions of the two hemispheres. A left hemisphere lateralization of temporal processing might be an important factor in the use of other left hemisphere functions related to language and movement skills (Nicholls et al., 2002). Also, lateralization in temporal processing might be particularly valuable when trying to understand human cerebral asymmetry, since temporal processing is a low-level cognitive function (Nicholls, 1996). Both behavioral and neuroimaging studies on temporal processing have found a left hemisphere advantage with amodal auditory and visual stimuli (e.g., Efron, 1963; Matthews et al., 2012; Schönwiesner et al., 2005). The range of stimuli and methodologies used to measure lateralization in temporal processing has led some to belive that the left hemisphere has a general temporal advantage (e.g., Mills & Rollman, 1980; Nicholls, 1996). The accurate binding of auditory and visual input creates audiovisual benefit and thereby a perceptual advantage compared to unimodal infomation (Lewkowicz & Ghazanfar, 2009; McGurk & MacDonald, 1976; Sumby & Pollack, 1954). However, lateralization with bimodal audiovisual temporal stimuli has, to our knowledge, not yet been studied. Given that unimodal auditory and visual temporal processing both show a left hemisphere advantage, bimodal audiovisual processing might also be expected to be left lateralized.

Therefore, the current study will focus on perceived synchrony in audiovisual speech. Using a binocular visual and a dichotic auditory presentation, the current experiment explores if a temporal left hemisphere advantage exists for audiovisual speech stimuli. The hypothesis is that the participants will display a narrower window of audiovisual synchrony when the auditory stimuli are presented to the right ear, thus targeting the left hemisphere, than when presented to the left ear. Thus, the participants are expected to perceive more incidents of asynchrony when the syllable is presented to the right ear, compared to when the syllable is presented to the left ear.

In addition to audiovisual temporal lateralization, the current study will look at gender differences in lateralization and in temporal processing. Given how small gender differences in lateralization are when using dichotic listening (Voyer, 2011), no lateralization differences are expected between the genders in audiovisual temporal synchrony processing. Even though no lateralization differences are expected between the genders, gender differences have been found in amodal auditory and visual temporal processing using SJ and TOJ tasks, which have all revealed that men have a higher acuity of temporal processing compared to women (Geffen et al., 2000a; Geffen et al., 2000b; Lotze et al., 1999; Wittmann & Szelag, 2003). Since both unimodal auditory and visual temporal processing have shown gender differences, bimodal audiovisual processing might also be expected to be left lateralized. This is further supported by Rammsayer and Troche (2010), who found a tendency for gender differences, where women had a higher temporal order threshold than men, when using an audiovisual TOJ task. To our knowledge however, gender differences in bimodal audiovisual temporal processing have not been studied using a SJ task. Compared to TOJ tasks, SJ tasks give better estimations of point of subjective simultaneity (e.g., García-Pérez, & Alcalá-Quintana, 2012; van Eijk et al., 2008; Weiss, & Scharlau, 2011) and may be more sensitive to temporal misalignments (e.g., Vatakis, Navarra, Soto-Faraco, & Spence, 2008; Weiss, & Scharlau, 2011). If SJ tasks are more sensitive to temporal misalignments, SJ tasks might be better at detecting gender differences in temporal processing, compared to TOJ tasks. Therefore, the current study uses an audiovisual SJ task, and hypothesizes that men will display a narrower window of audiovisual synchrony, and thus perceive more incidents of asynchrony in audiovisual speech, compared to women. These potential gender differences in temporal processing might contribute to the large individual differences found in synchrony research.

# Method

## Participants

In this study 60 native speakers of Norwegian (30 male and 30 female) between 20 and 28 years old (*M* = 23, *SD* = 2) participated, after two males and four females had been excluded. One female was excluded because of poor eyesight, and two females were excluded because of poor hearing. The data from three participants were excluded from the analysis, as one female had turned the response box in another direction than what was intended, and two males misunderstood the task. All participants were recruited at the Norwegian University of Science and Technology (NTNU) and gave written informed consent (see Appendix A). A questionnaire (see Appendix B) was included to control for variables that might affect asynchrony perception, e.g. music experience (Behne et al., 2013) and participants completed a pretest based on a variant of the Edinburgh Handedness Inventory (Oldfield, 1971) to ensure right handedness. The study was registered with Norwegian Social Science Data Services (see Appendices C and D).

Before the experiment started the participants were tested to ensure normal hearing (see Appendix E). Hearing was tested using a standard pure tone audiometry procedure (British Society of Audiology, 2004). To pass the test an average hearing threshold level at 15 dBA or below across the frequencies 250, 500, 1000, 2000 and 4000 Hz was needed.

To ensure the participants had normal vision, visual acuity, color vision and eye dominance were tested. To test their visual accuracy, a digital version of the traditional Snellen chart (e.g., Strouse Watt, 2004) was presented on a 24-inch iMac (1920x1200 pixel monitor). A binocular acuity of 20/20 or better was needed to pass the test (see Appendix F).

An Ishihara test (Ishihara, 1974) was used to test for colorblindness. Pictures of circles in different colors forming numbers were shown and participants needed to get all six numbers correct in order to pass the test (see Appendix G). Eye-dominance was tested by having the participants, with both eyes open, look through their hands forming a triangle, at a black cross on the wall (see Appendix H). The participants then alternated closing the eyes to determine which eye was focusing on the cross (i.e. the dominant eye).

All the pretests combined lasted approximately 30 minutes. Participants that failed a pretest were given a rejection letter (see Appendices I and J) and excluded from the study.

## Stimuli

The use of consonant-vowel pairs has been reported as producing the most reliable results when using dichotic listening to measure laterality (Voyer, 1998). The current audiovisual speech stimuli consisted of a video recording of a female speaker, with an urban eastern dialect familiar to most Norwegians. The syllables used different consonant place of articulation (labial /ba/, alveolar /da/, and velar /ga/), associated with different auditory and visual burst saliencies (Bengherel & Pichora-Fuller, 1982). Thus the velar /ga/ has a less visually accessible release, which makes it harder to identify and a poorer temporal reference point when judging audiovisual synchrony, compared to the labial /ba/.

The audio speech signals were presented dichotically with the syllables randomly presented to one ear and pink noise to both ears. Pink noise has a frequency distribution weighting to the lower frequencies, yielding a spectrum more similar to speech than, for example, white noise (Eg & Behne, 2013; Voss & Clarke, 1977). Authors of previous studies have argued both to present the syllables blocked to one ear at the time (e.g., Brancucci, D’Anselmo, Martello, & Tommasi, 2008; San Martini, De Gennaro, Filetti, Lombardo, & Violani, 1994) and randomly (Voyer & Flight, 2001). Blocking the syllables to one ear is meant as a way of controlling the factor of attention (Brancucci et al., 2008; Voyer & Flight, 2001). However, because syllable blocking favors the right ear bias (Voyer & Flight, 2001), the current study used random presentations.

The speech materials were recorded and for most part prepared for another experiment (Alm & Behne, 2013) at the Speech Laboratory at NTNU. Alm and Behne’s (2013) experiment showed these materials to be good examples of the different syllables by including audio only, video only and audiovisual syllable identification control conditions. The recordings were made in a sound-insulated studio with a PDWF800 Sony Professional XDCAM HD422 Camcorder camera and two Røde NT1-A microphones. One microphone was connected to the camera and one was fed through a RME FIREFACE 400 sound card to an Apple Macintosh G5 computer. Here, the two audio channels were recorded using Praat 5.1 (Boersma & Weenink, 2009) at a sampling rate of 48 kHz. Prior to the recordings, the speaker removed artificial distracters such as jewelry and glasses. She was instructed to keep a relatively flat intonation and to avoid non-speech-related facial gestures (see Figure 1).

Figure 1: The stimuli consisted of a female speaker uttering the syllables /ba/, /da/ and /ga/.  Prior to the recordings, the speaker removed artificial distracters such as jewelry and glasses. She was instructed to keep a relatively flat intonation and to avoid non-speech-related facial gestures

The MPEG-4 video files had a resolution of 1920x1200 pixels and a visual quality of 25 frames per second. AVID Media Composer 3.5 was used to segment the video files into separate syllables. All the stimuli were cut to 35 frames (1400 ms), where each frame was 40 ms. The stimuli were set so that the consonant release was at the 13th frame (between 480 and 520 ms).

Praat 5.1 was used to segment the sound file from the external microphone. The average sound pressure level was adjusted to 68 dBA, to ensure that all the stimuli would have the same unweighted intensity. Measured from the consonant release, the auditory speech signals had the following lengths: /ba/ = 404 ms, /da/ = 392 ms and /ga/ = 463 ms.

The audio segments from the video camera’s microphone and from the external michrophone were imported to Logic Pro 8.0.2 and synchronized. The sound from the external microphone saved in Logic Pro was exported to Avid, before substituting the sound from the video camera’s microphone. The stereo audio segment was then moved with 40 ms intervals, ranging from 440 ms audio lead to 440 ms visual lead, creating 23 levels of audiovisual alignments. A pink noise segment was cut to a length of 1400 ms, to equal the length of the video clip, and given the same unweighted intensity level as the syllables using Praat 5.1 (Boersma & Weenink, 2009). Avid was used to add the noise segment to the stimuli, with a 0 dBA signal-to-noise ratio, before the new videos were exported with a video resolution of 1133x850 pixels.

## Procedure

The experiment was carried out in the Speech Laboratory at the Department of Psychology, NTNU, using Superlab 4.5. Up to two participants were tested at a time (see Appendix K) and were facing 24-inch iMacs (1920x1200 pixels, refresh rate = 60 Hz) at a distance of approximate 50 cm. The audio signal was conveyed over AKG K271 studio headphones with the presentation level fixed at 68 dBA to both ears.

Each trial began with a blank screen shown for one second, followed by a stimulus. The videos were presented at the center of the monitor and the audio inputs were presented dichotically with the syllable in pink noise to one ear and pink noise to the other ear. The participants' task was to indicate if they perceived the audio and video to be synchronous. The next trial began after a response was given or 2400 ms after the onset of the stimulus. The response and response time were recorded for later analysis.

Participants gave their responses with their right hand on a Cedrus RB-530 response box with the vertically arranged response alternatives "synk", for synchronous, and "asynk", for asynchronous (see Figure 2). Two experiment versions were used in order to detect and control for possible response biases. Half of the participants had "synk" as the top button on the response box and "asynk" as the bottom button, from here on called the "SynkAsynk" experiment version, and the other half of the participants had "asynk" as the top button and "synk" as the bottom button, from here on called the "AsynkSynk" experiment version. In a pilot test conducted before the study the left and right buttons on the response box were used for the "synk" and "asynk" responses and the participants were not instructed to answer using a specific hand. This lead to a right hand / right side bias, which probably occurred because all the pilot participants were right-handed; that is, when having the right hand on one button and the left hand on another button, responding with the right hand is more natural and automatic for right-handers.  This pilot also showed that the pilot participants often automatically pressed the button on the same side as the ear the syllable was presented to. To avoid this bias, the responses were shifted to the top and bottom button, and the participants were instructed to only respond using their right hand.

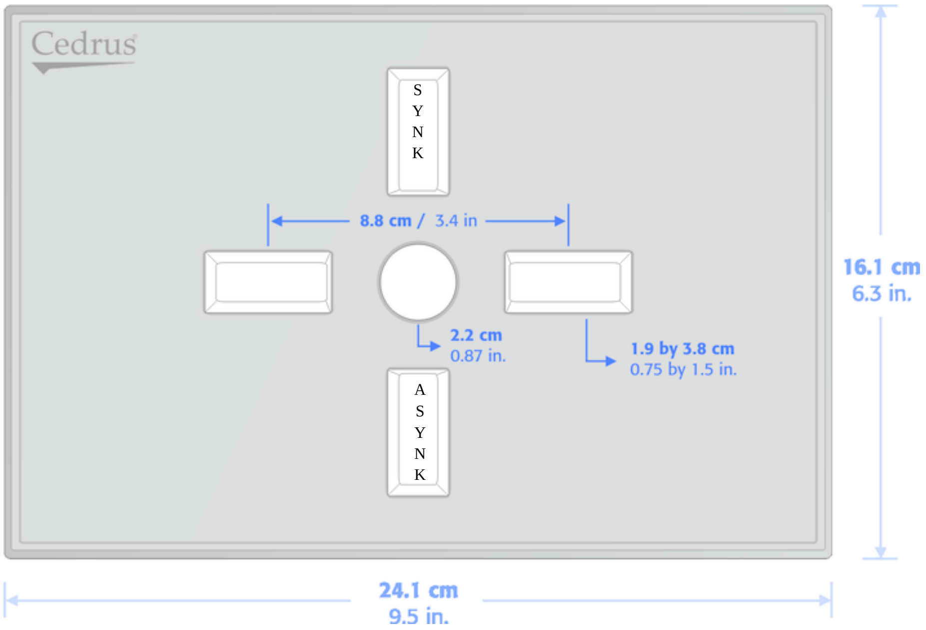

Figure 2: The Cedrus RB-530 response box illustrating the “SynkAsynk” experiment version. Adapted from the the Cedrus home page, Retrieved February 15, 2013, from: http://www.cedrus.com/responsepads/rb530.htm. Copyright 2013 by Cedrus Corporation. Adapted with permission.

The /ba/ stimuli had eight repetitions while the /da/ and /ga/ stimuli had four repetitions.  /Da/ and /ga/ had fewer repetitions than /ba/ in order to minimize the time needed to complete the experiment, however, all syllables was still included in the study to be able to replicate previous asynchrony studies and to give variety to the participants. The syllable /ba/ had more repetitions than /da/ and /ga/, allowing /ba/ to be used in the main data analysis if the assumptions of the ANOVA were violated for the syllables /da/ and /ga/, because of too few repetitions.

The experiment contained four blocks. For all the 23 audiovisual alignments, all blocks had two repetitions of /ba/ and one repetition of /da/ and /ga/. All stimuli were randomized within each block. The experiment had three 30 second breaks containing nature images presented visually on the monitor with no audio, because studies have shown that these images refresh and restore the participants’ attention (Herzog, Maguire, & Nebel, 2003; Kaplan, 1995; Ulrich et al., 1991).

Before the experiment started the participants were shown four examples of the stimuli with different asynchronies and had the possibility to ask questions. Before the experiment and before each block started, instructions about the experiment were given on the screen. The participants were instructed to sit quietly during the experiment and when the experiment was over until the other participants had completed their trials.

Across all blocks, the experiment consisted of 368 trials and lasted approximately 30 minutes. After completing the experiment the participants were debriefed about their experience, and questions about the experiment were answered. Participants received a small token of appreciation for their participation (see Appendix L).

## Results

For each participant, the mean percentage of synchronous responses was plotted for the different audiovisual alignments. As illustrated in Figure 3, the negative values on the x-axis represent the conditions where the audio was presented before the video, and positive values represent the conditions where the video was presented before the audio. To calculate each participant's window of synchrony a symmetrical Gaussian curve was fitted to the data in SigmaPlot 12.0 (see Conrey & Pisoni, 2006; Hay-McCutcheon, Pisoni, & Hunt, 2009). From this function the point of subjective simultaneity (PSS), audio lead threshold (ALT), visual lead threshold (VLT) and full width of half maximum (FWHM) were analysed. PSS is the x-value associated with the peak of the Gaussian curve. ALT and VLT are the chance level, that is, the point for which percent likelihood of a synchrony and an asynchrony response are equal. The x-value at which the 50th percentile crosses the Gaussian curve is ALT for a x-value which is less than the PSS (i.e. on the left portion of the curve) and VLT for a x-value which is greater than the PSS (i.e. on the right portion of the curve). FWHM is the window of synchrony, which is the difference between ALT and VLT. PSS, ALT, VLT and FWHM were the basis for further data analyses.

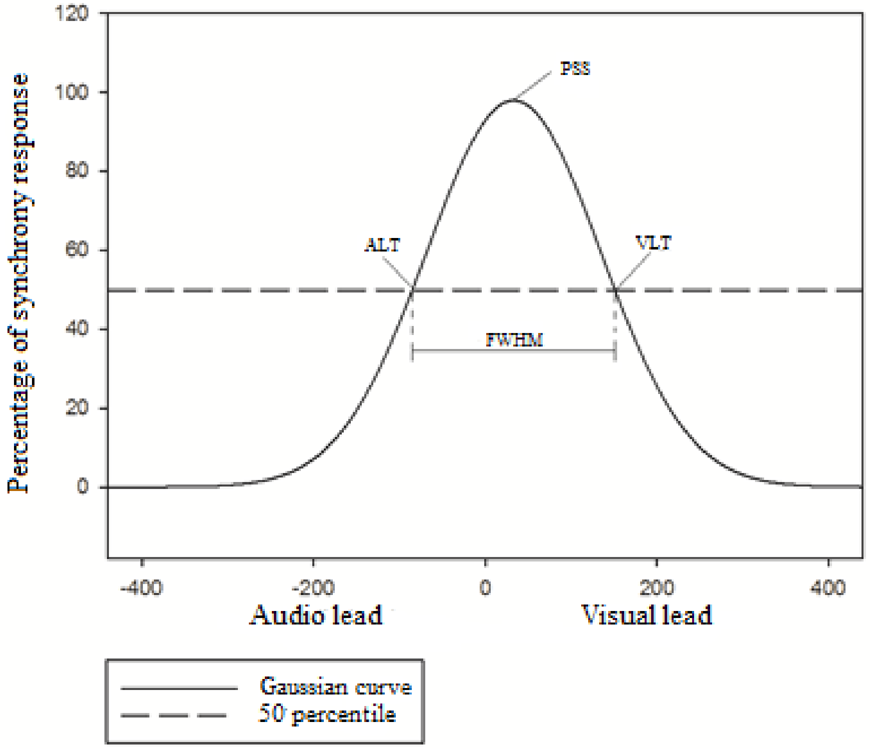

Figure 3. An example of the Gaussian curve of a participant’s percentage of synchronous responses.

A mixed repeated measures ANOVA was carried out with syllable (/ba/, /da/ and /ga/) and ear of presentation (left ear, right ear) as within subject variables, gender and experiment version as between subject variables, and PSS, ALT, VLT and FWHM as dependent variables. Shapiro-Wilk tests revealed that the data were normally distributed for the dependent variables in all conditions, and the z-score revealed no outliers. The within subject variable, ear presentation, was used to test the main hypothesis that the participants are expected to perceive more incidents of asynchrony when the syllable is presented to the right ear, compared to the left ear, while the between subject variable, gender, was used to test the hypothesis that men perceive more incidents of asynchrony in audiovisual speech than women.

## Syllable

As seen in Figure 4, results showed a main effect for syllable (/ba/, /da/ and /ga/) for ALT [$F(1, 59) = 37.41$, $p < .001$], VLT [$F(1, 59)=11.44$, $p < .001$] and PSS [$F(1, 59) = 77.67$, $p < .001$], but not for FWHM. Post hoc tests with Bonferroni corrected p-values revealed that ALT was significantly closer to the point of audiovisual synchrony for /ba/ ($M = -224$, $SD = 71$) ($p < .001$) and /da/ ($M = -227$, $SD = 68$) ($p < .001$) compared to /ga/ ($M = -275$, $SD = 72$). VLT was significantly closer to the point of audiovisual synchrony for /ga/ ($M = 202$, $SD = 70$) compared to /ba/ ($M = 249$, $SD = 63$) ($p < .001$) and /da/ ($M = 233$, $SD = 70$) ($p < .001$), and for /da/ compared to /ba/ ($p = .004$). PSS was significantly different among all the syllables with /ba/ ($M = 13$, $SD = 33$) shifted towards the visual lead condition compared to /da/ ($M = 3$, $SD = 37$) ($p = .005$) and /ga/ ($M = -36$, $SD = 42$) ( $p > .001$) and /ga/ shifted toward the audio lead condition compared to /da/ ($p > .001$). As seen in Figure 4, although the curves differed in placement, they were otherwise comparable in form. The velar /ga/, which has a less visually accessible release than the labial /ba/ and alveolar /da/, was particularly displaced from the other syllables. No interactions with syllable were found.

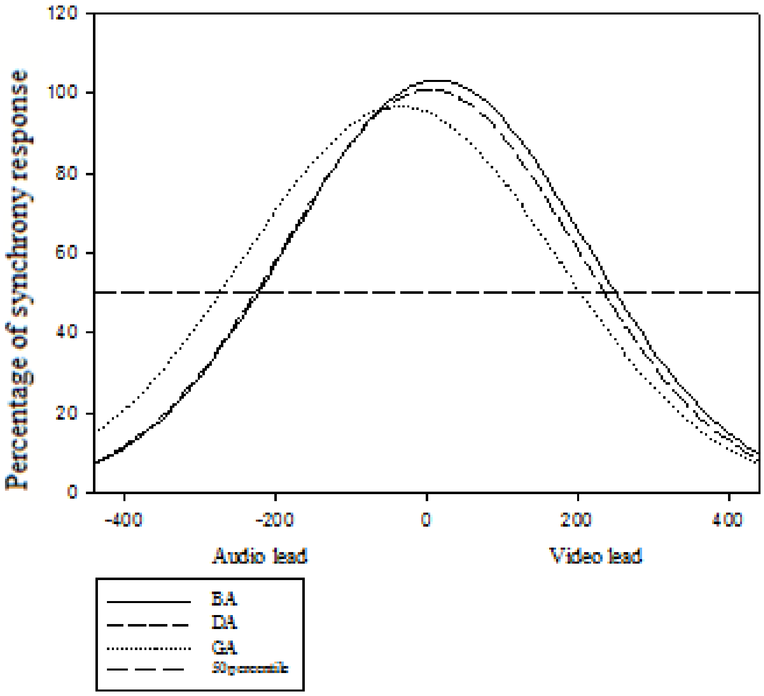

Figure 4. Normalized responses averaged across participants for the different audiovisual alignments shown as Gaussian curves for /ba/ (solid line), /da/ (dashed line) and /ga/ (dotted line). The horizontal line is the 50 percentile.

## Ear presentation

Although results showed no main effect of ear presentation or experiment version, as shown in Figure 5, an interaction for ear presentation and the experiment version was present for VLT [*F*(1, 58) = 6.61, *p* = .013] and FWHM [*F*(1, 58) = 5.08, *p* = .029]. Paired sampled t-tests, with p-values adjusted for multiple comparisons using Bonferroni–Holm’s correction, showed that the ear presentation differences in the “SynkAsynk” experiment version were not significant for any of the dependent variables. However, in the “AsynkSynk” experiment version, the ear presentation was significant for VLT [*t*(1, 29) = -2.61, *p* = .042, *r* = .44] and FWHM [*t*(1, 29) = -3.686, *p* = .004, *r* = .56]. VLT was closer to the point of audiovisual synchrony when the syllable was presented to the right ear (*M* = 227, *SD* = 59) than the left ear (*M* = 239, *SD* = 63) and FWHM was more narrow when the syllable was presented to the right ear (*M* = 458, *SD* = 92) compared to the left ear (*M* = 482, *SD* = 100). .

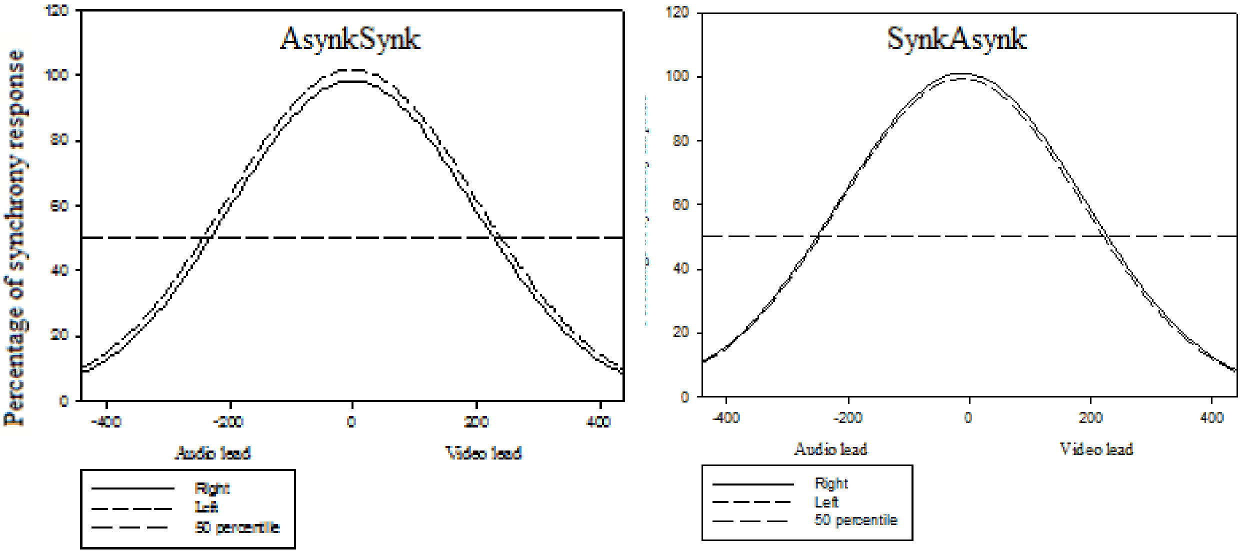

Figure 5. The normalized responses averaged across participants for the different audiovisual alignments shown as Gaussian curves for the syllable presented to the right ear (solid line) and presented to the left ear (dashed line) in the "AsynkSynk" and "SynkAsynk" experiment version. The horizontal line is the 50th percentile.

## Gender

Results also showed a main effect of gender for VLT and PSS, but not for ALT or FWHM. As shown in Figure 6, men had a VLT (*M* = 199, *SD* = 62) significantly closer to the point of audiovisual synchrony than women (*M* = 250, *SD* = 62) [*F*(1, 58) = 5.77, *p* = .001, *r* = .24] and men had a PSS shifted significantly towards the audio lead condition (*M* = -25, *SD* = 34) compared to women (*M* = 3, *SD* = 34) [*F*(1, 58) = 5.26, *p* = .018, *r* = .11].

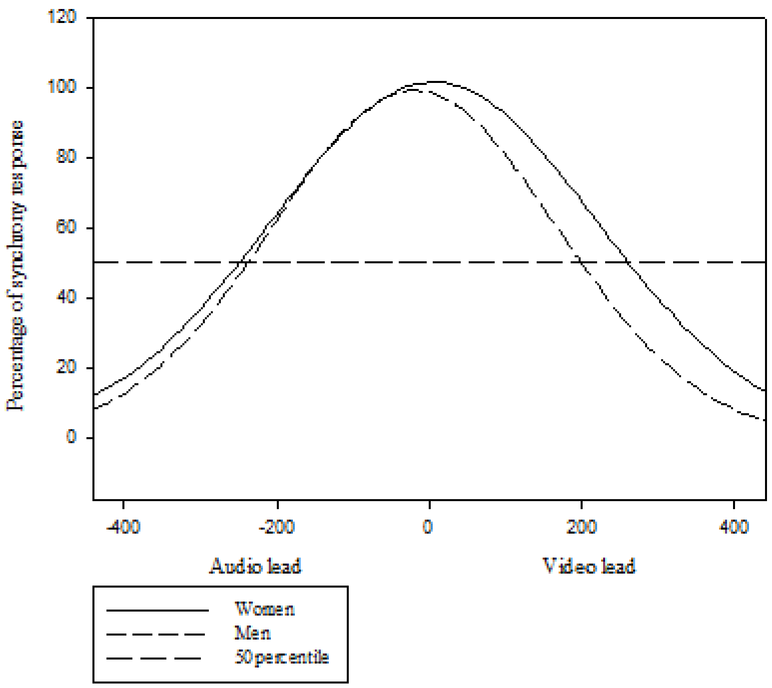

Figure 6. The normalized responses averaged across participants for the different audiovisual alignments shown as Gaussian curves for women (solid line) and men (dashed line). The horizontal line is the 50 percentile.

A significant interaction for ear presentation, experiment version and gender was observed for VLT [*F*(1, 58) = 4.89, *p* = .032] and PSS [*F*(1, 58) = 6.10, *p* = .017], but not for ALT or FWHM (see Table 1). However, when adjusting p-values for multiple comparisons using a Bonferroni–Holm's correction, the results were not significant for either VLT or PSS. Based on the mean scores for the different experiment versions (see Table 1), women do not seem to have ear differences in either of the experiment versions. Men show a non-significant tendency for the expected right ear advantage in the "AsynkSynk" experiment version. However, in the "SynkAsynk" experiment version, the opposite tendency, with a non-significant left ear advantage, occur. Before the Bonferroni–Holm's correction the ear presentation differences for men was significant for VLT [*t*(1,14) = -2.69, *p* = .018, *r* = .58], but not PSS in the "AsynkSynk" experiment version, while the ear presentation differences in the "SynkAsynk" experiment version were not significant. Results showed no interaction between gender and experiment version.

Table 1. *The means and standard deviations for VLT and PSS in each experiment version, presented to the right and left ear, for men and women.*

| | | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Right | | Left | | Right | | Left | |
| | | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| AsynkSynk | VLT | 204 | 55 | 222 | 58 | 250 | 55 | 258 | 64 |
| | PSS | -11 | 40 | -7 | 34 | 9 | 39 | 5 | 35 |
| SynkAsynk | VLT | 191 | 81 | 178 | 67 | 260 | 61 | 261 | 64 |
| | PSS | -24 | 39 | -28 | 32 | 5 | 32 | 2 | 30 |

## Summary of results

Summing up, no main effect was found for ear presentation, however a significant interaction between ear presentation and experiment version, for VLT and FWHM, revealed that the expected right ear advantage occurred in the AsynkSynk experiment version. The results also revealed a main effect of gender, which showed that men experienced more incidents of asynchrony compared to women in the visual lead condition. This lead to a a PSS that shifted significantly towards the audio lead condition for men compared to women. A three-way interaction between ear presentation, experiment version and gender was also found for VLT and PSS, however the differences were not significant when adjusting for multiple comparisons.

## Discussion

The main purpose of the current study was to investigate laterality and gender differences in audiovisual synchrony processing. This was done using the syllables /ba/, /da/ and /ga/ to measure the audio lead threshold, video lead threashold, window of synchrony and point of subjective simultaneity. The results showed a significant main effect for syllables for PSS, ALT and VLT, but not for FWHM; that is, the size of the window of synchrony does not differ between the syllables, but the curves are shifted towards audio lead for /da/ and /ga/, the syllables with less salient visual place of articulation (Bengherel & Pichora-Fuller, 1982). The windows of synchrony were consistent with previous findings, with a width of a few hundred milliseconds (Conrey & Pisoni, 2006). However, the expected skewed synchrony curves, with participants being more likely to perceive events as asynchronous when an auditory input precedes a visual input than vice versa (e.g., Dixon & Spitz, 1980), were not observed in the current experiment. As mentioned earlier the speech materials were recorded and for most part prepared for another experiment (Alm & Behne, 2013) at the Speech Laboratory at NTNU. In their asynchrony experiment, the expected skewed synchrony curves occurred, indicating that the lack of skewed synchrony curves in the current experiment is not due to the stimuli. However, even though the synchrony curves were skewed in Alm and Behne (2013), the syllable with the least visually salient consonant release, /ga/, had a synchrony curve which was almost symmetrical, due to more asynchrony responses for /ga/ in the audio lead condition compared to the other syllables. Alm and Behne (2013) argued that a less salient visual place of articulation causes less accurate audiovisual synchrony perception, and that these cues may thereby serve as a temporal reference point in judging synchrony. Their study nevertheless showed no differences in the visual lead condition across syllables, as in the current study.

The difficult auditory conditions in the current experiment, such as noise and uncertainty of what syllable would occur and at what ear, may have lead the participants to change strategy for synchrony recognition. Numerous cues can be used in audiovisual speech perception. Over 16 acoustic features have been identified for stop consonants (Dorman, Studdert-Kennedy & Raphael, 1977) and facial motion can often help predict speech acoustics (Barbosa & Yehia, 2001; Yehia, Rubin & Vatikiotis-Bateson, 1998). Which of these cues are utilised in audiovisual synchrony perception might vary with stimuli. When either the visual or, as in the current study, the auditory signal is reduced due to noise, participants might rely on different cues than in good perceptual conditions. Such a strategy might give the syllable /ga/ an advantage in the visual lead condition. Even though the syllable effect was different from previous asynchrony studies (e.g., Alm & Behne, 2013; Dixon & Spitz, 1980), results show no interaction between syllable and other factors. Thus, other findings in the current study show no indication of being influenced by the syllable effect.

## Lateralization

Although no significant main effect was found for ear presentation, results did show an interaction between ear presentation and experiment version. The two experiment versions, each used by half of the participants, were included as a control condition. Although no difference in ear presentation was observed in the “SynkAsynk” experiment version, a significant right ear advantage was found, for the visual lead threshold and the window of synchrony, in the “AsynkSynk” experiment version. An interaction between ear presentation, experiment version and gender, even though the p-values were not significant when adjusting for multiple comparisons, indicate that while no ear presentation differences were present for women, a tendency for the expected right ear advantage in the “AsynkSynk” experiment version, occurred for men. Thus the interaction found between ear presentation and experiment version, is probably due to a right ear advantage for men in one of the experiment versions. This difference between the experiment versions occurred despite precautions to avoid response bias. That no main effect was observed between the two experiment versions suggests that the “AsynkSynk” experiment version, for some reason, might be more sensitive in detecting the right ear advantage. If such a detail affects the responses for the different ear presentations, previous conflicting results (e.g., Brown & Sainsbury, 2002) may be related to choice of experimental protocol and resulting asymmetries in response bias rather than to a lack of lateralization for temporal processing. If, for example, the experiment versions had not been counterbalanced in the current experiment, the ear presentation effect would likely not have been detected. However, lacking comparable methodological information to evaluate in previous papers makes investigating this further difficult.

As mentioned earlier, in the current experiment the experiment versions were counterbalanced across participants and differed in the placements of the “asynk” and “synk” responses on the top and bottom response buttons. How this methodological detail affects the right ear advantage is uncertain. The participants were not instructed to use any specific finger for responding, as long as they used their right hand. However, several of the participants were observed responding with their index finger on the top button and their thumb on the bottom button, which might be a natural way to use two vertically arranged buttons using one hand. The arrangement of the fingers on the response buttons might be relevant because research has shown that tapping with the index finger induces higher cortical activation intensity compared to tapping with the thumb (Lotze et al., 2000). Furthermore, even though simple isolated finger movements are associated with activation that include the entire hand representation in the motor cortex, magnetoencephalography (Beisteiner et al., 2004) and magnetic resonance imaging (Dechent & Frahm, 2003) have revealed that when analyzing the center of the brain activity, thumb movements are processed more laterally than index movements, which are processed more laterally than little finger movements. Exactly how using different fingers would affect the results is not clear, however the differences in activation intensity and laterality for processing of the different fingers might have caused one of the experiment versions to be more sensitive in detecting the right ear advantage.

Neuroimaging studies (e.g., Pulvermüller et al., 2005) have demonstrated that passive auditory perception of speech activates the same motor circuits, as when articulating the same speech sounds. Also, Meister, Wilson, Deblieck, Wu and Iacoboni (2007) showed that speech perception is impaired by the disruption of the left premotor cortex. They used a transcranial magnetic stimulation to disrupt the human premotor cortex while participants performed an auditory syllable identification task, and a visual color identification task matched in difficulty, task structure and response characteristics, as a control condition. While the performance of the color identification task was unaffected, the disruption of the premotor cortex decreased the performance in the syllable identification task. Meister et al. (2007) argued that these results show that the left premotor cortex has an essential role in speech perception. Schubotz, Friederici and von Cramon (2000) used fMRI to identify brain activation during perception of unimodal auditory and visual temporal patterns. They found that the brain areas activated during this type of temporal perception are the same brain areas generally involved in motor preparation and motor coordination. These and other studies (e.g., Möttönen, Dutton, & Watkins, 2012; Möttönen & Watkins, 2012) show that the motor cortex is involved both in unimodal auditory speech perception and unimodal auditory and visual temporal perception. Thus, when the syllable was presented to the right ear, an increased activation in the left motor cortex would occur. And since the left motor cortex controls movements made with the right hand and tapping with the index finger is shown to induce higher activation intensity compared to tapping with the thumb (Lotze et al., 2000), this increased activation might in some way facilitate index finger responses in the right ear syllable presentation. This might contribute to the lack of right ear advantage in the

"SynkAsynk" experiment version where the index finger would be used for the synchrony response and to the expected right ear advantage in the "AsynkSynk" experiment version where the index finger would be used for the asynchrony response.

Thus, even though the results showed no main effect for ear presentation, the interaction between ear presentation and experiment version support the hypothesis that the participants perceive more incidents of audiovisual asynchrony when the syllables are presented to the right ear, thus targeting the left hemisphere, compared to when the syllables are presented to the left ear. This finding is consistent with other results showing hemispheric specialization in other types of temporal processing (e.g., Efron, 1963; Grondin et al., 2011; Nicholls, 1996). A hemisphere asymmetry for temporal processing has important ramifications for laterality research and may, for example, be an important factor in other left hemisphere functions, such as speech processing and movement skills (Nicholls, 1996).

## Audio lead and visual lead in audiovisual synchrony perception

Temporal processing being lateralized to the left hemisphere does not necessarily mean that the right hemisphere cannot process temporal information, but that the left hemisphere has an advantage in this type of processing. If that is the case for temporal processing, it might explain why the differences in ear of presentation in the current study occurred with the visual lead stimuli, but not audio lead stimuli.

Binaural dichotic auditory signals are initially primarily directed to the contralateral hemisphere via contralateral sensory channels, and then transmitted across the corpus callosum to the ipsilateral hemisphere (e.g., Kimura, 1967). Thus, the hemisphere receiving the second of the two inputs, auditory or visual, will be more decisive for temporal judgment, which in this case is the judgment that the auditory and visual inputs are synchronous or asynchronous, than the hemisphere receiving the first input (Clark, Balfour, & Geffen, 1989). In the audio lead conditions, the auditory input will, depending on the degree of asynchrony, reach both hemispheres before the binocular visual input, which will reach both hemispheres simultaneously. Thus both hemispheres will make the synchrony judgment, resulting in the lack of ear presentation differences for audio lead. However, in the visual lead conditions, the second input, the audio, will primarily be projected to the contralateral hemisphere at first, and thus that hemisphere will be decisive for the synchrony judgment. Thus, whereas with the audio lead, both hemispheres will be decisive for the synchrony judgment, concealing any hemisphere differences, in the visual lead conditions, the left hemisphere advantage becomes apparent.

## Gender differences in temporal processing

The results also showed a main effect for gender, revealing that men perceive more incidents of asynchrony in the visual lead condition and have a point of subjective simultaneity shifted towards the audio lead condition compared to women. The results support the hypothesis that men perceive more incidents of asynchrony in audiovisual speech, compared to women, and are consistent with previous findings showing higher acuity of temporal processing by men than by women (e.g., Kempe et al., 2012; Hancock & Rausch, 2010; Rammsayer & Troche, 2010; Wittmann & Szelag, 2003). Several arguments have been proposed attempting to explain why these differences occur.

**Internal clock.** Some authors argue that men are more accurate in experiments on temporal perception, compared to women, due to an internal clock ticking faster in men than in women (Rammsayer, 1999; Rammsayer & Lustnauer, 1989). The internal clock is suggested to generate neural pulses and the number of pulses associated with a time interval is the internal representation of this interval. Thus, a higher clock rate would give finer temporal resolution of the internal clock and better accuracy in temporal perception tasks (Rammsayer & Lustnauer, 1989). Rammsayer (1999) argue that this clock is a dopamine dependent mechanism, mediated by dopamine activity in the basal ganglia. However, no neurological evidence for such a neural clock exists (Wittmann & Szelg, 2003).

**Different problem solving strategies.** Gender differences in temporal processing have also been attributed to men and women using different problem solving strategies. Szelag (1997) argue that three different strategies might be activated when solving temporal tasks: a global process, an analytic process and a combination of the two strategies mentioned. In a global process, qualitative differences of the stimuli are recognized without identifying separate components of the stimuli, such as serial order. In an analytic process, identification of separate components of the stimuli, such as serial order, are established when recognizing qualitative differences of the stimuli. Divenyi and Hirsh (1974) trained participants in identifying the temporal order of three-tone sequences using a global strategy, which significantly improved their performance. According to Kimura (1999) men usually use a global strategy, whereas women usually use analytic strategy, such that gender differences in the current study might be due to different strategies for determining if the stimulus was synchronous or not. However, because Divenyi and Hirsh (1974) trained all their participants using a global strategy, the training itself, not the strategy used, might have caused the improvement. In order to know if different problem solving strategies causes the gender differences, experiments would have to be carried out were different groups were trained in different strategies. To date, no clear evidence different problem solving strategies causing of gender differences in temporal processing has been shown.

**Faster interhemispheric transmission time.** Geffen et al. (2000a, 2000b) argue that the temporal advantage for men probably reflects men's faster interhemispheric transmission time. Men have a greater proportion of white matter compared to women and vice versa for gray matter (Gur et al., 1999). White matter is myelinated connective tissue and has been associated with faster information transmission within the brain (Gur et al., 1999). Thus, men might have faster information transmission within and between the hemispheres which might give men a temporal advantage (Geffen et al., 2000a, 2000b; Rostad, Mayer, Fung, & Brown, 2007). However, several studies have found the opposite results, with women having faster interhemispheric transmission time compared to men (e.g., Moes, Brown, & Minnema, 2007; Proverbio, Mazzara, Riva, & Manfredi, 2012). Thus, because of these mixed findings, more research is needed before conclusions about gender differences in temporal processing can be made based on gender differences in interhemispheric transmission time within the brain.

**Spatiotemporal advantage in men.** The gender differences in temporal perception revealed in the current study might have been caused by the dichotic listening task. In the auditory TOJ studies by Lotze et al. (1999) and Wittmann and Szelag (2003), who found gender differences in temporal perception, the stimuli were presented binaurally using dichotic listening, while van Kersteren and Wiersinga-Post (2007), who did not find gender differences when using an auditory TOJ task, presented stimuli monaurally. Wittmann and Szelag (2003) suggest that the bilateral temporal processing in women might lead to a decrease of spatiotemporal performance during binaural presentation. Voyer argued that the effect size of lateralization differences between men and women revealed in dichotic listening studies is so small, that the differences would have little implications for an individual experiment. Thus, even though the results from the current experiment only showed a tendency for gender differences in lateralization, women might still process temporal information more bilaterally compared to men. Wittmann and Szelag (2003) argue that when the stimuli are presented binaurally, the spatiotemporal representation might be more accurate in men because a more lateralized processing might improve temporal left-right discrimination. Even though they used a binaural auditory presentation with one click presented to each ear, an improved temporal left-right discrimination should also be an advantage in the present study with a binocular visual and a dichotic auditory presentation of the stimuli. If men have a spatiotemporal advantage compared to women, the gender differences in the current experiment might either be due to the temporal or spatial attributes of the task, or both. A control condition without the dichotic auditory presentation would had to been applied in order to investigate this. However seeing how the tendency for a temporal processing advantage in men in the audiovisual TOJ task performed by Rammsayer and Troche (2010) did not have a dichotic auditory presentation, the gender differences are probably not only due to spatial attributes of the task.

**Gender differences in temporal processing.** Several arguments have been proposed attempting to explain the gender differences in temporal processing. However, no neurological evidence for a neural clock exists (Wittmann & Szelg, 2003), to our knowledge, no research have been carried out to investigate if a global or an analytic strategy has an advantage in temporal perception, and mixed findings have been reported about interhemispheric transmission time differences between the genders. Therefore, more investigation should be carried out before concluding anything based on these theories. Thus a spatiotemporal advantage in men compared to women might help explain the gender differences in temporal processing. A spatiotemporal advantage in men is especially interesting, since this theory also gives a possible explanation why previous audiovisual asynchrony studies have not reported any gender differences, since there would be no spatial aspect to the task without the dichotic auditory presentation. Also, if men have a spatiotemporal advantage due to increased lateralization in temporal processing, the theory that the hemisphere receiving the second of the two inputs is more decisive for the temporal judgment (Clark et al., 1989) could explain both why the right ear advantage and the gender differences in temporal processing revealed in the current experiment, occur in the visual lead but not audio lead condition.

## Conclusion

In summary, findings from the current study indicate a right ear advantage for audiovisual synchrony processing, which is most evident in men. However, the effect was only apparent in one of the experiment versions. How this methodological detail affects the right ear advantage is not certain, but the increased activation intensity and less lateralized processing of the index finger compared to the thumb might have caused one of the experiment versions to be more sensitive in detecting the right ear advantage. The motor cortex is involved in both speech and temporal perception and the left motor cortex, which controls movements with the right hand, might thus have a higher activation during right ear presentation of the syllable compared to left ear presentation. This might facilitate index responses during right ear presentations which would increase the right ear advantage in the “AsynkSynk” experiment version and decrease the right ear advantage in the “SynkAsynk” experiment version.

The right ear advantage was most evident in the visual lead conditions, which might be explained by the simultaneity judgment being made in the hemisphere first receiving the second of the two inputs. When the second input is a binocular visual input, both hemispheres will receive the input simultaneously, and thus both hemispheres will be decisive for the synchrony judgment, concealing the left hemisphere advantage in the audio lead conditions.

In line with the hypothesis the results revealed that men perceive more incidents of asynchrony in audiovisual speech, compared to women. These gender differences might be explained, at least partially, by a spatiotemporal advantage in men compared to women, possibly because of increased lateralization in men. This would not only explain why previous audiovisual synchrony studies have not reported any gender differences, but also why the gender differences are present in the visual lead but not audio lead conditions.

The results from the current study indicate that bimodal audiovisual synchrony is left lateralized, that gender differences might contribute to the large individual differences found in synchrony research and add to a growing body of research giving insight into temporal aspects of multisensory integration.

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# Appendices

The letters, questionnaire and procedures in these appendices are developed from standard procedural materials in the Speech Lab.

## Appendix A

Information and consent form

### Synkronitet og Audiovisuell Persepsjon

PSY3903 Høst 2012

Norges teknisk-naturvitenskapelige universitet
*Psykologisk institutt, NTNU*
7491 Trondheim

Forespørsel om deltakelse i forskningsprosjekt:
**Synkronitet og audiovisuell persepsjon**
Studien undersøker oppfattelsen av asynkronitet mellom bilde og lyd, hvor stavelser presenteres i enten høyre øre eller venstre øre samtidig som det blir presentert støy i begge ører. Det vil under forsøket bli vist korte filmklipp av stavelser der lyd og bilde har forskjellig grad av asynkronitet. Deltageren vil gjennom å trykke på knapper på en responsboks gi til kjenne om han/hun oppfatter det som synkront eller asynkront. Det vil ikke være noen rette eller gale svar; vi ønsker bare å finne ut hva deltakerens subjektive oppfattelse av asynkronitet er.

Studiens utvalg vil bestå av opptil 60 personer. Alle deltakerne vil være mellom 20 og 30 år og ha norsk som morsmål. De vil ha normal hørsel, normalt eller korrigert til normalt syn med linser, og være høyrehendte.

Deltakerne vil gjennomgå en synstest og en hørselstest før forsøket starter. Disse testene vil bare undersøke aspekter ved deltakerens syn og hørsel som er direkte relevante for forsøket. Ettersom eksperimentatorene ikke har optometrist- eller audiografutdanning kan de ikke diagnostisere eller anbefale behandling.

Undersøkelsen vil finne sted ved Talelaben, Psykologisk institutt, Dragvoll. Total varighet av forsøket er beregnet til maksimalt 1 time og 10 minutter.

Prosjektet er basert på frivillig deltakelse, og man kan når som helst trekke seg underveis og be om å få data slettet uten begrunnelse. Man er ikke forpliktet til å gjennomføre, og en eventuell avbrytning vil ikke få noen konsekvenser. Dataene fra eksperimentet vil benyttes i en eller flere forskningsartikler som vil bli vurdert for publisering og/eller faglige presentasjoner. Alle data som samles inn vil bli behandlet konfidensielt og vil kun være tilgjengelig for de som er direkte koblet til prosjektet. Når prosjektet avsluttes i utgangen av 2013 vil all informasjonen som kan knyttes til deltakerne bli makulert (kontaktinformasjon som e-postadresser etc.) Annen informasjon som vil bli beholdt i form av data fra eksperimentet vil ikke kunne føres tilbake til forsøksperson.

Eventuelle spørsmål og henvendelser kan rettes til Ane Eir Torsdottir (torsdott@stud.ntnu.no).

## **Synkronitet og Audiovisuell Persepsjon**
PSY3574 Vår 2012

### S**AMTYKKEERKLÆRING**

**Prosjekttittel: Synkronitet og audiovisuell persepsjon**

Jeg har lest informasjonsskrivet og jeg har hatt mulighet til å stille spørsmål angående min deltakelse i eksperimentet. Jeg sier meg villig til å delta i prosjektet.

| | | |
|---|---|---|
| …………………….. | ………………… | ……………………………………. |
| Sted | Dato | Underskrift |

## Appendix B

Questionare

# Synkronitet og audiovisuell persepsjon

## Høst 2012

# Spørreskjema

**Deltager ________________**

**Dato ___________________**

**Tester __________________**

Informasjonen som samles i dette spørreskjema vil bli behandlet konfidensielt. Svarene her vil bli koblet til svarene dine i eksperimentet, men ikke til ditt navn eller annen identifiserende informasjon. Informasjon skal kun brukes for å forstå resultatene fra eksperimentet bedre. Når prosjektet avsluttes i utgangen av 2013 vil informasjonen fra spørreskjemaene bli makulert.

For å svare på spørsmålene nedenfor, vennligst kryss av/skriv tydelig.

1. Kjønn ______

2. Alder_______

3. Bruker du noen form for synskorreksjon? Ja____ Nei____
   Hvis ja, hva bruker du (Briller, linser osv.)?_______________

   Bruker du dem i dag? Ja____ Nei____

4. Er norsk ditt morsmål? Ja___ Nei___

5. Har du flere førstespråk? Ja___ Nei___

Når begynte du regelmessing å bruke det/de andre førstespråket/ene? ____ år gammel

6. Føler du at du har hatt tilstrekkelig med søvn i natt, normalt for deg?
   Ja____ Nei____

7. Har du drukket alkohol i løpet av de siste 24 timene? Ja____ Nei____

8. Har du tatt medikamenter som kunne påvirke oppmerksomhet, syn eller hørsel?
   Ja____ Nei____

9. Har du noen helsehistorikk som kunne påvirke oppmerksomhet, syn eller hørsel i dag (hjernerystelse siste 6 mnd, epilepsi, ADHD etc)?
   Ja____ Nei____

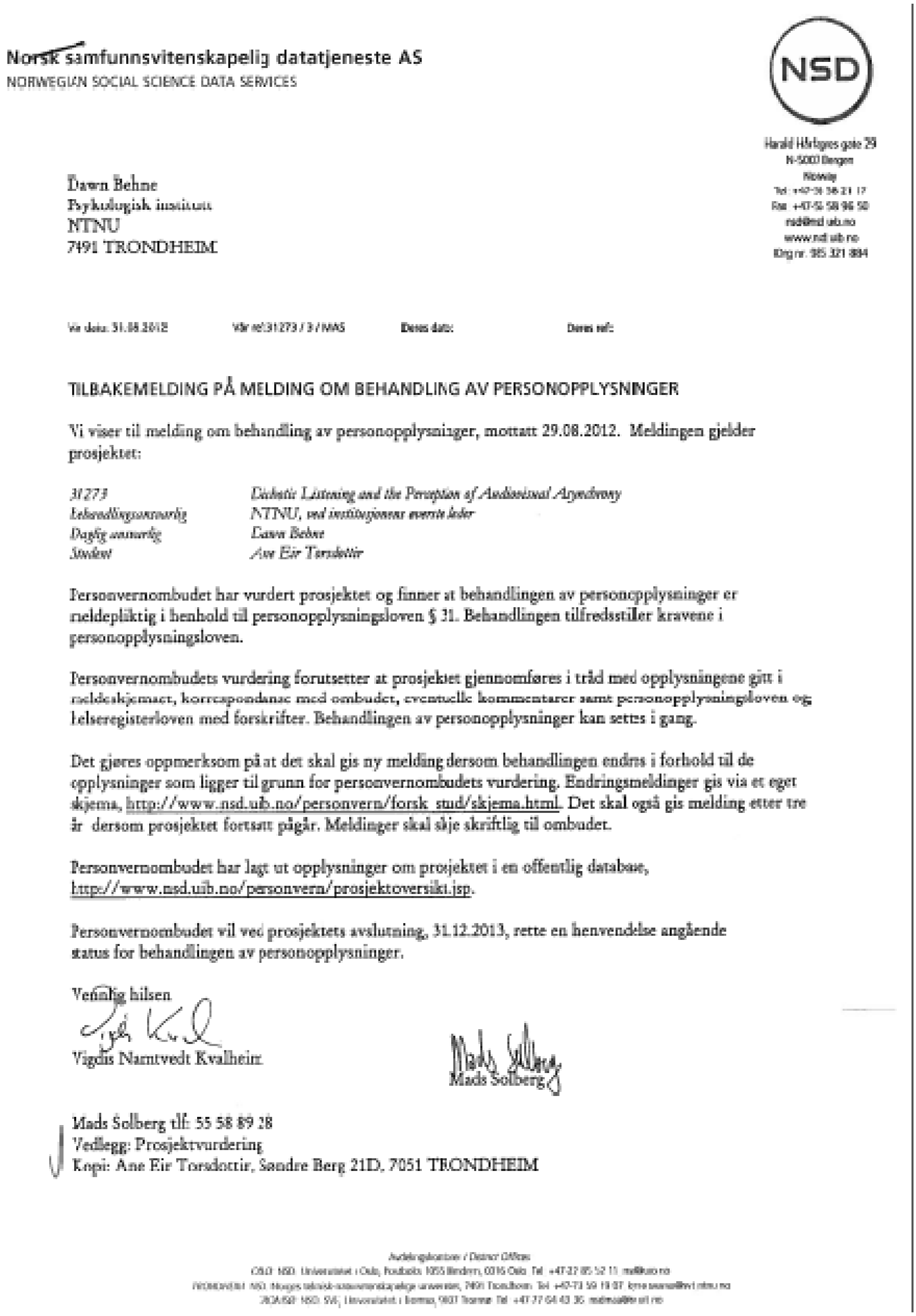
10. Hvor mange timer i uka spiller du: _________
    Dataspill:_____

    Konsoll (Xbox, Playstation etc.):_____

11. Er du musiker? Ja_____ Nei______
    Hvis ja, hvor mange år har du spilt? _________

# Appendix C

Approval from Norwegian Social Sciences Data Service (NSD). Part one



Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

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Dawn Behne
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Vår dato: 31.08.2012 Vår ref: 31273 / 3 / MAS **Deres dato:** **Deres ref:**

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 29.08.2012. Meldingen gjelder prosjektet:

| | |
|---|---|
| *31273* | *Dichotic Listening and the Perception of Audiovisual Asynchrony* |
| *Behandlingsansvarlig* | *NTNU, ved institusjonens øverste leder* |
| *Daglig ansvarlig* | *Dawn Behne* |
| *Student* | *Ane Eir Torsdottir* |

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, eventuelle kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/forsk_stud/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://www.nsd.uib.no/personvern/prosjektoversikt.jsp.

Personvernombudet vil ved prosjektets avslutning, 31.12.2013, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Mads Solberg

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Vedlegg: Prosjektvurdering
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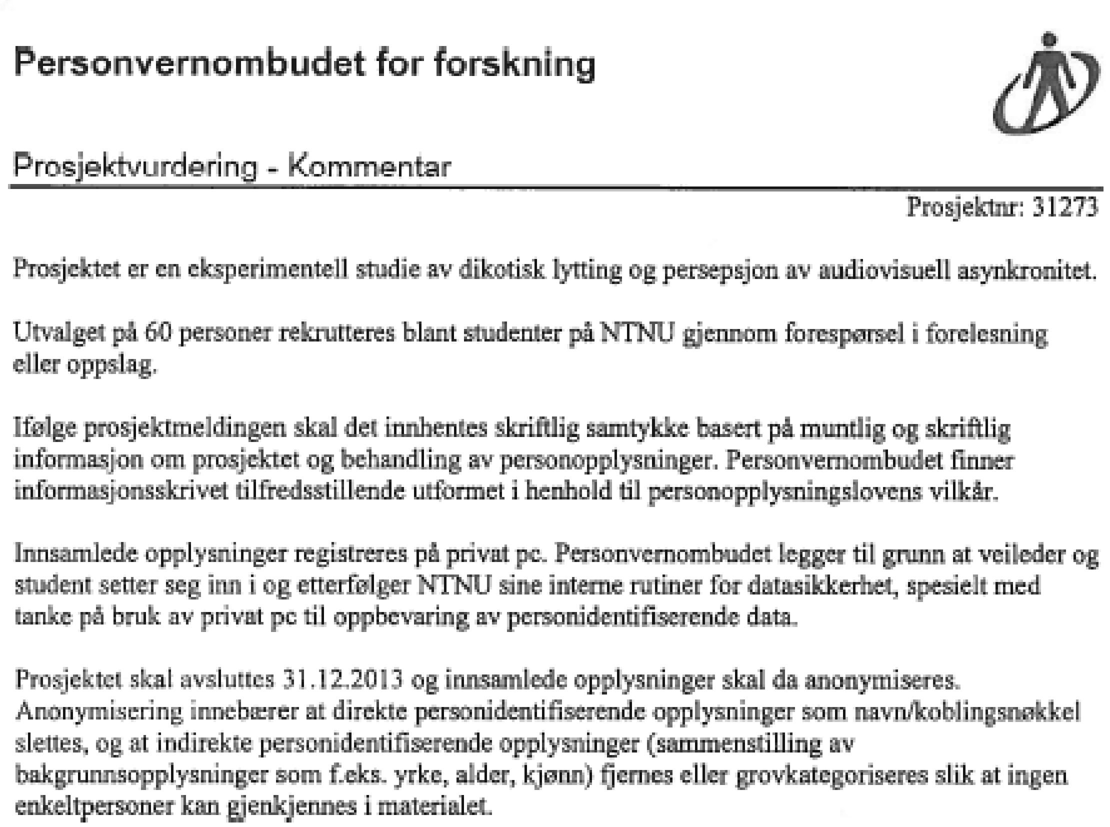
## Appendix D

Approval from Norwegian Social Sciences Data Service (NSD). Part two



# Personvernombudet for forskning

## Prosjektvurdering - Kommentar

Prosjektnr: 31273

Prosjektet er en eksperimentell studie av dikotisk lytting og persepsjon av audiovisuell asynkronitet.

Utvalget på 60 personer rekrutteres blant studenter på NTNU gjennom forespørsel i forelesning eller oppslag.

Ifølge prosjektmeldingen skal det innhentes skriftlig samtykke basert på muntlig og skriftlig informasjon om prosjektet og behandling av personopplysninger. Personvernombudet finner informasjonsskrivet tilfredsstillende utformet i henhold til personopplysningslovens vilkår.

Innsamlede opplysninger registreres på privat pc. Personvernombudet legger til grunn at veileder og student setter seg inn i og etterfølger NTNU sine interne rutiner for datasikkerhet, spesielt med tanke på bruk av privat pc til oppbevaring av personidentifiserende data.

Prosjektet skal avsluttes 31.12.2013 og innsamlede opplysninger skal da anonymiseres. Anonymisering innebærer at direkte personidentifiserende opplysninger som navn/koblingsnøkkel slettes, og at indirekte personidentifiserende opplysninger (sammenstilling av bakgrunnsopplysninger som f.eks. yrke, alder, kjønn) fjernes eller grovkategoriseres slik at ingen enkeltpersoner kan gjenkjennes i materialet.

## Appendix E

Audiometric testing procedure

# Prosedyre for audiometrisk test

Testen kan utføres en annen dag/tid enn forsøket.

***Før testen, pass på at…***

- ledningene sitter i riktig på baksiden, at hodetelefonene fungerer og at knappen fungerer.
- du har et audiometrisk test-skjema forberedt med deltakernr, dato og tester.
- du har tilgjengelig ”hørselsbrevet” i forbindelse med utilfredsstillende audiometrisk testing.

***Sammen med deltageren…***

1. Si at vi skal utføre en hørselstest.
2. Ingen mat/drikke eller tyggis i munnen under forsøket, ikke hår mellom øre og øreklokker evt. fjerne øredobber da dette kan bli ubehagelig å ha på.
3. Spørre om personen hører bedre på ett av ørene enn det andre.
    a. Hvis ja begynn testen med dette øret
    b. Hvis nei begynn testen med det høyre øret
4. Fortell at vi skal spille av en lyd og at de skal trykke på knappen hvis de hører lyden
5. Be dem om å prøve knappen slik at de vet hvordan det føles. Knappen skal i høyre hånd hos høyrehendte.
6. Sette på hodeklokkene blå = venstre øre, rød = høyre øre.
7. Pass på at du bruker riktig side av skjemaet.
8. **Hørselstest**:

    Sett X for hver respons og 0 for manglende respons på test kartet.

    Fortsett med prosedyren nedenfor for hver frekvens til forsøkspersonen får minst 2 av 3 responser (X) på det samme lydnivået.

    Begynner med 1000Hz, 40dB (Høyre øret, hvis venstre ikke er bedre).

    a. 40dB til 0db
        - Hvis respons (X), skru ned 20 dB (først fra 40 til 20, så fra 20 til 0)
        - Hvis ikke respons (O), skru opp 5 dB

    b. 0 dB og nedover
        - Hvis respons (X), skru ned 10 dB (fra 0 til -10)
        - Hvis ikke respons (O), skru opp 5 dB

    c. Fortsett (a) og (b) til man har minst 2 av 3 respons på samme dB nivå

    d. Når man har dette, gjøres tilsvarende på 2000 Hz og 4000 Hz.
    e. Etter dette går man tilbake til 1000 Hz og derifra nedover til 500 og 250 Hz.

   Når dette er gjort på høyre øre, gjenta samme prosess på venstre øre.

9. Vår målgruppe hører fra 15 dB og nedover for 250-4000 Hz. (Ingen spesifikasjoner for 125 Hz eller 8000 Hz)
10. Hvis disse kriteria ikke er oppnådd, blir testpersonen ikke med i eksperimentet og skal få et avvisningsbrev.

## Appendix F

Snellen test procedure

# Prosedyre for Snellen synstesting

2013

*Før testen, pass på at…*

- du har et Snellen test-skjema forberedt med deltakernummer, dato og tester.
- Snellen chart ligger på den utvalgte macen på Talelab 2 "Snellen_chart_dataskjerm2.tif". Du skal ikke åpne denne før punkt 5.

*Sammen med deltageren…*

1. Forsikre deg om at samtykkeskjema er utfylt før testen.
2. Under testen skal den som kjører synstesten stå ved siden av forsøkspersonen, og følge med på om forsøkspersonen leser det samme som i tabellen under.
3. Mål opp 50 cm fra ansiktet til forsøkspersonen til skjerm med et målebånd.
4. Be forsøkspersonen om å dekke det **venstre** øyet med hånden.
5. Åpne snellen chart-filen.
6. Kjør testen for det **høyre** øyet.
    a. Spør om forsøkspersonen klarer å lese høyt den øverste bokstaven, deretter linje 2 ovenfra og videre nedover til og med linje 8 (over den nederste streken).
    b. Si at forsøkspersonen kan blunke litt og ta en liten pause når de ønsker.
    c. Om forsøkspersonen mister bokstaver i en linje, be ham/henne om å prøve linjen igjen om han/hun ønsker det.
    d. Kryss av på skjemaet for passende alternativ for de linjene forsøkspersonen klarer å lese. Bruk evt kommentarfeltet.
7. Be forsøkspersonen om å dekke det **høyre** øyet med hånden.
8. Gjenta trinnene i punkt 6 med det **venstre** øyet
9. Snellen-testen er "bestått" om linje 7 og/eller linje 8 leses helt riktig.
10. Hvis dette ikke er oppnådd kan deltakeren ikke delta i eksperimentet, og skal få et avvisningsbrev.

| | |
|---|---|
| Linje 1 | **E** |
| Linje 2 | **F P** |
| Linje 3 | **T O Z** |
| Linje 4 | **L P E D** |
| Linje 5 | **P E C F D** |
| Linje 6 | **E D F C Z P** |
| Linje 7 | **F E L O P Z D** |
| Linje 8 | **D E F P O T E C** |

**Appendix G**

Ishihara test procedure

# Ishihara test

Kjøres ved iMacene på Talelab 2 eller på kollokvierom

1. Åpne Ishihara testen i Superlab fra desktopen.
2. Trykk > for å begynne.
3. Lagre resultetet i med deltakerens kode som filnavn.
4. Lagre resultatene i mappen AneMaster-Ishihara–resultater.
5. Forsøkspersonen blir bedt om å…
    - Se på sirkelen som kommer opp på skjermen.
    - Skrive inn i boksen (under sirkelen) det de ser i sirkelen.
    - Trykke på "neste" for å gå videre.

NB: Ikke se på datafilen mens deltakeren er der.

Ishihara testen er "bestått" om alle svarene i datafilen er riktige.

Ring rundt ”bestått” eller ”ikke bestått” på testskjemaet (som også gjelder for Snellen, øyedominans og hendthet).

**Appendix H**

Eye dominance test procedure

# Procedure to test eye dominance

**Where:** This test can be performed wherever there is a white wall and normal lighting available. A cross is marked on the wall using two bits of black tape. Before performing the test mark a specific point on the floor to be spot where the participant will stand during the test. If you are at Dragvoll, use the hallway in the speech lab area. If you are somewhere else, find a suitable place and mark the crosses with black tape.

**Ask the participant to:**

1. Stand by the marked point
2. Stretch both arms and form a triangle by overlapping the thumbs and have the fingers covering the knuckles.
3. Have **both** eyes open, look through the triangle and center the black cross made by tape.
4. Close the **left** eye: Is the cross within the triangle?
5. Close the **right** eye: Does the cross *remain* within the triangle, or *move* outside the triangle?

**Evaluation**

| LEFT eye closed | RIGHT eye closed | |
|---|---|---|
| Yes (X remains) | No | -> Right eye dominant |
| No | Yes (X remains) | -> Left eye dominant |
| Yes (X remains) | Yes (X remains) | Redo with a smaller triangle |
| No | No | Redo with a larger triangle |

Check off on the **Eye dominance form** (which also contains the Snellen , Ishihara and handedness form) if the person is right or left eye dominant.

## Appendix I

Vision rejection letter

Norges teknisk-
Naturvitenskapelige universitet
NTNU – Trondheim

2013

Takk for at du har vært villig til å delta i eksperimentet om audiovisuell asynkronitet.

For å etablere tilsvarende synsbetingelser på tvers av deltagergrupper i eksperimentet gjennomfører vi en synstest hvor synsterskelen er basert på kriterier som er tilpasset for dette eksperimentet. Dine resultater fra denne synstesten faller ikke innenfor kriteriene som er satt opp for eksperimentet. Vi ønsker likevel å understreke tre punkter:

(1) Synstesten var ikke gjennomført av en utdannet optometrist og konstaterer dermed ikke en medisinsk vurdering av ditt syn.
(2) Kriteriene som vi bruker er knyttet til spesielle betingelser for akkurat dette eksperimentet, og er ikke nødvendigvis de samme som ville blitt brukt i en synstest gjennomført på medisinsk grunnlag.
(3) Vår prosedyre for synstesten kan skille seg fra en prosedyre utført av en optometrist.

Vi takker deg for din interesse i eksperimentet!

Med vennlig hilsen,

Dawn M. Behne
Førsteamanuensis
Prosjektveileder

## Appendix J

Hearing rejection letter

Norges teknisk-
Naturvitenskapelige universitet
NTNU – Trondheim

2013

Takk for at du har vært villig til å delta i eksperimentet om audiovisuell asynkronitet.

For å etablere tilsvarende hørselsbetingelser på tvers av deltagergrupper i eksperimentet gjennomfører vi en hørselstest hvor hørselsterskelen er basert på kriterier som er tilpasset for dette eksperimentet. Dine resultater fra denne hørselstesten faller ikke innenfor kriteriene som er satt opp for eksperimentet. Vi ønsker likevel å understreke tre punkter:

(4) Hørselstesten var ikke gjennomført av en utdannet audiograf og konstaterer dermed ikke en medisinsk vurdering av din hørsel.
(5) Kriteriene som vi bruker er knyttet til spesielle betingelser for akkurat dette eksperimentet, og er ikke nødvendigvis de samme som ville blitt brukt i en hørselstest gjennomført på medisinsk grunnlag.
(6) Vår prosedyre for hørselstesten kan skille seg fra en prosedyre utført av en audiograf.

Vi takker deg for din interesse i eksperimentet!

Med vennlig hilsen,

Dawn M. Behne
Førsteamanuensis
Prosjektveileder

**Appendix K**

General procedure

# Generell prosedyre

## Testene

Testene/skrivene som skal utføres før eksperimentet er samtykkeskjema, spørreskjema, hendthetstest, Snellen, øyedominans,  og hørselstest. Alle deltakere skal først fylle inn samtykkeskjema.

## Testing

### *Før forsøkspersonen kommer:*

1. Pass på at det er plass i rommet der testene skal utføres (Analyserommet hvis det er ledig. Kollokvierom hvis Analyserommet er opptatt):
    - Hvis kollokvierom skal brukes, må en stasjonær Mac flyttes dit
    - Samtykkeskjema
    - Spørreskjema
    - Hendthetsskjema til deltakerne
    - Skjema for Snellen, hendthet, Ishihara og øyedominanstest
    - Et skriv som skal gis til forsøkspersoner som ikke kan delta pga ikke tilfredsstillende syns (Snellen) testing
    - Penner til alle forsøkspersoner (sjekk at disse fungerer)
    - Målebånd
    - Prosedyre for Snellen-test, øyedominanstest, Ishihara-test
    - Testskjema for audiometrisk testing
    - Prosedyre for audiometrisk testing
    - Mappe til samling av alle skjemaer som er utfylt
    - Et skriv som skal gis til forsøkspersoner som ikke kan delta pga ikke

    tilfredsstillende audiometrisk testing
  - Sjekkliste

2. Sjekk at krysset for øyedominanstesten er på døra i gangen.
3. Sjekk at de to iMacene som skal brukes til Ishihara-test, utregning av resultat på hendthets-testen og Snellen testen er slått på.
4. Sett eventuelt fram te, kopper, og varmt vann i vannkokeren.
5. Skriv deltakernummeret på:
    - Spørreskjema
    - Hendthetsskjema til deltakerne
    - Snellen, hendthet, Ishihara og øyedominans-skjema
    - Hørselssjema
    - Sjekkliste

## *Når forsøkspersonen er tilstede:*

6. Møt deltakeren ved avtalt sted og ønsk ham/henne velkommen.
7. Vis hvor han/hun kan legge klær, vesker osv.
8. Tilby eventuelt te.
9. Be deltakeren fylle ut samtykkeskjemaet. Det MÅ fylles ut før testing blir foretatt.
10. Fortell deltakerne at pretestene skal forsikre oss at alle deltakerne vi tester har de samme utgangspunktene for eksperimentet slik at de resultatene vi eventuelt finner ikke avhenger av deres fysikk eller andre forhold enn det vi ønsker å forske på.
11. Hvis deltakerne skulle ha spørsmål utenom utførelsen av eksperimentet slik som hva hypotesen er eller hva forventningene til resultatene er, må man fortelle at det ikke kan kommenteres før eksperimentet er avsluttet.
12. Utfør Snellentest på en iMac (se egen prosedyre)
13. Be deltakeren fylle ut spørreskjemaet.
14. Sjekk om besvarelsene i spørreskjemaet dekker våre kriteriene.
15. Be deltakeren fylle ut hendthetsskjemaet.
16. Utfør Ishihara-test på samme iMac (se egen prosedyre)
17. Utfør øyedominanstest i gangen utenfor rommet (se egen prosedyre)

18. Sjekk om deltakeren bestod Ishihara-testen ved å åpne tekstfilen på iMacen der testen ble utført.
19. Sjekk om deltakeren er høyrehendt ved å bruke hendthetskalkulatoren på den andre iMacen.
20. Følg deltakeren til persepsjonslaben.
21. Vis forsøkspersonene hvor de skal legge vesker, klær osv (i ytterste rommet).
22. Si at telefoner skal skrus av eller settes på lydløs
23. Skru av vifta og heng ut ”Ikke forstyrr”-skiltet
24. Utfør testen ved å følge prosedyren for audiometrisk testing.
25. Minn deltakeren på når han/hun skal møte opp til eksperimentet om ikke dette gjøres samme dag (se dette på timeplanen på wikien).

### *Etter at forsøkspersonen har gått:*

1. Eventuelle testskjemaer som ikke fylte kriteriene merkes med Eksperiment ikke gjennomført og legges i mappen sammen med andre skjemaer.
2. Legg samtykkeskjemaet og hørselstestskjemaet i safen i skapet på analyserommet. Lås dem inne.
3. Kryss av i sjekkliste og legg i mappen.

## Eksperimentkjøring

### *Før forsøkspersonene kommer:*

26. Gjør klar iMacene som skal brukes + ordne papirer og skrive deltakernummer på listen.
27. Luft ved å åpne døra og holde den oppe med en stol.
28. Skriv inn deltaker på loggbok (deltakernummer (kode), kjønn, alder, dato og klokkeslett. Dersom noe av informasjonen er ukjent kan dette fylles ut etter deltaker er kommet.)
29. Sjekk at dette ligger på bordet i det ytterste rommet.
    - Midtbysjekk
    - Kvitteringsbrev
    - Penner til alle forsøkspersoner (sjekk at disse fungerer)

  - Loggbok

30. Dersom iMacene er på, restart dem.
31. Logg på Alle – konto (passord: Alle)
32. Åpne eksperimentet i Superlab (fra desktopen: AneMaster-SynkAsynk eller AneMaster-AsynkSynk)
33. Sjekk lydnivåene på iMacene (Bruk lydknappene på tastaturet. Det skal være 4 prikker. Tast F12 for høyere lyd og F11 for lavere lyd).
34. Sjekk lysnivåene på iMacene (Bruk lysknappene på tastaturet. Det skal være 12 (av 16) prikker. Tast F1 for mer lys og F2 for mindre lys)
35. Sjekk hodetelefonene:
    - hodetelefoner er koblet til
    - hodetelefoner fungerer som de skal (at det er lyd på eksperimentet: start en blokk med lyd for å sjekke)
36. Sjekk at riktig responsboks står ved riktig iMac (synk- og asynk-knapper på riktig sted), og sjekk at de er koblet til.
37. Legg eventuelle gale responsbokser bak/ved siden hver iMac-skjerm, slik at bordene ser ryddigere ut. Eventuelt flytt gale responsbokser til bordet i det ytterste rommet.
38. Sjekk at vinkelen på skjermene er riktige slik at de står likt. De skal stå rett i forhold til bordet.
39. Sjekk at iMacene står i riktig avstand fra skjermen. Ti cm unna veggen.
40. Sjekk at det er firbente stoler og ikke kontorstoler med hjul ved iMacene.
41. Pass på at rommene er ryddige
    - Uten klær, vesker og søppel
    - Tavlen er ren. (Rengjøringsmidler er i skapet.)
    - iMac-skjermene er rene.
    - Støvsug i laben om nødvendig. (Støvsuger er i skapet.)
42. På Macen i rommet utenfor eksperimentrommet:
    - Remote desktop
        - ➢ Start programmet ”Chicken of the VNC” som ligger på desktopen
        - ➢ Velg ”Connection” og deretter ”Open connection”
        - ➢ Velg Perclab 1 (eller 2, 3, 4, 5)
        - ➢ Velg ”Connect”, og så får du se deltakerens skjerm på din skjerm
        - ➢ Gjør dette for alle skjermene det sitter en deltaker ved

    - Hvis ingenting skjer, trykk på ”Chicken of the VNC” øverst i venstre hjørne og velg ”Quit Chicken of the VNC”. Åpne deretter programmet på nytt.

## *Mens forsøkspersonene er til stede*

1. Hent deltakerne ved avtalt sted.
2. Forsøkspersonene ønskes velkommen
3. Vis forsøkspersonene hvor de skal legge vesker, klær osv (i det ytterste rommet).
4. Si at telefoner skal skrus av eller settes på lydløs.
5. Hvis deltakerne skulle ha spørsmål utenom utførelsen av eksperimentet slik som hva hypotesen er eller hva forventningene til resultatene er, må det fortelles at dette ikke kan kommenteres før eksperimentet er avsluttet.
6. Vis forsøkspersonene hvor de skal sitte i eksperimentrommet (slik at deltakernummeret de har fått stemmer med deltakernummeret på skjemaene).
7. I loggboka skal også informasjonen om hvilken iMac deltakeren blir plasser og hvilken responsboks som brukes fylles inn. Eksempel: Datamaskin: iMac 2, eksperimentversjon: Asynk-Synk.
8. Trykk > for å starte eksperimentet. Husk å krysse av for lagre data (save data) og sjekk at det ikke er krysset av for kjøring av enkeltblokker (run selected blocks).
9. Skriv inn filnavn for dataene: Deltagernummer, kjønn. Eksempel: Kvinne, deltaker 15 koding: 15f.
10. Skriv det samme filnavnet også i neste vindu og velg plassering for lagring: Resultatene skal lagres i mappen AneMaster 2012 RESULTATER
11. Legg tastatur og mus bak/ved siden av hver iMac-skjerm.
12. Gi felles instruksjoner angående
    - Hvordan deltakerne skal sitte (bakerst i stolen, rett i ryggen)
    - Hodetelefonene (hodetelefonene skal sitte på riktig vei og med bøylen opp. Hår skal ikke være i mellom dem og ørene.)
    - De skal sitte stille under forsøket og se rett frem
        - ikke snakke med andre
        - ikke flytte på seg
        - dette gjelder også i pausene samt hvis noen skulle forlate rommet.
13. Si at vi kan se hva som skjer på deres skjerm under eksperimentet. Si at ingen opptak

blir gjort, og at dette er bare for å sikre at alt gå bra!

14. Si at det er ingen rette eller gale svar, vi er bare ute etter deltakernes subjektive oppfattelser.
15. Si at nærmere instrukser om selve utførelsen av forsøket vil bli gitt på skjermen på starten av forsøket.
16. Si at de kan ta pauser mellom blokkene under eksperimentet.
17. Si at mellom hver blokk vil det være pauser – bilder som varer i 30 sekunder.
18. Gi beskjed om at det vil være noen eksempler før forsøket starter. Si at de skal rekke opp handa hvis de har spørsmål etter eksemplene. Jeg står i døråpningen, og hvis ingen gir tegn, går jeg ut og lukker døra etter meg.
19. Si at når forsøket er ferdig skal de sitte stille til de får beskjed fra meg (når alle er ferdige).
20. Si at om det skulle dukke opp noen problemer under forsøket som gjør at de må ut av laben, må deltakerne prøve å ikke forstyrre de andre som deltar. (Hvis noen forlater laben før forsøket er ferdig må vi også spørre om de har det bra eller om de trenger hjelp)
21. Spør om det er noen har spørsmål, svar evt. på disse
22. Plasser hodetelefoner på. (HUSK at de skal på riktig vei, over hele øret og med bøylen opp, og uten hår imellom).
23. Mens forsøket pågår, passer vi på at alle deltakerne har det bra og at de ikke har noen problemer med eksperimentet (ved å følge med på om alt går som det skal på deltakernes skjermer). Noter eventuelle problemer osv i loggboka.

## *Når alle deltagerne er ferdig med eksperimentet:*

24. Ta med loggboka.
25. Gi beskjed om at forsøket er ferdig.
26. **Debrifing:**

Husk å snakke med alle. Alle må få sjansen til å si noe, kan evt. tas ”under fire øyne” hvis de synes det er ubehagelig eller vanskelig å snakke om.

- Vi forteller litt grundigere om eksperimentet
    - Hypotese:
        - At det er en right ear advantage pga en left hemisphere

        advantage når det kommer til audiovisuell asynkronitet.
        - Forskning har vist en REA/LHA for temporale auditive og visuelle stimuli, men det er, så vidt vi vet, ikke blitt undersøkt med audiovisuelle stimuli.
        - Kjønnsforskjeller
    - Opplevelsen av asynkronitet når lyden kommer før bildet
        - Forskning viser at det er lettere å oppdage asynkronitet når lyden kommer før bilde enn når lyden kommer etter bildet.
- Spør om hvordan de har opplevd eksperimentet (særlig stimuliene)?
    - Hva har gått bra?
    - Har det vært noe rart ved forsøket, ubehagelig eller vanskelig å forstå?
- Hadde de forventninger til eksperimentet
    - Noe som ikke har skjedd?
    - Noe har skjedd uforventet?
- Har de noen spørsmål?

Hvis det er noen kommentarer, skriv disse ned i loggboka kodet med deltakerens kode.

27. Takk for deltakelsen og gi Midtbysjekker til alle.
28. Kvitteringen må skrives under av alle før de går, som bevis for at de har mottatt Midtbysjekk.
29. Vær sikker på at alle har det bra når de forlater talelaben

## *Etter at forsøkspersonene har gått:*

30. Lag en back up av resultatfila på minnepinnen (sjekk at det ikke er flere like filnavn, det skal det ikke være dersom kodene brukes riktig).
31. Slett data hvis det er noen som trekker seg under eksperimentet
32. Samle alle skjemaer og ta de med ut av laben for sikker oppbevaring
33. Tell over og sjekk at det er 6 skjemaer for hver person (samtykke, spørreskjema, hendthet, audiometrisk testskjema, synstest- og øyedominansskjema, Midtbysjekk-kvittering).
34. Legg mappen og minnepinnen i safen, som er i Talelab 2.
35. Gjør maskinen klar til neste forsøk.
    - Re-start maskinene (slå de av dersom det ikke er mer testing denne dagen)

- Koble fra responsboksene
- Koble til mus og tastetur
- Sjekk at laben er ryddig (stolene og hodetelefonene er på plass, ingen papir liggende osv.)
- Skru på vifta igjen

Ta ned ”ikke forstyrr”-skiltet og legg

## Appendix L

Receipt for Midtbysjekk

Norges teknisk-

Naturvitenskapelige universitet

NTNU – Trondheim

### Deltakelse i et persepsjonseksperiment

Jeg kvitterer herved for å ha mottatt en 200 kroner Midtbysjekk i forbindelse med å ha deltatt i et eksperiment om audiovisuell talepersepsjon i regi av Talelaben, Psykologisk institutt, NTNU.

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| Sted | Dato | Underskrift |