The social side of noise annoyance (De sociale kant van geluidhinder)
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The Social Side of Noise Annoyance

(De Sociale Kant van Geluidhinder)

PROEFSCHRIFT

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
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volgens besluit van het College der Promoties
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Eveline Maris
geboren te Amsterdam
in 1972

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Voor mijn ouders en tante Conny

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Het heeft geholpen: mijn boekje is af!

Eveline

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CHAPTER 1 **Introduction**

1.1 THE SOCIAL SIDE OF NOISE ANNOYANCE

Being exposed to man-made sound is a social[1] experience. This statement implies that when you expose me to sound, the way I think, feel or behave in response to that sound will be influenced by your actual presence, or my imagination of it (Allport, 1985). You expose Me, We expose Them, etc. (Stallen, 1999; Van Gunsteren, 1999). If the above is true, then annoyance problems that arise due to exposure to unwanted man-made sound are a social issue, too. Social scientific research on noise annoyance commonly addresses noise annoyance not as a truly *social* problem. If indeed exposure to man-made sound is a social experience, then consideration of the social side of exposure to man-made sound is valuable. It creates possibilities to draw from the extensive social psychological literature, which can further the theoretical understanding of noise annoyance. It may also inspire innovative ways of annoyance abatement or prevention.

1.1.1 The aims of this thesis

With the research reported in this thesis, I aim to test the ‘social hypothesis of noise annoyance’: Annoyance with man-made sound is the response to a social experience. I will do this by means of experiments in which I expose participants to noise, and systematically vary the social process between the ‘exposer’ (the person operating the sound source, i.e., the experimenter) and the ‘exposee’ (the sound-exposed participant), and assess the arising noise annoyance. For the design of the experiments, I use a social psychological model of noise annoyance (Stallen, 1999) in combination with social psychological theories on procedural justice (e.g., Lind and Tyler, 1988). Procedural fairness is a dimension of the social process in an exchange relationship, which is known to influence the evaluation of received outcomes (e.g., Lind and Tyler, 1988; Greenberg, 1993; Thibaut and Walker, 1975). With these experiments, I test the central hypothesis that the procedural fairness of the social process between the person(s) operating the sound source and the person(s) being exposed to the sound influences the latter’s evaluation of the sound.

In this introductory chapter, after a brief description of the scope and consequences of environmental noise, the relative absence of a social perspective in noise research is illustrated by a summary of relevant scientific knowledge with regard to noise annoyance. It is indicated why this absence is considered a problem. The introduction continues with descriptions of a social psychological model of noise annoyance, which does address the social side of the issue (Stallen, 1999), and some social psychological theory on procedural fairness (e.g., Lind and Tyler, 1988; Greenberg, 1993; Thibaut and Walker, 1975). The introduction concludes with a short outline of the contents of the remaining chapters of this thesis.

1.1.2 Noise: its scope and consequences

Noise, commonly defined as unwanted sound, is an environmental problem, and it has been since time immemorial. The myths of the Sumerians (3500-1750 B.C.), written on baked clay tablets found in contemporary Iraq, mention how the god Enlil is angered by the noise made by the people of an overpopulated city. As a solution for his noise problem, Enlil sends a big flood that sweeps over the city (Webster, n.d.). Several thousands of years later, Roman rulers make an effort to reduce noise annoyance when they pass a law that prohibits chariot driving at night through the cobblestone streets (World Health Organization (WHO), 2001). City life in medieval Europe is just as noisy: “Since the guilds insisted that work be done in the open, noise from industrial operations, including the death throes of animals being slaughtered and their cries while driving alive through the cities to the meat hall, were ever-present. Bells tolled the hours. Peddlers hawked their wares, and shopkeepers announced their goods” (Nicholas, 2003, p.160). The town crier wanders the streets spreading information, and official proclamations are read from the balustrades of the town hall. In addition, public processions and itinerant musicians, particularly fiddlers and pipers, perambulate the streets, exposing many inhabitants to the sound they make. In the days of Queen Elisabeth I (1533-1603) noise is certainly not the least of the societal problems: officials make an effort to restore some quiet

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[1] In social psychology, *social* refers to ‘the way in which people’s thoughts, feelings, and behaviors are influenced by the real or imagined presence of other people’ (Allport, 1985, quoted in Aronson, Wilson, and Akert, 2002, p.6).

by prohibiting men to beat their wives after ten o'clock at night, because the victims' screaming may keep the neighbors awake (Myncke and Cops, 1985).

Today, still, unwanted sound is a problem. In Europe alone, it is estimated that well over 120 million people are extremely annoyed by noise (European Communities, 2002). The main source of noise pollution is transportation (road, air, and rail traffic). Other important sources are industry, construction activities, and residential activities (WHO, 1999). The World Health Organization mentions a variety of effects on health and well-being associated with noise [2]: interference with communication, noise-induced hearing loss, annoyance responses, as well as detrimental effects on sleep, reading acquisition, social behavior, performance, productivity, and on the cardiovascular and psychophysiological systems (WHO, 1999, 2001; see also Cohen and Spacapan, 1984; Hygge, Evans, and Bullinger, 2002). The costs of general noise to society are estimated to amount to 120 billion Euros a year for the European Union (EU) (European Commission, 1996). The social costs of aircraft noise in the EU can be estimated to amount to 6.8 billion Euros a year[3] (Faburel and Luchini, 2000).

A lot is being done to abate environmental noise problems. Less noisy engines are developed, the operations of noisy artifacts are controlled or restricted (e.g., flight operations, speed limits), environmental planning takes noisy land-use into account; sound absorbing road coating and sound barriers are installed; houses are sound-insulated (e.g., Jue, Shumaker, Evans, 1984). Recently, experiments with agricultural methods and anti-noise are carried out (Murphy, 2002, March 28; TNO, 2006).

Despite all these efforts, a global reduction of noise exposure levels cannot be expected in the near future due to the increasing welfare and mobilization of growing numbers of people (WHO, 2001). In The Netherlands, within ten years, noise may likely be the number one "burden of disease" [4] (in comparison with other environmental stressors) when measured in Disability-Adjusted Life Years (Nederlandse Stichting Geluidhinder, NSG, 2007).

Noise annoyance, one of the negative effects of noise, receives a lot of attention from scientists, policy makers, and the general public. For good reason: annoyance is one of the most common negative effects of noise, and it has been suggested to be an indicator of other adverse noise effects, although no empirical evidence or theoretical underpinning for the latter suggestion is provided (Miedema, 2007). In The Netherlands, noise annoyance has political meaning too, since policy targets with regard to the improvement or preservation of the acoustical quality of residential areas are commonly defined in terms of the prevalence of noise annoyance. Given the actual and future importance of noise and its negative effects on health and well-being, knowledge on noise and its negative effects is of importance to preserve or improve people's quality of life.

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[2] It is subject to discussion whether the link between noise and health effects is causal (Lercher, 1996).

[3] Faburel and Luchini (2000) have tried to relate the nuisance of aircraft noise annoyance to an economic value, using the contingent valuation method. For the area around Paris-Orly airport (population of 62,350 people), where more than half of the people are annoyed by aircraft sound, they calculate that the yearly social costs (measured as the 'willingness to pay in order to suppress the sound annoyance') are about 12 million French francs. This sum equals to 2 million Euros a year. If it is assumed that in this area a number of 35,000 people are annoyed, the willingness to pay per annoyed person can be estimated to 57 Euro per year. For a number of 120 million annoyed people in Europe, the social costs would be 120 million times 57 Euro, which equals 6.8 billion Euros a year.

[4] The notion "burden of disease" and the metric Disability-Adjusted Life Years (DALY) are new means to assess the importance of public health problems that seriously impact well-being but do not (commonly) result in mortality. A short explanation taken from a medical research paper (McKenna, Michaud, Murray, & Marks, 2005, p. 415):

"Mortality data are the most widely used source of information for identifying most important health problems for a population. However, during the 20th century, death rates in economically developed countries have fallen substantially. Correspondingly, many persons live many years with serious illness and disability. Therefore, causes of deaths are increasingly viewed as inadequate measures of the health of a population. Assessments that include more than mortality data to measure population health are frequently called "burden" of disease and injury studies. Such analyses frequently include incidence, prevalence, years of life lost due to premature death, the direct monetary costs of medical care, and the indirect costs related to lost wages and productivity.

A growing body of literature describes the use of summary measures of population health. These reflect both the length of life lost to premature death as well as the time spent in unhealthy states. One such metric, called the disability-adjusted life year (DALY), was introduced by the World Bank in 1993. Subsequently, the World Health Organization (WHO) and Harvard University published a more detailed assessment that used the DALY to enumerate the burden associated with >100 different diseases and injuries. This work, entitled Global Burden of Disease (GBD) primarily assessed burden at the regional, rather than country-specific, level. WHO continues to publish regular updates on the GBD as a statistical annex to the World Health Report."

1.1.3 Brief overview of noise annoyance research

To illustrate the relative absence of a social perspective in noise annoyance research, a brief overview of the preceding research, as far as relevant for the research described in this thesis, is now given.

In the preceding noise research, a large variety of definitions of noise annoyance have been applied in ample scientific studies on noise annoyance. Noise annoyance has been regarded as an emotion, as a result of disturbance, as an attitude, as knowledge, as a result of rational decisions, and as psychological stress (e.g., Guski, Felscher-Suhr and Schuemer, 1999; Stallen, 1999). The World Health Organization (WHO) defines annoyance as “a feeling of discomfort which is related to adverse influencing of an individual or a group by any substances or circumstances” (WHO, 2004, p.3). In this thesis, noise annoyance is defined as “a feeling of discomfort which is related to adverse influencing of an individual by unwanted sound and its circumstances”. The WHO-definition of annoyance is followed but for two aspects: firstly, the definition in this thesis is limited to the feeling of an individual (to the exclusion of ‘a group’) because in the reported experiments the annoyance of individuals has been assessed. Secondly, the sound and its circumstances are expected to be perceived in indissoluble association and are therefore referred to as such (‘substances or circumstances’ has been replaced by ‘sound and its circumstances’).

Noise annoyance due to transportation (i.e., road, rail, and aircraft) has been subject to scientific study over the last 60 years (Fields, 2001). The bulk of these studies are large field surveys that investigate the annoying effect of different types of transportation noise on residents in the area surrounding the noise source. Commonly, sound pressure levels are either measured or calculated, and self-reported noise annoyance is assessed with a questionnaire. Generally, noise annoyance levels rise when sound pressure levels increase. Most noise annoyance studies are merely descriptive, although a minority of has aimed at the development of a conceptual model of noise annoyance (for studies aiming at the development of a conceptual model of noise annoyance, see Glass and Singer, 1972; Fidell, Schultz, and Green, 1988; Fields, 1990; Green and Fidell, 1991; Staats and De Jong, 1993; Lercher, 1996; Stallen, 1999; Guski, 1999; Job and Hatfield, 2001).

Dosage-response curves, synthesized from the aggregated data of large numbers of these survey studies, describe this relationship between dose and annoying effect (e.g., Schultz, 1978; Miedema & Vos, 1998). Dosage-response curves are commonly used in applied settings (e.g., decision making in urban planning) to predict the prevalence of annoyance in an area for a given sound pressure level (sound pressure levels are often not measured, but calculated, e.g., based on information on flight patterns) (Fidell, Barber, and Schultz, 1991).

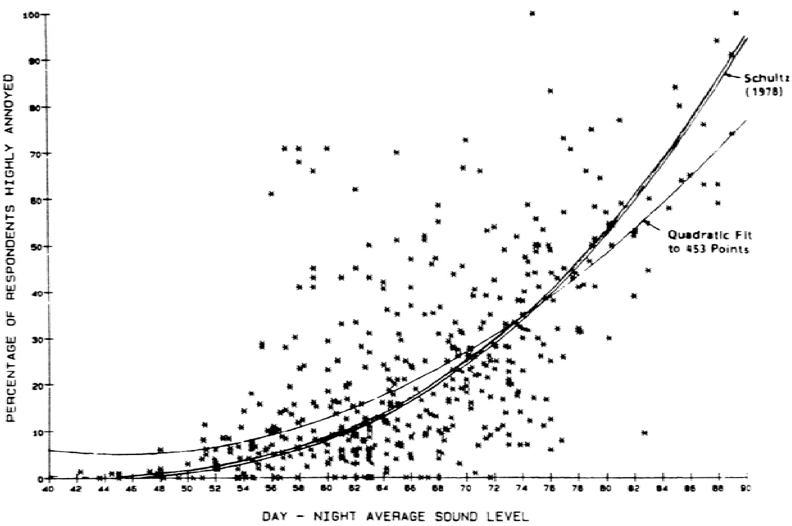

FIGURE 1.1: The third-order polynomial fitting function (Schultz, 1978), and the quadratic fit function (Fidell, Barber and Schultz, 1991) superimposed over 453 data points (reprinted with permission from Fidell, S., Barber, D. S., and Schultz, T. J. Journal of the Acoustical Society of America, Vol. 89, Issue 1, Page 230, 1991. Copyright 1991, Acoustical Society of America). Both dosage-response curves describe the percentage of highly annoyed respondents as a function of the day-night average sound level of transportation noise. However, in particular for sound levels between 54 dB and 80 dB, the difference between predicted and observed annoyance scores is often quite substantial.

The predictive power of the dosage-response curves is typically rather low. The variance in observed annoyance scores is considerable high, as can be seen in Figure 1.1. “Even with the full range of exposure covered and very accurate noise and reaction measurements, noise exposure may only account for 25% – 40% of the variation in reaction” (Job, 1988, p. 996; see also Guski, 1999). Therefore, actual noise annoyance levels frequently turn out to have been over- or underestimated. With regard to using dosage-response relationships for noise policy purposes, Fidell (2003, p. 3011) remarks: “In hindsight, the purely descriptive and exclusively acoustic approach to the problem of predicting community reaction to noise (…) has not been as much of a panacea as once hoped, because the resulting relationships fail to take into account or explain the great variability of community reaction”.

Several attempts to improve the curves’ predictive power have been made: e.g., using other sound metrics or indices (e.g., Fields, 1984; Schultz, 1982; Miedema, Vos and De Jong, 2000), using other mathematical models describing the dosage-response relationship (e.g., Hall, Taylor, and Birnie, 1985; Fidell, Schultz, and Green, 1988; Fidell, Barber, and Schultz, 1991), building source-specific curves (Fields and Walker, 1982; Hall, Birnie, Taylor, and Palmer, 1981; Miedema and Vos, 1998), correcting for ambient noise effects (Fields, 1998), and improving the accuracy of the measurement of annoyance (e.g., Job, Hatfield, Carter, Peploe, Taylor, and Morrell, 2001; Fields, De Jong, Gjestland, Flindell, Job, Kurra, et al., 2001; Berglund, Berglund, and Lindvall, 1976; Botteldooren, Verkeyn, Cornelis, and De Cock, 2001). These alterations have improved the predictive power of the curve to some extent. The approach to noise annoyance research remains ‘purely descriptive and exclusively acoustic’.

Already in the early days of research on the effects of aircraft noise, nonacoustical variables influencing aircraft noise annoyance have been known and studied. For example, the influential Tracor-study identified seven nonacoustical variables that are strongly correlated with noise annoyance: (1) fear of aircraft crashing in the neighborhood, (2) susceptibility to noise (‘noise sensitivity’), (3) distance from the airport, (4) noise adaptability (‘perceived control’), (5) city of residence, (6) belief in misfeasance on the part of those able to do something about the noise problem, and (7) extent to which the airport and air transportation are seen as important (Tracor, 1971, p. 49-53). The sound pressure level (SPL) explained only 14% of variance in noise annoyance scores. The amount of variance in annoyance scores explained by the mathematical model describing the relationship between sound metrics and noise annoyance is boosted to 61% when the above mentioned nonacoustical variables are included (Tracor, 1971, p. 81).

Since the study by Tracor (1971), more has been learned about the nature and scope of nonacoustical correlates of noise annoyance. Many studies have shown a correlation between noise annoyance and nonacoustical variables, like perceived control, noise sensitivity and attitudinal variables (e.g., Fields, 1993; Job, 1988; Goodman and Clary, 1976; Vanderhei Moran, Gunn, and Loeb, 1981; Miedema and Vos, 1999; Guski, 1999, Pedersen and Persson Waye, 2004). In addition, noise annoyance has been found to correlate with situational variables like changes in the sound exposure (e.g., Guski, 1999; Fidell, Silvati, and Haboly; Brown, 1987; Brown, Hall and Kyle-Little, 1985), and exposure context (Weiler, Mortimer, and Stuebing, 1981). Whether nonacoustical variables operate as mediators, moderators, or even as causes of annoyance is unclear (Job, 1988; Guski, 1999; Alexandre, 1976).

The influence of nonacoustical variables on annoyance with transportation noise is quite substantial. Based on a meta-analysis of several survey studies, it has been estimated that the effects of acoustical (e.g., the loudness, pitch, predictability) and nonacoustical variables (e.g., perceived control, personality traits like noise sensitivity, and attitudes towards the sound and its source) each account for about one third of the variance in annoyance scores (e.g., Job, 1988; Fields, 1993; Guski, 1999). The final 33% of the variance is considered error variance.

Perceived control as a cognitive nonacoustical variable influencing noise effects has first been studied about 35 years ago (e.g., Glass and Singer, 1972; Sherrod, Hage, Halpern, and Moore, 1977; Lefcourt, 1973). In (laboratory) experiments, people’s adaptability to noise was investigated. It has been found that the more control a person perceives to have over the noise (or any other stressor), the smaller the negative impact of that stressor (Hatfield, Job, Hede, Carter, Peploe, Taylor, and Morrell, 2002; Jue, Shumaker, and Evans, 1984). Believing that an event is controllable may, however, not always have a positive effect (Folkman, 1984; see also Van den Bos, Bruins, Wilke, and Dronkert, 1999). Personality factors (e.g., internal or external locus of control; ‘learned helplessness’) and situational factors (i.e., whether a person has access to the control switch of the noise source) have been found to determine how much control a person perceives to have (Glass and Singer, 1972). Specifically the situational factors influencing perceived control have a social touch to them. Nevertheless, they have, to the best of my believe, not been explicitly identified or studied as such.

Noise sensitivity and other personality traits influencing noise annoyance have mainly been studied in an epidemiological context, aiming at the identification of groups of people who are more vulnerable to the negative effects of noise (e.g., Stansfeld, 1992; McLean and Tarnopolsky, 1977). Susceptibility to noise, or self-reported noise sensitivity has been studied in this respect, and is a powerful predictor of noise annoyance (Van Kamp, Job, Hatfield, Haines, Stellato, Stansfeld, 2004; Öhrström, Björkman, and Rylander, 1988; Smith and Stansfeld, 1986; Broadbent, 1972; Miedema and Vos, 2003). Noise sensitivity is supposedly randomly distributed over the population; it is stable over time and it is not influenced by sound pressure level. Noise sensitive individuals commonly perceive more threat from sound, and experience higher noise annoyance than the general public, but they do not perceive the sound to be louder (Stansfeld, 1992; Ellermeier, Eigenstetter, and Zimmer, 2001). Results indicate that about 25% of the individuals in a population are more sensitive to noise (and other environmental aspects) than others.

Attitudinal variables (e.g., beliefs about misfeasance on the side of those operating the noise source, fear of danger from the noise source; beliefs about the importance of the noise source, annoyance with non-noise impacts of the noise source) correlate strongly with noise annoyance (e.g., Guski, 1999; Fields, 1993; Staples, Cornelius and Gibbs, 1999; Taylor, 1984). It has been suggested that the relationship between some attitudinal variables and noise annoyance is, to some extent, causal (Job, 1988; Schomer, 2005). In most studies, attitudinal variables are regarded as individual difference variables: in isolation of the (social) context in which they are formed. A small number of field experiments have shown that the sound management (e.g., providing people with relevant information) can induce an attitudinal change. This may influence the evaluation of the sound, but the results are not conclusive (e.g., Jonsson and Sörensen, 1967; Cederlöf, Jonsson, and Sörenson, 1967; Sörenson, 1970; Maziul and Vogt, 2002; Haugg and Vogt, 2002). Attitudinal nonacoustical variables like 'trust' and 'perceived misfeasance' indicate that beliefs annoyed people have about the person(s) responsible for the sound influence their noise annoyance. Some of the laboratory experiments described by Glass and Singer (1972) suggest that social processes, like social comparison, modify sound effects (For a more detailed description of these experiments, see Chapter 3).

Generally, models of noise annoyance do not consider the social side of noise annoyance. The simplest models on which the dose-response curves are (implicitly) based, consider only a (curvi-) linear relationship between sound metrics and the annoyance response: the louder the sound, the more likely it is that the individual will be annoyed by it. Nonacoustic influences are denominated as error variance. In psychological models of noise annoyance, the nonacoustic variables influencing noise annoyance are represented as isolated variables, unrelated to external (that is: extra-personal, situational) variables. In such models, sound is considered as an external stimulus perceived by the individual. The model represents no other external stimuli beside the sound. The evaluation of the perceived sound is studied as if it were an individual process, taking place in a social vacuum. The relationship between the sound pressure level and annoyance is (curvi-) linear. The relationship between the sound and the annoyance response of the organism is moderated or mediated by personal difference variables. Sometimes, specifications to the relationship are made for specific sound types (e.g., Glass and Singer, 1972; Staats and De Jong, 1993; Taylor, 1984; Fidell, Schultz, and Green, 1988; Fields, 1990; Green and Fidell, 1991; Lercher, 1996; Guski, 1999; Job and Hatfield, 2001). A minority of scholars has taken a sociological (Fields, 1990, 2003; Bröer, 2006, 2007), historical (Bijsterveld, 2008), or linguistic (Dubois, 2000; Dubois, Guastavino and Raimbault, 2006) perspective on noise annoyance. Generally, the perspective generally taken in noise annoyance research is psychological rather than social.

FIGURE 1.2: Being exposed to a natural nuisance.

1.1.4. Problem definition

Studying noise annoyance from a psychological perspective is a problem if the annoying sound is man-made. Because being exposed to man-made sound is a social interaction: ‘You expose Me’ (Stallen, 1999; Van Gunsteren, 1999). Even though the nonacoustic variables in psychological models may represent attitudes about the social process (e.g., perceived misfeasance), the social process itself is not represented, and can therefore not be subject of study. In this way, possibly relevant information is easily overlooked. An investigation of the social side of noise annoyance, using a social psychological model, is important because it can further the theoretical understanding of exposure to man-made sound, and may inspire innovative ways of annoyance abatement or prevention. Supposedly, the idea that exposure to natural or man-made sound are two distinctly different experiences is not commonplace.

The crucial difference between annoyance with natural and man-made nuisances is illustrated in Figures 1.2 and 1.3. Both pictures show a lady in an unfortunate situation: her dress has been ruined by unexpected downpour. Likely, a lady will be more or less annoyed by this piece of bad luck. Figure 1.2 gives an example of exposure to a nuisance of natural cause: the nuisance (i.e., rain) does not result from a person’s action. Figure 1.3 gives an example of exposure to a man-made nuisance: the nuisance (i.e., spilled water) is caused by the (lack of) action of another person. In both situations, the extent of the lady’s annoyance will depend on qualities of the water (e.g., temperature, amount, cleanness, etc.), and on personal difference variables (e.g., perceived control, personality traits, attitudes). Unlike the situation in Figure 1.2, however, the situation in Figure 1.3 is a social interaction: the ladies thoughts, feelings, and behaviors are influenced by the presence of the man on the balcony. Not just his presence, but his behavior as well. When a nuisance is man-made, the social process between the exposer[5] and the exposee influences how the exposee evaluates the nuisance.

The quality of this social process depends, among other things, on the behavior of the exposer. If the lady in Figure 1.3 perceives that the water falling on her is coming from a garden hose, she will hold the man holding the hose responsible for her mishap. It will matter to her whether the man apologizes, or is clearly not paying attention, or laughs at her face. Her annoyance will be influenced by these perceptions. In a social situation or interaction, an outcome is evaluated by its value *and* by the social dimensions of the situation (e.g., Lind and Tyler, 1988). This implies that manageable social variables codetermine outcome evaluation.

Although nicely parsimonious, a psychological model of annoyance is too limited to explain annoyance with nuisances that are caused by other people. Interestingly, the sounds people complain about are mainly man-made (sounds from transportation, industry, construction and residential activities). Therefore, to study and explain noise annoyance, a *social* psychological model of annoyance is needed: a model that considers as stimuli both the sound and social dimensions of the exposure situation. Annoyance with man-made sound needs to be considered a *social* problem.

1.2 THE PRESENT RESEARCH

1.2.1 Theory

In the next section, the theoretical underpinning of the research described in this thesis is introduced. The presentation starts with the social psychological model of noise annoyance (Stallen, 1999). This model of noise annoyance applies a social perspective, and is the basis of the experimental design of the studies described in this thesis. Social psychology, in particular the social psychology of fairness (e.g., Tyler and Lind, 1992; Thibaut and Walker, 1975; Folger, 1977) is introduced. In the experiments, the fairness of the social process between exposer and exposee is systematically varied, and induces differences in annoyance.

Social psychological model of noise annoyance

The social psychological model of noise annoyance (Stallen, 1999; see Figure 1.4) considers as external stimuli both the sound ('sounds at source') and a social dimension of the exposure situation ('noise management by source'). The perception of these two stimuli influences an internal evaluation process that can result in noise annoyance. This internal evaluation process includes the appraisal of perceived disturbance and perceived control. Stallen presumes that the sound influences the perception of disturbance. The sound management by the source influences the perception of control over one's sound exposure. The model is rooted in the cognitive theory of stress and coping (Lazarus, 1966). The social psychological model of noise annoyance predicts that changing either the sound pressure level or the noise management can influence the level of noise annoyance.

The social psychologic\al model of annoyance (Stallen, 1999) has advantages over a psychological model. The social psychological model gives a more complete description of the noise exposure situation, as the exposee perceives it. It provides the opportunity to make use of existing social psychological knowledge on the influence of social processes. The 'sound management by the source' provides a manageable, nonacoustical codeterminant of noise annoyance that can be controlled separately from the sound. This allows for theory-based, experimental testing of the presumed relationship between social variables and noise annoyance. If the sound management is a codeterminant of noise annoyance, it may be a means of preventing or reducing elevated annoyance levels. This can have practical value if most people have largely the same wishes or norms with regard to the sound management.

Social psychology of fairness

The application of existing social psychological knowledge is an advantage. Social psychology is the scientific study of social behavior. It studies, amongst other topics, how people are affected by social situations. It aims, like general psychology, to understand and predict human behavior. It focuses on generalizations rather than idiosyncrasies, and formulates theoretical explanations for the phenomena it observes. It describes norms most people have with regard to social situations, and describes how specific characteristics of social situations affect most people. Applying social psychological theories in noise annoyance research can further the development of theoretical

[5] Exposer: the person who exposes others to sound, the operator of the sound source; Exposee: the person who is being exposed to sound by others.

knowledge of noise annoyance, in particular because it addresses manageable aspects of the social process between exposer and exposee. Social psychological knowledge may proof to be a source of helpful information for policy makers and airport officials dealing with the abatement of noise annoyance, as well as annoyed citizens, too.

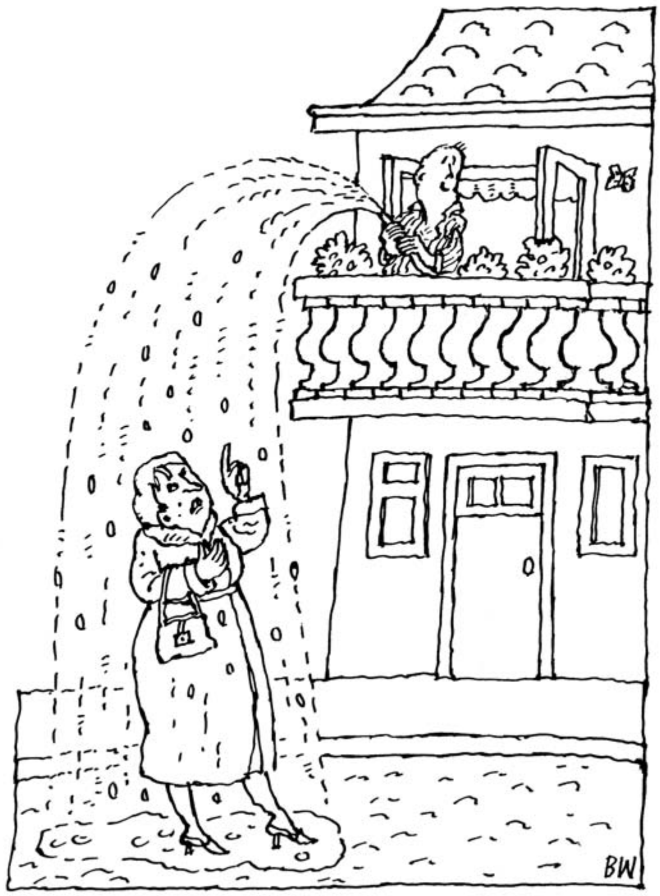

FIGURE 1.3: Being exposed to a man-made nuisance is a social experience.

Social psychological knowledge on fairness (or justice[6]) is of particular interest to noise annoyance research. It is very plausible that people have fairness considerations when judging the distribution of unwanted sound. Generally, people formulate norms in terms of fairness regarding the social dimension of an interaction in which goods are distributed (Adams, 1965, Thibaut & Walker, 1974). They use the fairness (or unfairness) of a distribution as an argument for (or against) that particular distribution. This wish to be treated fairly seems to be deeply rooted. It appears to be an anthropological universal (Montada, 2001), and fairness concerns may even transgress the borders of our species[7] (Brosnan, 2006; Van Wolkenten, Brosnan, De Waal, 2007).

Fairness norms can concern both the actual distribution of the goods (e.g., the fairness of the amount of noise received relative to some standard) (Adams, 1965; Deutsch, 1975; Leventhal, 1976) as well as procedural aspects of the distribution (e.g., the procedure used to decide about a certain distribution, or the behavior of the decision makers) (Thibaut and Walker, 1975; Folger, 1977; Bies and Moag, 1986; Tyler and Lind, 1992; Greenberg, 1993). A number of characteristics of procedures

6 In this field of theory, the words fair and just are used interchangeably.

7 Concerns for equity have been observed in nonhuman primates (i.e., chimpanzees and brown capuchin monkeys), ravens, and canids (the family of carnivorous mammals including dogs, wolves, foxes, coyotes and jackals) (Brosnan, 2006; Van Wolkenten, Brosnan, De Waal, 2007)

have repeatedly been found to correlate with evaluations of procedural fairness. Examples of such characteristics are, e.g., opportunities for participation in decision making ('voice'), transparency, consistent application over people and over time, and respectful treatment (e.g., Lind and Tyler, 1988; Mikula, 2001; Greenberg, 1993).

One of the most frequent findings in social psychological justice research is that people, who receive certain goods or outcomes in a social interaction, evaluate these outcomes more positively (or less negatively) when the procedures used to decide about the outcomes are fair. This so-called *fair process effect* has been demonstrated in a wide variety of contexts: e.g., organizations, court trials, police-citizen encounters, and political situations (Folger, 1977; Lind and Tyler, 1988). Fair procedures have been shown to enhance feelings of trust in authorities, and increase people's support for policies (e.g., Mikula, 2001). Unfair treatment has been shown to result in negative affect, protest, contra productive behavior, and illegal actions (Lind and Tyler, 1988). The fair process effect is stronger when the outcomes are negative, or when physical stress is experienced (Tepper, 2001; Vermunt and Steensma, 2001). The effect of procedural fairness on evaluations of man-made sound has, to the knowledge of the author, not been investigated.

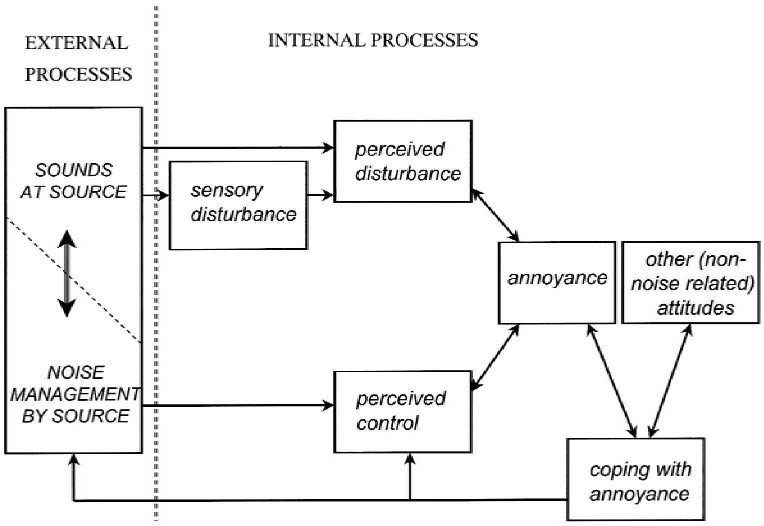

FIGURE 1.4: Social psychological model of noise annoyance. Noise annoyance is a stress response to two external stimuli: 'sound' and 'sound management by the source' (source: Stallen, 1999).

1.2.2 Central hypothesis

This chapter began with the statement that being exposed to man-made sound is a social experience. It follows that noise annoyance is the response to a social experience. The central hypothesis in this thesis is that the procedural fairness of the social process between the person(s) operating the sound source and the person(s) being exposed to the sound influences the latter's evaluation of the sound. It has been derived from the theory described in the previous section. A confirmation of this central hypothesis corroborates the statements made in the beginning.

1.2.3. Method

The central hypothesis is tested in a series of laboratory experiments. Causal relationships are best studied in a theory-based laboratory experiment, in which pre-defined hypotheses can be tested in an environment where random factors influencing the dependent variable (i.e., noise annoyance) can be controlled to an important extent. By analyzing the data with, for instance, Analysis of Variance (ANOVA) conclusions regarding causality can be drawn.

In the experimental design, participants are exposed to a 15-minute sample of aircraft sound while working at a linguistic task. The sound pressure level (SPL) is either low (50 dB A) or high (70 dB A). The procedural fairness of the social process between the 'exposer' (the person operating the sound source, i.e., the experimenter) and the 'exposee' (the sound-exposed participant) is systematically varied. The experimenter manages their exposure to the sound. A neutral, a fair, and an unfair sound management procedure have been designed. Self-reported noise annoyance is assessed with a questionnaire after 15 minutes of sound exposure. In the pilot study, annoyance is assessed also after one minute of exposure. For the design of the experiments, I have used the social psychological model of noise annoyance (Stallen, 1999), in combination with social psychological theories on procedural justice (e.g., Lind and Tyler, 1988; Greenberg, 1993; Thibaut and Walker, 1975) (For theoretical details, see the theory section in this chapter).

1.3 OUTLINE OF THIS THESIS

Chapter 1, this introduction, describes the central hypothesis and aim of this thesis. For the purpose of illustration, it begins with a bit of history on annoyance with environmental sounds. Next, arguments are presented why, for the study of annoyance with man-made (as opposed to natural) sounds, a social perspective is better suited than a psychological perspective. The general scientific background of the studies is outlined.

Chapter 2 is a report on the pilot of the experimental design. The pilot indicates that the design is promising, and provides suggestions for its improvement. The chapter is written in the style of a journal article, to facilitate comparison of its contents with the contents of Chapters 3 and 4.

The ‘Fair experiment’ is a refined replication of the pilot study. It investigates the effect of a fair relative to a neutral sound management procedure on noise annoyance. In this experiment, the fair procedure reduces noise annoyance relative to a neutral procedure when the sound pressure level (SPL) is high (70 dB), but not when SPL is low (50 dB). Chapter 3 presents the integral text of the article describing the Fair experiment, as it has been published in Journal of the Acoustical Society of America. It begins with a lengthy introduction, in which preceding studies addressing the social side of sound, be it mostly inexplicitly, are described in some detail. The paper has been written from the perspective of exploring the potential of social nonacoustical variables as instruments for annoyance reduction.

The effect of unfair sound management on noise annoyance, relative to a neutral procedure, is investigated in the ‘Unfair experiment’. In this experiment, the unfair procedure increases noise annoyance relative to a neutral procedure for both sound pressure levels (70 dB, as well as 50 dB). Chapter 4 presents the integral text of the article describing the Unfair experiment, as it has been published in Journal of the Acoustical Society of America. The paper has been written from the perspective on finding an explanation for systematic (group-level) deflections from dosage-response curves of noise annoyance. In its introduction, some background information on the dosage-response curve is presented.

The findings of these two experiments, and to a lesser extent the pilot study, are considered in combination in Chapter 5. Conclusions with regard to the central hypothesis and aim of this thesis are drawn. Additional results are described and discussed. Consequences of the findings for a model of noise annoyance, for theory and practice are discussed.

This thesis can be of interest to scientists, policy makers in urban planning, officials from airports and other noise-producing enterprises, and possibly citizens, with an interest in the abatement or prevention of annoyance with man-made noise. The research presented in this thesis shows that taking a *social* perspective on annoyance with a man-made sound makes it possible to profit from existing social psychological knowledge, in particular knowledge about procedural fairness. The findings are likely applicable to annoyance with other types of man-made environmental nuisances.

CHAPTER 2 **A Pilot Study**

The influence of procedural fairness on evaluations of noise[8]

2.1 INTRODUCTION

Traditionally, noise annoyance is studied from either a physical or a psychological approach. The physical approach considers mainly attributes of the sound itself (decibel level, noise source type, timing, and the like) as determinants of noise annoyance. The psychological approach considers, besides acoustical variables, a range of individual difference variables (e.g., sensitivity, daily hassles, perceived control, and attitudes) and situational variables (e.g. non-steady state conditions) that correlate with noise annoyance (e.g., Job, 1988; Fields, 1993). Both approaches consider the influence of individual difference variables, but underestimate the influence of the social context of exposure to man-made sound on noise annoyance. In this chapter, the pilot study of an experimental design to study the social side of noise annoyance is described.

2.1.1 The social context of exposure to man-made sound

Exposure to man-made sound has a social context. When the operator of a sound source (e.g., a radio) manages its sound, he or she exposes others to sound that they may, or may not, want to hear. The operator distributes a resource (the sound) for particular reasons in a particular way over time, people, and places. This resource can be negative, in the case of unwanted sound or noise, or positive, for instance in the case of appreciated music. If people are confronted with sound and recognize that it is man-made, the sound distribution process can be felt as a social experience or interaction. The distribution process becomes part of the exposure situation. This social side of sound exposure has been captured with the phrase 'You expose Me' (Stallen, 1999; Van Gunsteren, 1999). In the case of man-made sound there is always a social interaction: You (the operator of the sound source) expose Me (the exposee) to sound.

2.1.2 A social psychological model of noise annoyance

The social psychological model of noise annoyance (Stallen, 1999) considers besides the 'sounds at source' also the 'sound management by the source' as determinants of noise annoyance. Both determinants are evaluated in a process of cognitive appraisals (named 'perceived disturbance' and 'perceived control'). Noise annoyance arises when a sound-exposed person evaluates their sound exposure situation as threatening because their perceived disturbance in the situation exceeds their control over it, given the coping resources available to them. Stallen reasons that, partly depending on the way the operator of the source manages the sound, the exposed person will have more, or less, control options, or coping resources. Thereby, the sound management by the operator of the sound source influences the level of noise annoyance experienced by the exposee.

The social psychological model of noise annoyance regards noise annoyance as psychological stress. It has been shown that noise can be regarded a negative stimulus or potential psychological stressor (Glass and Singer, 1972). The social psychological model has been derived from the well-known cognitive theory of stress and coping (e.g., Lazarus & Folkman, 1984; Folkman, 1984). According to the cognitive theory of stress and coping, a potential stressor (e.g., unwanted sound) does not necessarily result in psychological stress. When during the *primary appraisal* of a situation a potentially harmful situation is perceived, this triggers the perceiver to assess their coping resources (this process is called *secondary appraisal* of the situation). If the available coping resources appear to fall short, psychological stress arises. If coping resources appear to be sufficient, no psychological stress arises. The process of appraising potential threat and available coping resources is supposed to be ongoing. Several categories of coping resources have been distinguished: physical, material, psychological and social coping resources (Folkman, 1984).

2.1.3 Fair management procedures

When a person receives a resource in a social interaction, not only its value, but also the fairness of the distribution will be evaluated (e.g., How much do I receive compared to others?). Even,

[8]Earlier versions of this chapter have been presented as conference papers at the 18th IAPS conference "Evaluation in Progress", 7 – 10 July 2004, Vienna, Austria, and at the InterNoise 2004 conference, 21 – 25 August 2004, Prague, Czech Republic.

the fairness of the distribution *procedure* is evaluated. Social psychological literature on justice (or fairness) shows abundantly that the fairness of the procedure affects the evaluation of the outcome of the procedure (e.g., Folger, 1977; Tyler and Lind, 1992). The perceived value of the outcome will be higher when the procedure is evaluated as fair and lower when the procedure is evaluated as unfair.

Many studies on procedural justice have demonstrated this so-called *fair process effect*: when people receive an outcome as a result of a fair distribution procedure, they tend to be more willing to accept the outcome they get and feel more satisfied with it, compared to people who receive the same outcome as a result of an unfair procedure (Folger, 1977; Van den Bos, Wilke, Lind, & Vermunt, 1998, Lind & Tyler, 1988; Tyler, 2000)). The fair process effect has been found with positive as well as with negative outcomes. When exposure to unwanted sound is a social interaction, for instance when 'You expose Me', then the fairness of the sound management procedure will likely influence the arising level of noise annoyance.

From an ethical or philosophical point of view, it is difficult to define when a procedure is fair. From a social psychological viewpoint, however, the answer to the question of what is fair is descriptive rather than normative (i.e., based on empirical data instead of normative considerations). Basically, in social psychology fairness is defined as "that what people perceive as fair".

Studies in the field of the social psychology of procedural fairness have identified several characteristics that generally increase the perceived fairness of procedures. For example, when a procedure gives the opportunity to give one's opinion in the decision making process (even when this moment of 'voice' happens after the allocation decision has been made), this characteristic generally enhances the perceived fairness of the procedure (Leventhal, 1980; Bies & Moag, 1986). In addition to the voice characteristic, procedures are judged to be fairer when they, for instance, 1) are transparent; 2) are applied consistently across time and across persons; and 3) are applied in a respectful manner (e.g., Lind and Tyler, 1988; Leventhal, 1980).

To summarize, the social psychological model of noise annoyance predicts that sound management procedures used by the operators of a sound source codetermine people's annoyance with the resulting sound. This prediction is in line with the frequent finding in field studies that, for instance, perceived misfeasance by airport officials correlates with noise annoyance (Tracor Inc., 1971; Fields, 1993; Schomer, 2005). An investigation of the proposed causal link between sound management procedure characteristics and noise annoyance has theoretical and practical value. Theoretically, the existence of this causal link will imply that a model of noise annoyance is incomplete when it does not address social aspects of the exposure situation. Practically, this causal link will be an indication that there may be alternative strategies for dealing with noise annoyance problems. Based on the *fair process effect*, it is predicted that unwanted sound is more acceptable, and hence evaluated as less annoying, to people when they consider it the outcome of a fair rather than a neutral or unfair sound management procedure.

2.1.4 Pilot study

An experimental design has been developed to study the presumed causal relationship between the fairness of sound management procedure and the noise annoyance experienced by a person exposed to man-made sound. In the experiment, participants are asked to perform on a certain task while they are exposed to disturbing sound (of a certain sound pressure level). The experimenter manages the sound exposure of the participants in a fair, or a less fair, manner: in the fair procedure conditions, participants are asked to 'voice' their preference for a certain sound type, in the neutral procedure conditions they are not. Noise annoyance with this sound is assessed during and after the sound exposure. The present chapter describes the pilot study that has been carried out to test and eventually refine the experimental design.

The pilot study needs to answer a variety of questions. A first group of important questions is related to the effectiveness of the manipulations. Do the manipulations of the independent variables (sound management procedure and sound pressure level) induce the required effects? Do the manipulated sound pressure levels, in combination with the task, induce annoyance? Do participants evaluate the fairness of the procedure manipulations as intended? Does the procedural fairness induce differences in noise annoyance? And: are the measures used to assess the main variables suited?

A second group of questions concerns issues that are not, or only vaguely, predicted by the social psychological model of noise annoyance (Stallen, 1999). Answers to these questions are important, however, to increase the validity of the research design. For instance, based on the social psychological model of noise annoyance it is difficult to predict the best time for measuring effects of procedure. Do procedural effects appear immediately or only after continued exposure? Other models of environmental evaluation suggest that the appraisal of a situation has conceptually different psychological stages (e.g., Folkman, 1984; and in particular, Ulrich, 1983). Hence, timing can be delicate. The pilot is needed to find out what is the best moment to assess effects from SPL and procedure on noise annoyance.

In addition, the social psychological model of noise annoyance does not explicitly address potential interaction effects between the two independent variables. Do procedure effects appear with all sound pressure levels, or only with certain sound levels? This pilot study is needed to find out which sound pressure levels are best used for the study of procedural fairness effects on noise annoyance.

Lastly, it is important to check whether the strength of the induced effects of SPL and procedure are balanced (because in statistical analyses, a strong effect can dominate a weaker effect), and how many participants are needed to create enough statistical power.

For this pilot study, it is predicted, firstly, that higher sound pressure levels result in higher annoyance levels. Secondly, it is predicted that a fairer procedure results in lower annoyance compared to a less fair procedure. No explicit ideas regarding interaction effects of sound pressure level and procedural fairness are formulated, but it is anticipated that the effect of procedure can depend on sound pressure level. It is expected that the strength effect of procedural fairness will depend on the timing of the assessment of noise annoyance. Therefore, noise annoyance is assessed at two moments during the experiment.

2.2 METHOD

2.2.1 Participants

Seventy-six students have been paid 4 Euro each to participate in the experiment. Nineteen participants have been randomly assigned to each cell of the experimental design.

2.2.2 Experimental design.

The experimental design is a 2 (Procedure: Fair versus Neutral procedure) × 2 (Sound Pressure Level (SPL): Low (50 dB) versus High (70 dB)) complete factorial design.

2.2.3 Laboratory layout and stimulus material.

The laboratory consists of four separate cubicles, each equipped with a desk and chair, and a complete PC-set with two loudspeakers plus one subwoofer.

The sound sample is composed of self-recorded audio material of aircraft passages. It lasts fifteen minutes during which, at random intervals, eleven aircraft passages of differing length and loudness are audible. The sound sample is played at either 50 dB A (15 min Leq) (low SPL conditions) or 70 dB A (15 min Leq) (high SPL conditions), which implies a sound level of quiet background noise in the low SPL conditions, or of speech interfering loudness in the high SPL conditions. The indicated sound pressure levels (15 min Leq) are average sound pressure levels over the course of 15 minutes. The maximal sound pressure level (due to incidental peaks) is 68 and 88 dB A Lmax, respectively. All sound pressure levels have been measured in the cubicle at the position of the listener.

The reading task (an English text with multiple choice questions, taken from a Dutch exam from pre-university education) is selected to match the cover story, to assure participants' motivation to perform well, and to closely match their capacities.

2.2.4 Experimental procedure and manipulations.

The experimenter welcomes the participants, and guides them to their cubicle where they take their seat behind the computer. All further interaction is with the computer. Participants are informed that they are participating in a study on the effects of sound on task performance. They will work on a reading task for 15 minutes during which they will be exposed to possibly interfering sound. Further, they are led to believe that three different sound samples are being compared, and they are to hear only one of those three samples. It is explained that they may prefer one sound sample to another. A vague description of the three concocted samples is given. Participants in the Fair procedure conditions are given the opportunity to express their personal preference for one or another sample, and are informed that the experimenter will take their preference into account as much as possible. Participants in the Neutral condition conditions are not given this opportunity. They are simply informed that they will be assigned to one of the three (unspecified) sound samples. Then all participants start working on the reading task and questions while being exposed to the aircraft sound sample. After one minute of exposure, their level of noise annoyance is assessed for the first time. After 15 minutes of exposure, the reading task and sound exposure are automatically terminated, and participants are presented the main questionnaire, which includes the second assessment of noise annoyance.

2.2.5 Measures

The first noise annoyance assessment ($Annoyance^{Early}$) is taken with a visual scale representing a thermometer with verbal labels at the low end ("not annoying at all") and the high end ("highly annoying"). The distance between the low end and the high end of the thermometer is ten centimetres. Participants indicate their current level of noise annoyance by marking a line on the thermometer. The marked distance is transformed into a number ranging from 1 to 7 using a transformation formula: $Annoyance^{Early}$ = (((marked distance in cm/10) *6) +1). In this way, the $Annoyance^{Early}$ variable with scores ranging from 1 'not at all annoyed' to 7 'highly annoyed' is created (*M*(SD)= 3.69 (1.82)).

The second assessment of noise annoyance ($Annoyance^{Late}$) is directly after the 15-minutes of sound exposure. The measure used is different from the $Annoyance^{Early}$ measure, to prevent participants from copying their score from the first assessment to the second, willing to be consistent (social desirability bias). The $Annoyance^{Late}$ measure consists of 3 items: (i) "How did you experience the aircraft sound while answering the exam questions?" (ii) "To what extent did the sound annoy you while you were working at the task?" (iii) "How pleasant did you feel the aircraft sound was while working on the exam?". Answers are given on a 7-point numerical rating scale with verbal markers at the end points: (i) 1="very positive," 7="very negative," (ii) 1="not at all annoying," 7="highly annoying," (iii) 1="very pleasant," 7="very unpleasant." The $Annoyance^{Late}$ scale, ranging from 1 'not at all annoyed' to 7 'highly annoyed', is constructed by averaging the scores on the three items (Cronbach's α= 0.90, *M*(SD)= 5.07(1.22)).

The perceived loudness of the presented aircraft sound is assessed with a single question: "If you are to give a grade for the average loudness of the aircraft sound, what grade do you give?". In the instruction, verbal labels are given to the end points of a 10-point numerical rating scale: 1= "very soft," 10= "very loud." Participants respond by clicking on one out of the ten numbered virtual buttons (*M*(SD) = 5.76(1.87)). A 10-point scale is used, contrary to the 7-point $Annoyance^{Late}$ scale, to prevent participants from ticking the exact same number on both scales, aiming to give a consistent rather than accurate answer. The Pearson's correlation between Perceived Loudness and $Annoyance^{Early}$ is $r = 0.63$ ($p < 0.001$, $N = 76$), and between Perceived Loudness and $Annoyance^{Late}$ is $r = 0.57$ ($p < 0.001$, $N = 76$). This indicates that the measure for loudness and the measures for annoyance tap related but distinct concepts.

The check for the effectiveness of the procedure manipulation consists of two statements. Answers are given on 7-point numerical rating scales with verbal markers at the end points: 1="completely disagree" to 7="completely agree". The first statement ('consideration') checks whether the voice manipulation has induced differences in the perception of the experimenter's willingness to consider the participant's preference: "The experimenter sought to take my preference for a certain combination of sound characteristics into account," (*M*(SD)=3.97(1.77)). The second statement ('respect') checks whether the voice manipulation has induced differences in perceived respectfulness of the experimenter: "The experimenter made an effort to treat me with respect," (*M*(SD)=4.97(1.39)). Even though the items 'consideration' and 'respect' measure two aspects of procedural fairness, they have not been combined into a scale because they share little variance (Pearson's correlation $r = 0.31$, $p < 0.01$, $N = 76$).

Three measures for (unintended) performance effects on the reading task are automatically registered by the computer ("time:" time taken to read the first text and answer question one, *M*(SD) = 89.79(38.75); "correct:" total number of correct answers, *M*(SD) = 11.24(4.14); "false:" total number of false answers, *M*(SD) = 4.18(3.03)).

Finally, some individual difference questions (e.g., age, gender) are included.

2.3 RESULTS

2.3.1 Manipulation checks

Sound pressure level manipulation

An Analysis of Variance (ANOVA) with Perceived Loudness as the dependent variable and SPL and Procedure as the independent variables is performed to check the effectiveness of the sound pressure level manipulation. A significant main effect of SPL on perceived loudness ($F(1,72)= 34.16$, $p < 0.001$, $\eta^2 = 0.32$) indicates that the SPL manipulation is highly effective: in the high SPL conditions the sound is perceived to be much louder than in the low SPL conditions (M_{Low}(SD) = 4.71 (1.59) vs. M_{High}(SD)= 6.82 (1.50)). No main effect of Procedure on perceived loudness ($F(1,72)= 0.02$, $p = 0.88$, n.s), nor an interaction effect of SPL by Procedure on perceived loudness ($F(1,72)= 0.00$, $p = 1.00$, n.s.) are found, indicating that the perceived loudness is not influenced by the procedure manipulations.

Procedure manipulation

An MANOVA with ‘consideration’ and ‘respect’ as the dependent variables and SPL and Procedure as the independent variables shows that the fair procedure is perceived to be fairer with regard to these two fairness characteristics than the neutral procedure. The experimenter is perceived to be more willing to take the participant’s preference into account and moderately more respectful in the fair procedure conditions than in the neutral procedure conditions (multivariate test: $F(2,71)=13.51$, $p < 0.001$, $\eta^2=0.28$, univariate test for ‘consideration’: $F(1,72)=27.13$, $p < 0.001$, $\eta^2=0.27$; univariate test for ‘respect’: $F(1,72)=2.98$, $p = 0.09$, n.s.; for marginal means, see Table 2.1).

The SPL manipulation has an effect on the perceived fairness characteristics, too. In the low SPL conditions the experimenter is perceived to be more respectful and moderately more willing to consider the participants ‘preference than in the high SPL conditions (multivariate test: $F(2,71)=3.54$, $p < 0.05$, $\eta^2=0.09$; univariate test for ‘respect’: $F(1,72)=5.85$, $p < 0.02$, $\eta^2=0.08$; univariate test for ‘consideration’: $F(1,72)=2.84$, $p = 0.10$, n.s.; for marginal means, see Table 2.1). The interaction effect of SPL by procedure on the procedural fairness items is not significant (multivariate test: $F(2,72)=1.94$, $p = 0.15$, n.s.).

To conclude, the ‘voice’ manipulation in the fair procedure has not gone unnoticed. The procedure has induced differences in the scores on ‘consideration’ and ‘respect’, which are in the expected direction. They show that the fair procedure scores stronger on those two fairness characteristics than the neutral procedure. However, the fairness of the procedure has not been addressed explicitly. Nothing is known about possible other fairness characteristics that may have influenced the fairness of the procedure. In future studies, it is therefore advisable to include an item that assesses the fairness of the procedure explicitly.

Table 2.1: Cell means and marginal means (*M*), standard deviations (SD), and number of cases per cell (*N*) on the two items checking the effectiveness of the procedure manipulation: ‘consideration’ and ‘respect’ (1= low consideration, or respect, 7= high consideration, or respect).

		consideration		*respect*		
SPL	Procedure	*M*	SD	*M*	SD	*N*
Low	Neutral	3.11	1.37	5.21	1.13	19
50 dB	Fair	5.42	1.26	5.47	1.47	19
	Tot. Low	4.26	1.75	5.34	1.30	38
High	Neutral	3.05	1.65	4.21	1.18	19
70 dB	Fair	4.32	1.67	5.00	1.49	19
	Tot. High	3.68	1.76	4.61	1.39	38
Total	Neutral	3.08	1.50	4.71	1.25	38
Total	Fair	4.87	1.56	5.24	1.48	38
	Total	3.97	1.77	4.97	1.39	76

Performance effects

An ANOVA with 'time' as the dependent variable and SPL and Procedure as the independent variables indicates no unintended performance effects (SPL: $F(1,72)=0.32$, $p=0.57$, n.s.; Procedure: $F(1,72)=0.38$, $p=0.54$, n.s.; SPL * Procedure: $F(1,72)=0.28$, $p=0.60$, *n.s.*).

An ANOVA with 'correct' as the dependent variable and SPL and Procedure as the independent variables indicates no unintended performance effects (SPL: $F(1,72)=0.05$, $p=0.83$, n.s.; Procedure: $F(1,72)=0.09$, $p=0.66$, n.s.; SPL * Procedure: $F(1,72)=1.33$, $p=0.25$, n.s.).

An ANOVA with 'false' as the dependent variable and SPL and Procedure as the independent variables indicates a trend of an unintended performance effect of SPL on 'false', such that slightly more false answers are given in the high SPL conditions (M(SD) = 4.84(3.21)) than in the low SPL conditions (M(SD) = 3.53(2.72); $F(1,72)=3.69$, $p < 0.10$). A post-hoc analysis shows that the Pearson's correlation between 'false' and noise annoyance is insignificant ($r=0.07$, $p=0.53$, n.s.). No other unintended effects on 'false' are found (Procedure: $F(1,72)=0.71$, $p=0.40$, n.s.; SPL by Procedure: $F(1,72)=0.71$, $p=0.40$, n.s.). It is concluded that the performance effect of SPL is not related to differences in noise annoyance and therefore not relevant to the current study. It is advisable to check for performance effects in future studies.

2.3.2 Dependent variables

An Analysis of Variance (ANOVA) with $\text{Annoyance}^{\text{Early}}$ as the dependent variable and SPL and Procedure as the independent variables, shows a strong main effect of SPL on noise annoyance ($F(1,72) = 28.78$, $p < 0.001$, $\eta^2 = 0.29$, for cell means see Table 2.2). This indicates that, in line with expectations, noise annoyance is higher in the high SPL conditions than in the low SPL conditions. No main effect of Procedure on $\text{Annoyance}^{\text{Early}}$ is found ($F(1,72) = 0.42$, $p = 0.52$, n.s.), nor an interaction effect of SPL by Procedure on noise annoyance ($F(1,72) = 0.01$, $p = 0.92$, n.s.).

The ANOVA with $\text{Annoyance}^{\text{Late}}$ as the dependent variable and SPL and Procedure as the independent variables shows a significant main effect of SPL on noise annoyance ($F(1,72) = 9.43$, $p < .005$, $\eta^2 = 0.12$, for cell means see Table 2.2). No main effect of Procedure on $\text{Annoyance}^{\text{Late}}$ is found ($F(1,72) = 0.80$, $p = 0.38$, n.s.). Inspection of the cell means suggest that within the high sound pressure level conditions, noise annoyance is slightly lower in the fair procedure condition than in the neutral procedure condition. However, this interaction effect of SPL by Procedure on noise annoyance is not significant ($F(1,72) = 1.05$, $p = 0.31$, n.s.). The statistical power for detecting this effect is low (observed power = 0.17). (See Figure 2.1 for a graphical representation of the change in the pattern of results between $\text{Annoyance}^{\text{Early}}$ and $\text{Annoyance}^{\text{Late}}$).

Table 2.2: Noise annoyance scores for two measures of noise annoyance ($\text{Annoyance}^{\text{Early}}$ and $\text{Annoyance}^{\text{Late}}$; 1="not at all annoyed," 7="highly annoyed"; note that the scores for $\text{Annoyance}^{\text{Early}}$ have been transformed) arranged by conditions of sound pressure level (SPL: low or high) and procedure (neutral or fair). Cell means and marginal means (M), standard deviations (SD), and number of cases per cell (N).

		Early Annoyance		*Late Annoyance*		
SPL	Procedure	*M*	SD	*M*	SD	*N*
Low	Neutral	2.86	1.57	4.65	1.34	19
50 dB	Fair	2.59	1.29	4.68	0.94	19
	Total Low	2.72	1.42	4.67	1.14	38
High	Neutral	4.75	1.55	5.74	0.75	19
70 dB	Fair	4.56	1.83	5.23	1.46	19
	Total High	4.66	1.67	5.48	1.17	38
Total	Neutral	3.81	1.81	5.19	1.20	38
Total	Fair	3.57	1.85	4.96	1.24	38
	Total	3.69	1.82	5.07	1.22	76

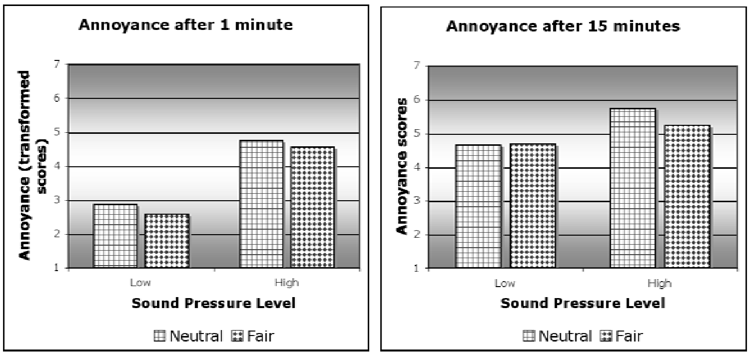

FIGURE. 2.1. A graphical representation of the change in the pattern of Noise Annoyance scores after one minute (left hand figure) and after 15 minutes (right hand figure) of exposure (Annoyance^{Early} vs. Annoyance^{Late}). Scores range from 1 (not at all annoyed) to 7 (highly annoyed).

Note 1: After one minute of exposure (left hand figure) there is no significant main effect of procedural fairness ($F(1,72) = 0.42$, $p = 0.52$, n.s.).

Note 2: After 15 minutes of exposure (right hand figure) there is no significant main effect of procedural fairness ($F(1,72) = 0.80$, $p = 0.38$, n.s.). The cell means suggest an interaction effect, however this effect is only significant in the post-hoc analysis of covariance including Annoyance^{Early} as the covariate.

Note 3: The absolute scores on the two annoyance measures cannot be compared because of the transformation of the Annoyance^{Early} scores. The seeming rise in the average noise annoyance level between 1 and 15 minutes may be an artifact due to this transformation.

The power of a statistical test is related to the alpha level of testing (α), the effect size (*d*), and the sample size (*N*) (De Heus, Van der Leeden, and Gazendam, 1995). When a difference in means does not yield a significant effect in, for instance, an ANOVA, this implies that either 1) there is no true effect, 2) the effect size of the true effect is too small to be detected (among the error variance and/or variance caused by stronger effects on the dependent variable), 3) the sample size is not large enough to create enough statistical power to detect the effect, or 4) a combination of 2 and 3. Given the explorative nature of this pilot study, and the low statistical power for detecting an interaction effect, it is justified to explore the data with a post hoc analysis before rejecting the experimental design.

Post hoc analyses. The SPL effect on noise annoyance is relatively strong and induces relatively large individual differences. This lowers the statistical power to detect a more subtle effect of procedural fairness during the secondary appraisal. The statistical power to detect the procedure effect on noise annoyance can be increased with a covariate that corrects for the individual differences in noise annoyance induced by the SPL. Unfortunately, the need for a covariate has not been anticipated.

The Annoyance^{Early} measure may serve as a post-hoc covariate that can control for the strong effect of SPL to the benefit of the subtle (if any) effect of procedure. It may be that Annoyance^{Early} has tapped the primary appraisal of the sound exposure situation, and Annoyance^{Late} the secondary appraisal. The Annoyance^{Early} measure shows a strong effect of SPL. Fifteen minutes later, the SPL effect on Annoyance^{Late} is significantly less strong[9]. At the same time, the Annoyance^{Late} measure shows a slight difference in means between the fair and the neutral procedure condition, within the high SPL conditions only. This seeming change in the result pattern may indicate that the Annoyance^{Early} measure has assessed the effect of the evaluation of the potential harmfulness of the sound on noise annoyance, whereas the Annoyance^{Late} measure has assessed the effect of the evaluation of available coping resources, including the fairness of the procedure. Assuming that the effect of procedural fairness depends on secondary appraisal, using Annoyance^{Early} as a covariate may bring out the procedure effect by controlling for variance due to the SPL.

An ANCOVA (Analysis of Covariance) with Annoyance^{Late} as the dependent variable, SPL and Procedure as the independent variables, and Annoyance^{Early} as the 'covariate' may solve the

[9]The effect of Sound Pressure Level on Annoyance^{Early} was significantly stronger than the same effect on Annoyance^{Late}. This was tested with the *t*-test for differences in dependent correlations (Cohen & Cohen, 1983, pp. 56-57), comparing the correlation of Sound Pressure Level and Annoyance^{Early} with the correlation of Sound Pressure Level and Annoyance^{Late} ($t(73) = -2.71$, $p < 0.01$).

presumed statistical power problem[10]. Conventionally, a covariate is a variable that is measured before the treatment begins. Annoyance^{Early} is a post-treatment variable. “If a covariate is used that is measured after treatments and that variable was affected by treatments, then a change on the covariate may be correlated with change on the dependent variable. Thus, when the covariate adjustment is made, you will remove part of the treatment effects” (Stevens, 2002, pp. 347). In the present case, this is exactly what we want to achieve: remove the effect of SPL on Annoyance^{Late}. Because Annoyance^{Early} is a post-treatment variable, a statistical model that includes, besides the main effect of Annoyance^{Early} on the dependent variable, all possible interaction effects of the independent variables and the covariate is used.

The results of this ANCOVA show a significant main effect of the covariate on Annoyance^{Late} ($F(1,68)= 58.56$, $p< 0.001$, $\eta^2=0.46$), indicating that the two variables are strongly correlated. As expected, the main effects of SPL on Annoyance^{Late} has been removed ($F(1,68)= 0.04$, $p= 0.83$, n.s.). The main effect of Procedure on Annoyance^{Late} is not significant ($F(1,68)= 0.84$, $p= 0.36$, n.s.). However, the interaction effect of SPL by Procedure on Annoyance^{Late} is significant ($F(1,68) = 5.56$, $p < 0.05$, $\eta^2 = 0.08$) and the observed statistical power has substantially increased (observed power = 0.64). Estimated cell means (corrected for the covariate) indicate that within the high SPL conditions, noise annoyance is lower in the fair procedure condition than in the neutral procedure condition.

A post hoc pairwise comparison (with covariate) with Fisher’s protected LSD procedure (Huitema, 1980, pp. 82-86) confirms that this difference in estimated cell means is significant ($M_{High-Fair}$ (s.e.)= 4.71 (0.21) vs. $M_{High-Neutral}$ (s.e.) = 5.39 (0.24); $t(73) = -2.5$, $p < 0.05$.)

In the low SPL conditions, no effect of procedure on annoyance late is found ($M_{low-Fair}$ (s.e.)= 5.15 (0.26) vs, $M_{low-Neutral}$ (s.e.) = 5.17 (0.22)). The two-way interaction effect of SPL by the covariate on Annoyance^{Late} ($F(1,68)=0.21$, $p=0.65$, n.s.), and the two-way interaction effect of Procedure by the covariate on Annoyance^{Late} ($F(1,68)=0.06$, $p=0.81$, n.s.) are not significant. A trend of a three-way interaction effect of SPL by Procedure by the covariate on Annoyance^{Late} is found ($F(1,68)=3.36$, $p< 0.10$) indicating that the relationship between Annoyance^{Early} and Annoyance^{Late} is not identical in all cells of the experimental design.

The post hoc analysis lends credence to the assumption that the effect of procedural fairness on Annoyance^{Late} did not reach significance in the ANOVA (without a covariate) due to low statistical power.

2.4 CONCLUSIONS

The social psychological model of noise annoyance predicts that the sound management procedure used by the operators of a sound source codetermines people’s annoyance with the sound. Based on *the fair process effect*, it has been predicted that unwanted sound is less annoying when it is the outcome of a fair rather than an unfair or neutral sound management procedure. The fairness of the sound management procedure is then a codeterminant of the level of annoyance with noise.

This chapter described the pilot study that tests an experimental design developed to study whether the fairness of the sound management procedure has an influence on noise annoyance. The results of the pilot study are used to explore the predicted procedure effect on noise annoyance, and ultimately to refine the experimental design.

The experimental design generally has proven to work well. The sound pressure manipulations induced differential levels of perceived loudness, yet the sound was experienced to be neither extremely loud nor very soft. The aircraft sound induced noise annoyance during the performance on the task. The scales used to assess noise annoyance appear to be suited for use in this type of experiment, as in all conditions noise annoyance levels are within the range of the measurement scales. The results show a strong effect of SPL on noise annoyance, which is stronger after one minute than after 15 minutes.

The effectiveness of the procedural fairness manipulation was less clear. In the fair procedure conditions, participants perceive the experimenter to be far more willing to consider their preference than in the neutral procedure conditions. Also, the experimenter is perceived to be slightly more respectful in the fair relative to the neutral procedure conditions. However, the two manipulation

[10] A Repeated Measures technique is less suitable here since the two annoyance measures are 1) not identical measures and 2) measuring tow potentially different psychological concepts (the primary and the secondary appraisal of the sound exposure situation).

check items do not correlate well and they do not explicitly address the perceived fairness of the procedure; they appear to assess more than one psychological concept, and it is unclear whether procedural fairness is assessed. Besides, the SPL manipulation influences the scores on the two items, too. Future experiments should explicitly assess procedural fairness.

On neither of the Annoyance measures, a procedure effect has been found. When the effect of the primary appraisal of the exposure situation on noise annoyance is removed by using $\text{Annoyance}^{\text{Early}}$ as a covariate in ANCOVA, a significant interaction effect of Sound Pressure Level and Procedure is found. The cell means indicate a *fair process effect* in the high sound conditions only, such that the fair procedure reduces annoyance, compared to a neutral procedure. The post-hoc analysis may indicate that no procedure effect has been found in the planned analyses due to low statistical power.

With regard to future studies, the following recommendations are made: 1) the manipulation of procedural fairness needs to be stronger relative to the manipulation of SPL (the manipulation of SPL needs not to be changed; 2) a covariate assessing individual differences in response to the sound needs to be included; and 3) more participants per cell are recommended. It is recommended to assess annoyance after fifteen minutes rather than one minute of exposure. The reading task used motivates the participants to perform well, and matches their capacities. Although no effects of task performance on noise annoyance have been found in the pilot study, it is advisable to check for unintended performance effects in future studies.

The results of the pilot study encourage further noise annoyance research with a social approach. It has theoretical and practical value to investigate whether indeed there is a causal link between noise management procedure characteristics and noise annoyance. Theoretically, this knowledge is important for the development of a psychological model of noise annoyance. Practically, the knowledge is important for the development of noise annoyance abatement strategies.

CHAPTER 3 **The Fair Experiment**

Annoyance reduction through fair procedures

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ABSTRACT

The social context of noise exposure is a codeterminant of noise annoyance. The present study shows that fairness of the exposure procedure *sound management* can be used as an instrument to reduce noise annoyance. In a laboratory experiment *N=117* participants are exposed to aircraft sound of different sound pressure level (SPL: 50 vs 70 dB A) —which is experienced as noise—while they work on a reading task. The exposure procedure *fair versus neutral* is modeled in line with findings from social justice theory. In the fair condition, participants can voice their preference for a certain sound sample, although they cannot deduce whether their preference is granted. In the neutral condition, participants are not asked to voice their preference. Results show the predicted interaction effect of sound pressure level and procedure on annoyance: Annoyance ratings are significantly lower in the fair condition than in the neutral condition, but this effect is found only in the 70 dB condition. When the SPL is considerably disturbing, fair procedures reduce noise annoyance. Consequences of the reported findings for both theory and practice are discussed.

3.1 INTRODUCTION

It is a common observation that people's evaluations of environmental sound differ widely, given equal acoustics. Where to some the arousing roar of a Concorde supersonic jet was like music to their ears, to others it was truly intimidating noise (Adams, 1981). Noise is unwanted sound, and therewith a subjective description. Beside acoustic variables *e.g., loudness, pitch*, nonacoustic variables (like perceived control, noise sensitivity, and attitudes toward the source) explain a substantial proportion of variance in annoyance reactions to noise (e.g., Job, 1988; Fields, 1993). Many studies of community reactions to noise consider nonacoustic variables. They address them mainly as personal sources of variance that blur the dosage-response relationship (e.g., Schultz, 1978; Fidell *et al.*, 1988; Schomer, 1988; Green and Fidell, 1991; Miedema and Vos, 1998). Few studies have addressed nonacoustic variables as a potential instrument to reduce *or increase* noise annoyance (e.g., Cederlöf *et al.*, 1967; Maziul and Vogt, 2002). The present study addresses the social side of sound exposure as a potential instrument for annoyance reduction.

"Increased attention in the late 1960s and early 1970s to noise as a social problem stimulated the initial interest of social psychologists in noise research" (Cohen and Spacapan, 1984, p. 221). This attention has since not faded. But despite this recognition of noise as a *social* problem, the research focus has not been on the social side of the issue, but rather on the acoustic side, specifically the measurement of annoyance, and the predictive relationship between noise metrics and annoyance. Job (1988) has reviewed a body of survey studies on subjective reactions to environmental noise, and concludes that even when data are collected with the most accurate measurement of both the acoustics and the annoyance reaction, noise exposure accounts for only 25%–40% of variation in reaction (Job, 1988; also Guski, 1999). A range of variables other than noise exposure has been shown to correlate significantly with annoyance. Such nonacoustic variables are repeatedly estimated to account for more variation in annoyance scores in survey data than acoustical variables do (e.g., Job, 1988; Fields, 1993; Guski, 1999; Ouis, 2001, 2002). Job (1988) presumes that some nonacoustic variables (i.e., attitudes toward the noise source and noise sensitivity), besides being part of the reaction to noise, may also be codeterminants of annoyance. In theory, ameliorating codeterminants of annoyance will result in annoyance reduction (Guski, 1999). However, this abatement strategy is interesting for policy makers only if such codeterminants are tractable on a large scale. In that respect, *social* nonacoustical variables (e.g., Guski, 2001) may possess the required features. In the present paper it is experimentally tested whether social nonacoustical variables are tractable on a group level, and whether they operate as codeterminants of noise annoyance. It is argued that, in order to study and hopefully profit from, the possibilities for annoyance reduction through social nonacoustic variables, noise as a *social* problem needs to be acknowledged. Sound exposure has a social side, and social processes have the potential of modifying nonacoustic codeterminants of noise annoyance.

In this paper, "management of the sound by the source" (Stallen, 1999) is explored as a nonacoustic instrument for annoyance reduction. To this end, noise annoyance is regarded from a social psychological perspective: The sound source, being either a person or an institution operating the source, allocates a *negative* outcome *i.e., sound* to the exposed. For example, Heathrow airport has decided upon a runway operation regime of "daytime runway alternations" (i.e., using one main runway for departures and another for arrivals, and changing this segregation halfway through the day). "Alternation gives a wider distribution of noise than permanent segregated mode *without alternation*, and reduces overall noise exposure for those most heavily exposed while at the same time increasing overall noise exposure for those areas around the airport that would not otherwise have been overflown" (Flindell and Witter, 1999, p. 34). Stallen captures this social relationship between the source and the exposed by the phrase "You expose Me." From social psychology it is known that the evaluation of the outcome of an allocation depends on both the *actual outcome* as well as the *fairness* of the allocation procedure (e.g., Lind and Tyler, 1988). When the allocation procedure is perceived to be fair, the subjective evaluation of the related negative outcome is more positive. For example, Folger (1977) found that boys evaluated a disappointing monetary reward less negatively when this reward was brought about by a fair procedure (when the reward was not disappointing, the fairness of the procedure had no effect on the outcome evaluation). A fair procedure *as an instrument of sound management* can therefore be expected to have a positive influence on the affective evaluation of the sound, and hence be an instrument to reduce noise annoyance. Results from the laboratory experiment described in this paper corroborate this expectation. The social psychological perspective on noise annoyance, used for the design of the experiment, will be outlined in the remainder of this introduction.

3.1.1 A social psychological model of noise annoyance

From a psychological perspective, annoyance can be considered as psychological stress (e.g., Glass and Singer, 1972). The assumption that the amount of psychological stress is not simply a reflection of the severity of the stressor is pivotal to the cognitive theory of stress and coping (e.g., Lazarus and Folkman, 1984). In this theory stress is defined as "a relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and as endangering his or her well-being" (Folkman, 1984, p. 840). The appraisal of a situation is theorized to take place in two phases: primary and secondary appraisal. In primary appraisal the person evaluates the significance of a specific situation with respect to well-being. An array of personal and situational factors shapes the primary appraisal[11]. When a situation is appraised as being harmful or threatening to well-being, negative emotions such as anger or fear arise, and a secondary appraisal is triggered. "In secondary appraisal, coping resources, which include physical, social, psychological, and material assets, are evaluated with respect to the demands of the situation" (Folkman, 1984, p. 842). Perceived control (known to be an important modifier of stress responses, e.g., Glass and Singer, 1972; Campbell, 1983) is in the context of this theory considered both as a personality trait (influencing primary appraisal) and as a situational appraisal (secondary appraisal). People continuously appraise their situation; hence the relationship between the environment and the person is dynamic (Folkman, 1984)[12].

When applied to the sound exposure situation, the cognitive theory of stress and coping predicts that a person will experience annoyance when they appraise the sound as threatening or harmful *primary appraisal*, and, considering their options to cope with the sound *secondary appraisal*, find that their coping resources fall short. Noise annoyance becomes a *social* problem when the sound is man-made and, consequently, a source is held responsible for the sound production. Therewith, the relationship between source and exposed becomes a relevant resource. If the exposed

[11] Among the most important personal factors thought to shape primary appraisal are beliefs [ranging from generalized (e.g., religious) beliefs to specific beliefs (e.g., personal control over important outcomes)] and commitments [ranging from values and ideals (e.g., care for the environment) to specific goals (e.g, living in a quiet neighborhood)]. Situational factors include the nature of the threat or harm, the familiarity, novelty, and likelihood of occurrence of the event, and the ambiguity of the expected outcome (Folkman, 1984, pp. 841–842). The authors regard perceived loudness, disturbance and pleasantness of the sound as personal or situational factors.

[12] The effect of the continuous appraisal of situations is that, in practice, primary and secondary appraisal are parallel processes that are difficult to discriminate. Experiences in previous encounters may alter people's beliefs and goals, and consequently have an impact on the appraisal of new encounters. Nonacoustical variables like attitudes may be a result of one encounter, and the modifier of another. A fair sound management procedure may be evaluated as a coping resource in one situation (and influence the secondary appraisal of that situation), and at the same time changes people's attitudes toward the source (influencing the primary appraisal of a subsequent encounter with the sound).

has, for instance, little control over the source, or little trust in the source, the perceived coping resources will be reduced and psychological stress will rise.

Stallen (1999) alludes to the social relationship between the source and the noise exposed person as a resource when he argues that the management of the sound (e.g., activities by the source ranging from keeping the sound volume within limits, to supplying residents with sound insulation or information, to asking the opinion of residents) relates to the degree of perceived control: "to a large extent perceived control is rooted in how noise is managed in practice by the source. Thus, pointing at perceived control implies pointing at another external determinant of annoyance next to sound levels: the management of sound levels. This outside stimulus is as much a stimulus for annoyance causation as the stimulus 'sound' itself" (Stallen, 1999, p. 77). Sound management by the source is, in other words, considered as a potential stressor, like noise (e.g., Evans et al., 1995).

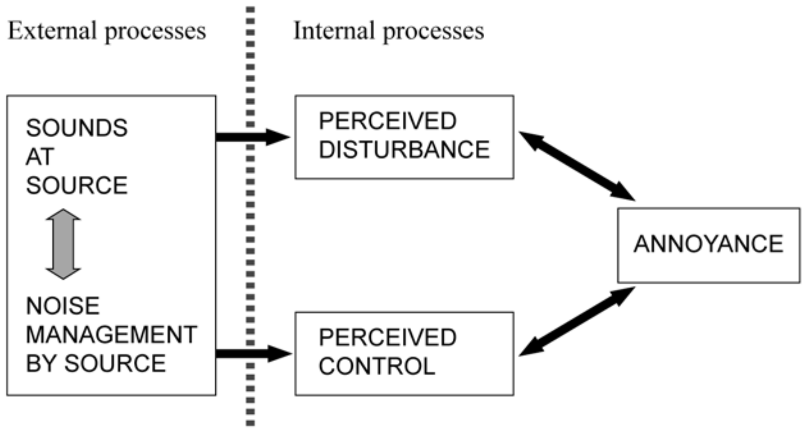

FIGURE. 3.1. Social psychological model of noise annoyance. The model, which is a simplification of the model by Stallen (1999), considers both the sound ("sounds at source," e.g., sounds generated by the source) and its management ("noise management by source," e.g., activities by the source ranging from keeping the sound volume within limits, to supplying residents with sound insulation or information, to asking the opinion of residents) as determinants of noise annoyance. The perception of these external processes results in perceptions of disturbance and/or control (internal processes). A perceived misbalance between disturbance and control results in annoyance. The model predicts that an increase in noise annoyance results from a deterioration of the acoustics, or from unsound management

The social psychological model of noise annoyance (Stallen, 1999) is an application of stress theory on the noise exposure situation. It emphasizes the social side of noise annoyance. In short: "You expose Me." A simplification of this model is used for the design of the present study, and is depicted in Fig. 3.1. The model considers as codeterminants of noise annoyance both the sound *"sounds at source"* and its management by the source *"noise management by source"*. The appraisal of these "external processes" results in perceptions of disturbance and control ("internal processes," reminiscent of primary and secondary appraisal). A perceived misbalance between disturbance and control results in annoyance. The model predicts that annoyance can be reduced by improving the acoustics, and/or by improving the sound management.

In the present paper, too, noise annoyance is considered an expression of psychological stress, related to the perceived adverse influence of acoustical variables *i.e., sound* and nonacoustical variables *i.e., sound management*, given personal variables (e.g., basic coping capacity, perceived control as a personality trait). This description is quite in line with the World Health Organization's definition of annoyance as "a feeling of discomfort which is related to adverse influencing of an individual or a group by any substances or circumstances" (WHO, 2004, p. 3). Having outlined the social psychological perspective taken in the current study, now the earlier noise research addressing more or less explicitly sound management and the social perspective will be briefly reviewed to relate the current study to the experiments that ultimately inspired it. After that, social justice theory, used for the design of the management procedures used in the current experiment, will be introduced.

3.1.2 Preceding studies addressing social nonacoustical variables

To the best of the authors' knowledge, the potential of nonacoustical variables or sound management as an instrument to reduce noise annoyance has rarely been experimentally tested. The present authors know of four studies, which will be described in this paper. A Swedish scenario experiment (Jonsson and Sörensen, 1967) describes how participants' anticipated disturbance with sound is reduced (or aggravated) by giving them a positive (or negative) description of the noise source. A related field study reports a reduction in noise annoyance among residents of an area surrounding a Swedish Air Force base as a result of them reading positive, propaganda-like statements concerning the Air Force in a bogus questionnaire (Cederlöf et al., 1967). No strong conclusions can be drawn from these data, however, as both studies suffer from methodological weaknesses[13]. In a more recent German field experiment, supplying residents with an informative telephone service reduced their annoyance, but the effect has been found only among the few residents who made use of the service (Maziul and Vogt, 2002). A fourth study has investigated the effect of citizen participation in the decision making process (i.e., selection of a sound protection barrier) on their annoyance. Results from this scenario experiment (with realistic sound samples) show no significant effect of participation on annoyance compared to a control group (ZEUS GmbH, 2002). The results of the above-mentioned studies suggest that sound management, like providing people with relevant information, may influence evaluations of noise. However, the results are inconclusive, and the theoretical underpinning of the design of the sound management procedures used is unclear.

The results of three other experiments (Glass and Singer, 1972) are illustrative of the social nature of the sound exposure situation, even though annoyance has not been assessed as a dependent variable. Glass and Singer describe a series of experiments on noise as a stressor in which the moderating effect of several cognitive factors is investigated. Dependent measures are negative after effects (e.g., performance on a proof reading and a Stroop task). One experiment investigates the effect of indirect control over the sound. Participants are, in the company of a confederate, exposed to high-intensity noise (108 dB A). Three conditions are compared: two experimental conditions and a reference condition. In the two experimental conditions the confederate is given a switch to control their noise exposure. In one experimental condition (indirect control) the participants are allowed to communicate to the confederates if they prefer the noise to be switched off. In the other experimental condition (no-indirect control) the participants are not allowed to communicate their preference. In the reference condition, neither the confederate nor the participant is given a switch. The results show that indirect control reduces the negative aftereffects of noise exposure compared to the reference condition. In the no-indirect control condition negative aftereffects increase in comparison to the reference condition, much to the researchers' surprise. Glass and Singer have explained the latter result as a serendipitous effect of *relative deprivation*[14] *of control resources*. This study nicely illustrates how sound management affects perceptions of *indirect* control over a stressor, and thus attenuates the impact of sound. Moreover, it illustrates how the perception of a difference in resource availability (i.e., access to the control switch) between two noise exposed individuals can aggravate the impact of the stressor. A follow-up of the experiment failed to replicate the presumed relative deprivation effect.

The disappearance of the relative deprivation effect may be due to a change in the verbal instructions and interactions between experimenter, confederate, and participant. Where in the initial study the experimenter instructs the confederate about the switch in a one-to-one conversation (the participant is seated behind a wooden partition and overhears them talking), in the follow-up study the experimenter includes both the participant and the confederate in the conversation. (For the original description of the two experiments, see Glass and Singer, 1972, Chap. 5) Possibly, what creates the effect in the initial study is the participant's *social exclusion*, rather than their relative deprivation of control. Another possibility is that the overt advance notice of relative deprivation in the follow-up study causes the situation to be felt as being less unfair, and hence attenuates the relative deprivation effect (Cropanzano and Randall, 1995). Yet another experiment investigates the effect of relative deprivation of exposure. The results indicate that receiving more *or less* intense sound than a comparable other aggravates (respectively, ameliorates) negative aftereffects. These three experiments described by Glass and Singer illustrate the social side of noise annoyance, namely the importance of

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[13]Caution in the interpretation of these data is warranted. In the first study (Jonsson and Sörensen, 1967) anticipated disturbance is measured with a 4-point verbal scale consisting of items that refer more to attitude toward the source than to disturbance with the sound. It is questionable which concept was measured. In the second study (Cederlöf *et al.*, 1967) the population studied showed unusually high prelevels of annoyance (due to exceptionally high exposure levels). It is therefore unclear whether any effect would have been found under normal starting conditions. Moreover, the design of the study may have made individuals in the experimental condition sensitive to give socially desirable answers.

[14]Relative deprivation: A situation in which someone compares their situation to that of a relevant reference peer, and feels discontented with it, not because of the situation itself, but because the peer seems better off.

the relative value of noise as an outcome. That is: people evaluate their outcomes relative to outcomes of comparable others.

3.1.3 Fair management procedures

The above-described experiments nicely illustrate the two major stances taken in this paper: (1) Sound management, or allocation procedure, has an influence on sound evaluation, and (2) social processes modify sound effects. This leads us to social justice theory. One of its major contributions is that effects of a negative outcome (e.g., being relatively deprived of something valuable, or receiving a lot of something unpleasant) are ameliorated when the outcome is realized by a fair procedure: *the fair process effect* (e.g., Folger, 1977; Lind and Tyler, 1988; Van den Bos *et al.*, 1997; Van den Bos and Lind, 2002).

People have a strong interest in fairness or justice (in this literature, the terms "justice" and "fairness" are used interchangeably[15]), e.g., Cohen, 1986. Being treated fairly results in a positive reaction, and the opposite situation holds too: An unfair treatment results in negative affect, protest, contraproductive behaviors, and illegal actions (e.g., Tyler, 2000). These so-called fair process effects have been found in both laboratory experiments and in field settings, as well as in a variety of situations like organizations, court trials, police-citizen encounters, and political situations (e.g., Lind and Tyler, 1988). Social justice theory will now be briefly introduced, as it is the theoretical underpinning of the design of the management procedures applied in the current experiment.

Social justice theory investigates under which circumstances people consider a procedure to be fair. Studies of procedural justice judgments have identified several primary criteria that people use to evaluate fairness of procedures: (i) whether there are opportunities to participate in the decision making process ("voice"), (ii) whether the opinions of all parties involved are taken into account, (iii) whether authorities are free from bias, and whether people trust their motives, (iv) whether people are treated with dignity and respect, (v) whether the information used to come to the decision is accurate and relevant, (vi) whether the provided information about the process and the decision is clear and appropriate, and (vii) whether procedures are applied consistently across people and across time (e.g., Tyler, 2000; Greenberg, 1993; Steensma and Doreleijers, 2003; Steensma and Otto, 2000; for a concise review and meta analysis of 25 years of justice research, see Colquitt *et al.*, 2001).

The participation criterion (or voice) of procedural justice is the most often studied criterion of the above-presented list, and is also used as the fairness manipulation in the current experiment. Effects of voice on procedural fairness judgments are strongest when the voice is given before the decision is made ("predecision voice"). When the voice is given afterwards, it still enhances fairness judgment ("postdecision voice") (Lind et al., 1990). Thibaut and Walker (1975) refer to this distinction as "instrumental" voice, in which people's comments may influence the decision, and "noninstrumental" voice, in which the comments will have no bearing on the outcome (e.g., comments are only allowed after the decision had been made). "Mediation analyses showed that perceptions of control account for some, but not all, of the voice-based enhancement of procedural justice" (Lind et al., 1990, p. 952). "People have also been found to value the opportunity to express their views to decision makers in situations in which they believe that what they are saying has little or no influence upon the decisions being made (...) People are primarily interested in sharing the discussion over the issues involved in their problem or conflict, not in controlling decisions about how to handle it." (Tyler, 2000, pp. 121–122). Consequently, giving people voice with regard to their sound exposure situation will increase the perceived fairness of the management procedure (even when this voice is noninstrumental), and may result in a more positive reaction toward the sound and less psychological stress.

[15]It should be noted that the semantics of the concept "justice" or "fairness" are context dependent. The concept has been studied by philosophers for centuries, if not millennia, and in a whole range of scientific disciplines (e.g., political sciences, anthropology, sociology, computer sciences) research on fairness (or justice) is conducted. "In contrast to other disciplines, social psychology does not take a normative approach [to justice]. It deals with justice in a descriptive rather than a prescriptive way. The aim is not to define what is just and unjust, and how justice can be achieved. The focus on the contrary is on the subjective sense of justice and injustice and its impact on human action and judgment. Social psychologists study what people regard as just and unjust under given circumstances, how people deal with the concept of justice, how they react to situations that they regard as unjust, and under which circumstances, and why, people care about justice" (Mikula, 2001, pp. 8063–8064). In the current paper, the following definition of fair (or just) procedures is operated: procedures that people judge to be fair. Although it is very likely that substantial cultural differences exist with regard to which procedures people regard as just, the wish to be treated in a just way appears to be an anthropological universal (Montada, 2001).

The required link between psychological stress and the fairness of outcome distribution and allocation procedures has been explored within an organizational context (Tepper, 2001; Vermunt and Steensma, 2001, 2003, 2005). A framework that integrates the cognitive theory of stress and coping (e.g., Lazarus and Folkman, 1984) with social justice theory (e.g., Lind and Tyler, 1988) has been proposed (Tepper, 2001). The perceived fairness of distributions and procedures is hypothesized to influence the primary and secondary appraisal of the situation, and hence affect psychological stress. In a work environment, managers distribute demands and resources among their subordinates. When a subordinate perceives a discrepancy between these demands and available resources, they may experience stress, in line with the cognitive theory of stress and coping. Tepper (2001) has found that the perceived fairness of outcomes as well as allocation procedures correlates negatively with psychological stress. Vermunt and Steensma (2001, 2003, 2005) have theorized and shown that fair procedures can be used to reduce stress, and conclude that a fair treatment reduces the threat value of an event. An instrumental explanation for the relation between fairness and stress is that fair procedures offer opportunities for process control (i.e., the opportunity to present information or evidence as input into the decision) and decision control (i.e, the opportunity to influence the decision itself), which increases the likelihood of receiving favorable outcomes. A noninstrumental explanation holds that people care about procedural justice because it provides feedback regarding their status in the group or community: A high status provides the group member with two vital coping resources: a social support system and a sense of self-efficacy (Tepper, 2001; Tyler and Lind, 1992).

In social justice literature, generally additive main effects of procedural and distributive justice on outcome satisfaction are reported (Lind and Tyler, 1988, pp. 68–69). In his study on the relationship between procedural fairness and stress, Tepper (2001) has found that the effects of distributive fairness and procedural fairness on stress interact: The effect of procedural fairness is far stronger when the distribution is unfair. Sometimes, procedures only have an effect when outcomes are unfair. Tepper (2001) argues that, since the secondary appraisal (in which the procedure is evaluated) is triggered by perceived harm or threat (i.e., distributive unfairness, primary appraisal), it is the distributive fairness that moderates the effect of procedural fairness. Vermunt and Steensma (2003) have found that the effect of procedural fairness depends on the level of stress a person is actually experiencing. However, solely based on empirical data the opposing explanation, that procedures moderate the effect of the distribution, is also plausible.

3.1.4 Hypotheses

In the present experiment effects of two sound pressure levels *SPL*, low and high ("sounds at source"), and two exposure procedures, neutral and fair ("noise management by source"), on noise annoyance are compared. Participants are exposed to interfering sound (low or high SPL) while working on a task. It is assumed that the low SPL will induce lower stress than the high SPL will; hence it is hypothesized that the noise annoyance ratings will be lower in the low SPL condition than in the high SPL condition (Hypothesis 1). Within each SPL condition and before exposure, half of the participants are given noninstrumental voice (fair procedure). The other half do not receive voice (neutral procedure). Based on fairness research (e.g. Tepper, 2001; Folger, 1977; Lind and Tyler, 1988, pp. 68–69, 72), it is predicted that a *fair process effect* will be present only when the sound is appraised as harmful or threatening (i.e., disturbing sound). For most people, this will be the case in the high SPL condition, and not or to a lesser extent in the low SPL condition. Specifically, we predict that, within the high SPL condition, participants will report lower annoyance in the fair procedure condition than in the neutral procedure condition, while this effect of procedure is absent or less strong in the low SPL condition (Hypothesis 2).

3.2 METHOD

3.2.1 Participants

One hundred and seventeen students (75% female; mean age 22 years) are paid 4 Euro each to participate in the experiment, which lasts approximately 45 min. Participants are randomly and evenly spread over the four cells of the experimental design.

3.2.2 Experimental design

The experimental design is a 2 (procedure: fair versus neutral procedure) x 2 (sound pressure level (SPL): low (50 dB) versus high (70 dB)) complete factorial design.

3.2.3 Laboratory layout and stimulus material

The laboratory consists of four separate cubicles, each of which contains a desk and chair, and a complete PC set with two loudspeakers plus one subwoofer.

The two sound samples are composed of self-recorded audio material of aircraft passages of various loudness and duration[16]. The “hearing test” sample is a 1 min sound sample of a single aircraft passage, and is played at 60 dB A (1 min Leq). The experimental sample lasts 15 min, during which, at random intervals, 11 aircraft passages are audible. The experimental sample is played at either 50 dB A (15 min LAeq) (low SPL condition) or 70 dB A (15 min LAeq) (high SPL condition), which implies a sound level of quiet background noise in the low condition, or of speech interfering loudness in the high condition. The maximal sound pressure level of the experimental sample is 68 or 88 dB A Lmax, respectively. All sound pressure levels are measured in the cubicle at the position of the listener.

The reading task (an English text with multiple choice questions, taken from a Dutch exam from preuniversity education) is selected to match the cover story, and because it assures participants’ motivation to perform well, and to closely match their capacities. With too easy a task, the experimental noise may not cause any disturbance and hence not induce any annoyance, whereas too difficult a task may give rise to performance effects, which may cloud the effects of the procedure and/or the SPL manipulation (Smith, 1989).

3.2.4 Experimental procedure and manipulations

Upon their arrival at the laboratory, participants check with the experimenter who obtains their informed consent and guides them to their cubicle. After being seated, participants are left to themselves. All further communication is through the computer, which is used for the presentation of the stimulus information and for the recording of the dependent variables. Participants are told (on screen) that they are engaged in a study on effects of sound on people’s performance during high school exams. As part of the experiment, they will take an exam while being exposed to possibly interfering sound. Then, a bogus hearing test is administered: The “hearing test” sample is played and participants are asked to judge how loud and how annoying this sample is to them. In fact, this test gives them a frame of reference for loudness, assuring that they will later on experience the experimental sound sample either as softer or as louder than the reference sample. The test provides a baseline measure for annoyance as well, to be used as a dummy for basic coping capacity (covariate in the analyses). Next, participants are led to believe that the experimenter intends to compare three different sound samples that are equal in length, but differing in number and duration of the aircraft passages. The three concocted samples are described as: (A) many, but short lasting aircraft passages; (B) few, but longer lasting aircraft passages; or (C) aircraft passages of intermediate number and duration. Participants are led to believe they are to listen to one of these three samples during the task. It is suggested that they may have a personal preference for one sound sample over another.

Participants in the *fair procedure condition* are asked to express (voice) their personal preference for one of the three samples. A confirmation of their expressed preference is given, and the experimenter states that they will take this preference into account as much as possible (literal text, on screen, in a small font: “You have indicated that you expect sample X to cause you the least annoyance”, and then in a larger, bold font: “We will take this into account as much as possible”). Participants in the fair procedure condition then are asked to confirm their preference. The experimenter states once more that they will take this preference into account as much as possible.

Participants in the *neutral procedure condition* are not asked to voice any preference. They are informed that the experimenter will select one of the three samples for them. After the procedure manipulation, all participants start with the exam (reading task) while being exposed to the experimental sound sample. The sample is identical for all subjects and ambiguous with respect to the relative number and duration of the passages. It is played at either 50 or 70 dB, depending on the participant’s sound pressure level condition. After 15 min of exposure, the experimental sound and the task are terminated (none of the participants have by then finished the task). Participants are then

[16] The audio material was recorded outdoors, with clear weather conditions, on one location in the vicinity of a runway in use for landings only. Ambient sounds were removed from the recordings by a professional company. The 15 min experimental sample was made up of 11 noise events of aircraft passages of various loudness, duration, and aircraft type. The quiet time dispersing two passages (1 min, on average) was shorter than in real life and of variable length.

presented with the questionnaire that assesses the dependent measures and the manipulation checks. (See Fig. 3.2 for a visual representation of the flow of the experiment).

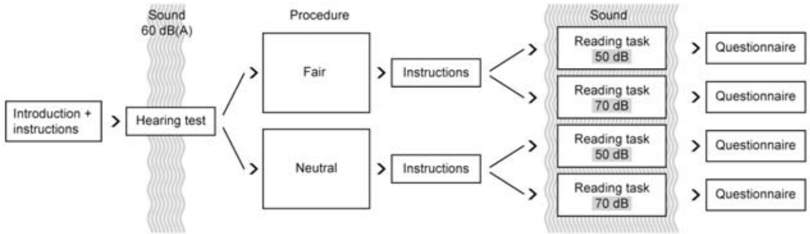

FIGURE.3 2. Visual representation of the flow of the experiment.

3.2.5 Measures

The baseline measure for annoyance (covariate) is a single-item question: "How annoying was the aircraft sound you have just listened to, to you?" Answers are given on a 7-point Likert scale with verbal markers at each end point: 1="not annoying at all," 7="highly annoying" [*M*(s.d.) =4.38(1.40)].

In the questionnaire, three questions assess annoyance with the experimental sound: (i) "To what extent did the sound annoy you while you were working at the task?" (ii) "How did you experience the aircraft sound while answering the exam questions?" (iii) "How pleasant did you feel the aircraft sound was while working on the exam?" Answers are given on a 7-point Likert scale with verbal markers at each end point: (i) 1="not at all annoying," 7="highly annoying," (ii) 1="very positive," 7="very negative," (iii) 1="very pleasant," 7="very unpleasant." An annoyance scale is constructed from the three items (Cronbach's α =0.76). The mean annoyance score of the scale [*M*(s.d.) =5.21 (1.03)] is significantly different from 4 (neutral score) [$t(116)=12.71$, $p < 0.001$], indicating that, on average, participants consider the sound to be annoying.

One question checks the effectiveness of the sound pressure level manipulation: "If you were to give a grade for the average loudness of the aircraft sound, what grade would you give?" In the instructions, verbal labels are given to the end points of the scale: 1="very soft," 10="very loud." Participants respond by clicking on the virtual button numbered with the grade of their choice [*M*(s.d.) =6.38(1.91)]. (The measure for the hearing test is identical to this manipulation check for sound pressure level.) A 10-point scale is used (deviant from the annoyance measure, which uses a 7-point scale) to prevent participants from ticking the exact same number on the annoyance measure and the loudness measure, aiming to give a consistent (socially desirable) rather than a faithful answer. The Pearson's correlation between perceived loudness and annoyance (r=0.36, $p < 0.001$, N =117) indicates that participants regard loudness and annoyance as two related but conceptually different concepts.

Five items check the effectiveness and fairness of the procedure manipulation: (i) "The experimenters sought to take my preference for a certain combination of sound characteristics into account," (ii) "In my opinion, the procedure that was applied to select my sample is …," (iii) "In your opinion, how fair is it that the participants were not all given the same sample?," (iv) "I was given the sample of my preference," and (v) "The experimenters have made an effort to tax the participants as little as possible." Answers are given on a 7-point Likert scale with verbal markers at each end point: 1="completely disagree" and 7="completely agree" for items i, iv and v, and 1="very unfair" and 7="very fair" for items ii and iii. A "don't know" option is included and scored as a missing datum. A perceived procedural fairness scale is constructed from the five items, excluding the missing values [*N*=83, *M*(s.d.)=4.73 (1.11), Cronbach's α =0.64], and including the missing values replaced by the series' mean [*N*=117, *M*(s.d.)=4.62 (1.01), Cronbach's α =0.60].

Finally, some general questions [e.g., gender, selfreported hearing impairments ("Do you have any hearing impairments?," response categories: (i) "yes" (ii) "somewhat" and (iii) "no"] are included.

Besides, the computer automatically registers some explorative measures of task performance, to be used as checks for unintended performance effects ("time:" time taken to read the first text and answer question one; “correct:” total number of correct answers; “false:” total number of false answers).

3.3 RESULTS

3.3.1 Manipulation checks

Perceived loudness

Analysis of variance (ANOVA) with perceived loudness as the dependent variable and sound pressure level (SPL) and procedure as the independent variables indicates that the sound pressure level manipulation was successful: Participants in the low conditions experience the sound to be significantly less loud than participants in the high conditions [*M*low(s.d.)=5.24 (1.59) vs *M*high(s.d.)=7.49 (1.50), $F(1,113)=61.11$, $p < 0.001$; an alpha level of 0.05 is used for all statistical analyses]. The SPL manipulation is independent of procedure: Perceived loudness is not influenced by procedure [*M*fair(s.d.)=6.42 (1.78) vs *M*neutral(s.d.)=6.33 (2.05), $F(1,113)=0.08$, $p = 0.79$, *n. s.*], nor is there an interaction effect of SPL and procedure on perceived loudness [$F(1,113) =0.47$, $p = 0.50$, *n. s.*] (See Fig. 3.3).

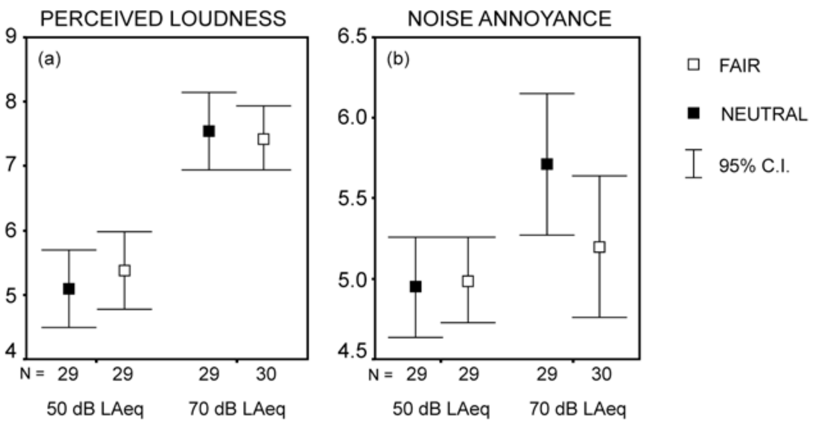

FIGURE 3.3. Perceptions of loudness (left) of and annoyance (right) with the experimental sound. Means dots and 95%-confidence intervals whiskers are shown. Whereas the perceived loudness of the experimental sound is not influenced by procedure, the evaluation of the sound in terms of annoyance is: Within the high sound condition, a fair procedure results in a reduction of reported noise annoyance.

Perceived fairness

ANOVA with perceived fairness (excluding missing values, N=83) as the dependent variable and SPL and procedure as the independent variables indicates that the fairness manipulation was successful: Participants in the fair condition experience the procedure to be significantly more fair than participants in the neutral condition [*M*fair(s.d.)=5.09 (1.11) versus *M*neutral(s.d.)=4.30 (0.96), $F(1,79)=10.93$, $p < 0.002$]. The procedure manipulation is independent of SPL: Perceived fairness is not influenced by SPL [*M*low(s.d.)=4.85 (1.14) versus *M*high(s.d.)=4.58 (1.07), $F(1,79)=0.94$, p=0.34, *n.s.*], nor is there an interaction effect of SPL and procedure on perceived fairness [$F(1,79) =0.94$, p=0.34, *n.s.]*.

ANOVA with perceived fairness (missing values replaced with the series mean, N=117) as the dependent variable and SPL and procedure as the independent variables gives similar results [Effect of procedure: *M*fair(s.d.)=4.89 (1.07) vs *M*neutral(s.d.)=4.34 (0.86), $F(1,113)=9.51$, $p < 0.01$; effect of SPL: *M*low(s.d.)=4.75 (1.07) vs *M*high(s.d.)=4.49 (0.94), $F(1,113)=2.04$, p=0.16, *n.s.*; interaction effect of SPL and Procedure: $F(1,113)=1.94$, $p =0.17$, *n.s.*].

Performance measures

The three checks for unintended performance effects indicate no systematic differences between the four conditions in performance on the reading task. The mean time spent on task item 1 is about 90 s, and no differences between conditions are found [*M*time(s)(s.d.)=96.62 (37.49), $F(3.113) =1.62$, p=0.19, *n.s.*]. On average, participants answer ten task items correctly and four task items falsely, and no differences between conditions are found [*M*correct(s.d.)=10.05 (4.03), $F(3.113)=1.80$, $p=0.15$, *n. s.*; *M*false(s.d.)=4.37 (2.77), $F(3.113)=0.76$, $p=0.52$, *n.s.*].

3.3.2 Dependent variables

Analysis of Covariance (ANCOVA) with annoyance as the dependent variable, SPL and procedure as the independent variables, and baseline annoyance as the covariate shows a significant main effect of SPL [$F(1,112)=11.25$, $p < 0.005$, $\eta^2=0.09$] (see Table 3.I for marginal means). Participants who are exposed to low sound express less annoyance than those receiving high sound (this finding confirms Hypothesis 1). No significant main effect of procedure is found [$F(1,112)=2.39$, $p=0.13$, *n.s.*]. The interaction effect of SPL by procedure is significant at the $p < 0.05$ level [$F(1,112) =3.95$, $\eta^2 =0.03$, see Table 3.I for cell means, and Fig. 3.3 for a visual representation of these results] and indicates a *fair process effect* in the high sound condition (confirmation of Hypothesis 2). If the SPL is high, the fair procedure condition yields lower levels of annoyance than the neutral procedure condition does. Within the High SPL condition, the fair process effect explains 9% of the variance in annoyance scores. Within the low SPL condition, variance in annoyance scores cannot be attributed to procedure conditions.

Hearing impairments. Several participants indicate having hearing impairments ("yes:" N=2, "somewhat:" N=12). When these cases are left out of the analysis, the pattern and significance level of the effects remains largely the same [main effect of SPL: $F(1,98)=7.79$, $p<0.01$, $\eta^2=0.07$; main effect of procedure: $F(1,98)=1.53$, $p=0.22$, *n.s.*; interaction effect of SPL by Procedure: $F(1.98)=6.65$, $p<0.05$, $\eta^2 =0.06$].

TABLE 3.I. Annoyance scores (1="not annoyed at all," 7="highly annoyed") arranged by conditions of sound pressure level (SPL: low of high) and procedure (neutral or fair). Estimated marginal means and cell means (M), standard deviations (s.d.), and number of cases per cell (N).

SPL	Procedure	*M*	*SD*	*N*
Low	Neutral	4.94	0.83	29
50 dB	Fair	4.99	0.70	29
	Total Low	4.97	0.76	58
High	Neutral	5.70	1.16	29
70 dB	Fair	5.19	1.19	30
	Total High	5.44	1.19	59
Total	Neutral	5.32	1.07	58
	Fair	5.09	0.98	59
	Total	5.21	1.03	117

3.4 CONCLUSIONS

Despite the definition of noise as a *social* problem (Cohen and Spacapan, 1984), noise annoyance has rarely been studied from a social perspective, that is: addressing the social relationship between the source and the noise exposed person(s). In the present laboratory experiment, the source relates to the exposed persons by allocating a negative outcome (i.e., disturbing sound) to them. The exposed persons are dependent on the source, as the latter has control over the stressor ("You expose Me," Stallen, 1999). The fairness of the allocation procedure applied by the source is manipulated. The results confirm that characteristics of the social relationship (or allocation procedure) codetermine noise annoyance: when sound levels are high, a fair procedure can reduce annoyance.

The model used for the design of the experiment (see Fig. 3.1) incorporates "sound" in combination with "sound management by the source" as substantive determinants of annoyance. Both the sound and its management influence perceptions of disturbance (threat or harm) and opportunities for control (resources), which can result in annoyance (psychological stress). Bad management can be a nuisance in itself; good management can be a coping resource (e.g., by providing a feeling of trust). In the experiment, the annoying effects of two sound pressure levels (50 and 70 dB aircraft sound) and two management alternatives (a fair and a neutral procedure) are compared. The reported findings corroborate the argument that the perception of both the sound and its management influence noise annoyance. It has been found that participants who are exposed to rather disturbing sound (i.e., 15 min of 70 dB aircraft noise) report significantly less noise annoyance when they have been given voice over their noise exposure than participants who are exposed to the same sound but who have not been given voice (see Table 3.I and Fig. 3.3). This *fair process effect* is of considerable strength: Within the 70 dB SPL condition, the fair procedure reduces the mean annoyance level to approximate the mean level in the 50 dB SPL condition. Up to 9% of variance in annoyance scores can be explained by the procedure manipulation (see Sec. 3 B). When participants are exposed to less disturbing sound (i.e., 50 dB aircraft noise) no fair process effect is found (see Table 3.I and Fig. 3.3). The present study demonstrates that, under laboratory conditions and with rather disturbing sound, a fair sound management can be used as a nonacoustic instrument to reduce annoyance.

The current study adds on the numerous survey studies (e.g., Fields, 1993; Job, 1988) that address nonacoustical variables and noise annoyance in four ways. First, the current study offers a theoretical framework that describes how an external nonacoustical variable (i.e., the allocation procedure) can be a codeterminant of noise annoyance. Second, social justice theory identifies characteristics of the allocation procedure that may ameliorate sound evaluations and are tractable for policymakers. Nonacoustical sources of variance are thus redefined into a potentially useful instrument for influencing annoyance. Third, being an experiment, the study allows for more firm conclusions regarding the direction of causality between social nonacoustical variables and annoyance than a survey study would. Fourth, the study shows that the shape and/or the position of the dosage-response curve (for sounds from the same source) can vary depending on identifiable aspects of the social context of exposure. Specifically, the dosage-response curve of the current data shows a far steeper slope in the neutral situation than in the fair situation, while standard deviations are found to be equal in both situations (see Fig. 3.3). This suggests that the substantial variance in annoyance scores, typical of any dosage-response plot, can be attributed not only to (internal) personal predispositions, but also to systematic external factors of social nature, which are tractable on a collective level.

The current results corroborate the argument made by Stallen (1999) that in order to fully understand noise annoyance, the sound management has to be considered as a stimulus beside the sound. An important question that remains to be resolved is whether sound management operates as a determinant of annoyance, or as a moderator of sound effects. Based on the justice literature, it can be argued that the sound level moderates the effects of sound management (e.g., Folger, 1977; Tepper, 2001). In the noise annoyance literature, several studies have found an interaction effect of SPL and nonacoustic variables (e.g., Maris *et al.*, 2004a, b; Schümer, 1974; Schümer-Kohrs and Schümer, 1974; Fields and Walker, 1982; Fidell *et al.*, 2002; Miedema and Vos, 2003). However, a large study on noise sensitivity has not found an interaction effect (Van Kamp *et al.*, 2004). The larger part of this data suggests a multiplicative model. Some authors assume a variable threshold (dependent on nonacoustic moderator variables) above which people start to consider sound as noise (e.g., Schümer, 1974; Fidell *et al.*, 2002; see also Dubois (2000) for a semantics perspective on the distinction between sound and noise). In this regard, it is interesting to recollect that in the current experiment the procedure affects the evaluation of the sound, but not the perception of its loudness (see Sec. 3 A and Fig. 3.3; see also Janssen *et al.* (2004) for similar results in pain research where reduced control over the pain affected the willingness to endure the pain, but not the sensory experience of it).

In a preceding study with the same paradigm (Maris *et al.*, 2004a, 2004b), annoyance was assessed twice: after 1 min and after 15 min of exposure. The results indicated that the effect of SPL on noise annoyance was immediate and significantly lost strength over time, whereas the effect of procedure grew over time to a significant interaction after 15 min. It is interpreted that the consideration of social factors, like the procedure, (1) is more likely when considerably disturbing sound levels are perceived, and (2) takes place somewhat later in the psychological process than does the perception of the sound itself. This alludes to a model of noise annoyance that includes attentional processes (e.g., secondary appraisal) as a moderator of procedure effects (e.g., Botteldooren *et al.*, 2004; Ulrich, 1983).

Some issues of validity have to be addressed. The data underlying the current findings have been gathered among students only. This may restrict generalizations of the current findings to the general public. Students are, on average, younger and more highly educated than the general public. In combination, these characteristics may cause students to have a higher need for autonomy, which, in turn, may make them more sensitive to (not) having voice, compared to the general public (Avery and Quiñones, 2004). Notwithstanding, in the general public substantial variation in need for autonomy will be present, and hence the current findings will likely apply to a significant proportion of the general public.

Generalizations from the current findings to situations outside the lab may be restricted in other respects. First situational and individual differences may influence the value of fair procedures. It is known that people value voice more when the situation is uncertain, or when trust in authorities is low. Personality differences [e.g., Big Five, belief in a just world (Vermunt and Steensma, 2005), noise sensitivity] and attitudes (e.g., attitude toward the source) influence whether or not a situation is perceived as disturbing, and hence whether coping resources are appraised.

Second, in the lab, participants are well aware that their exposure will not last longer than the course of the experiment (i.e., 15 min). They are participating voluntarily and can terminate their participation at any desired moment, plus they are financially compensated for their discomfort. These aspects may make the participants care less about the sound. However, the mean reported annoyance level indicates that the participants have not been indifferent to the sound, and the fact that, in the lab, an effect of procedure is found, bolsters rather than weakens the importance of fair procedures. The aim of the current study is to show, theoretically and experimentally, that social nonacoustical variables play a crucial role in the psychology of noise annoyance. Although it cannot simply be assumed that the psychology of annoyance will be identical in the field, results from survey studies confirm that social variables like trust and attitudes toward the source play a significant role (Guski, 1999).

Third, it may be objected that an instance of fair noise management is capable of drawing people’s attention in the confined reality of an experiment, but may easily go unnoticed in real life where an excessive number of stimuli and cognitions compete for attention. Consequently, outside of the lab, the effect of a single instance of fair sound management may be attenuated, should these not be reinforced by the continuous public debates, protests, media attention, and policy processes regarding aircraft noise and its management. Together, these sociological processes may exert a significant influence on people’s ideas about the fairness of sound management (Bröer, 2002; Wirth and Bröer, 2004). In sum, it is important to consider differences between lab and field, but it seems warranted to make careful generalizations. Finally, experiences with, e.g., community consultation and transparent communication around Heathrow airport (Flindell and Witter, 1999) and Sydney airport (Southgate, 2002), illustrate the practical value of fair noise management.

With regard to the present sound manipulation, some remarks need to be made. The recording and play back of the sound may not have created a state-of-the-art soundscape due to the unpretentious techniques used. However, it is not likely that a sound quality issue will endanger the conclusions drawn from the data. First, research has indicated that the cognitive responses to source events (other than to background sound where no source is easily identifiable) are rather robust to charges in sound reproduction method (Guastavino *et al.*, 2005). Second, the sound quality has been identical for all participants, ruling out the possibility that the procedure effects found are due to artifacts related to sound quality differences. Indeed, with regard to sound quality and exposure duration, a sound experience in the lab is different from outdoor situations. But even though this may influence the relative strength of the various processes within the psychological model of noise annoyance, the authors have no reason to expect that the psychological model of noise annoyance itself will be essentially different inside or outside of the lab.

Knowledge of the social determinants of noise annoyance will be of growing importance. On the one hand, decibel levels are expected to increase due to the increasing mobility of increasing numbers of people. On the other hand, a changing noise situation implies a lot of negotiation and allocation decisions, and is usually associated with increased annoyance levels (Fidell *et al.*, 2002). Thorough knowledge of the social processes that codetermine noise annoyance is needed to keep annoyance from nonacoustic sources as low as possible. Application of fair procedures in sound management is a promising instrument for annoyance reduction (e.g., Vermunt and Steensma, 2001, 2003, 2005), but some caution should be taken to prevent a reversal of the fair process effect (Van den Bos *et al.*, 1999). The influence of a variety of criteria of fair procedures has to be studied within a noise context, and their application and effectiveness in the field have to be explored.

Given the general WHO definition of annoyance, the framework suggested here for noise annoyance may also be applicable for annoyance with other man-made substances. For instance, studies on odor annoyance (Matthies *et al.*, 2000) and urban nuisances like incivilities (Robin *et al.*, 2004) signal the importance of a social perspective on annoyance.

Some caution is warranted, however. A reduction of selfreported annoyance does not necessarily indicate less bother (or increased well being). Several studies point out that a reduction of reported annoyance can also indicate that people suppress their annoyance (Fields and Walker, 1982), or compensate by adjusting their aims (Staples, 1997; Tafalla *et al.*, 1988). One study reports a negative correlation between expressed annoyance and physiological stress levels, suggesting that a suppressed expression of annoyance results in an increase of physiological stress (Miyakawa *et al.*, 2004).

If future noise annoyance levels are to be kept to a minimum, it is needed that, in addition to the important and impressive developments that are being made in the field of noise reduction engineering, both noise researchers and policy makers address social nonacoustic codeterminants of noise annoyance.

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CHAPTER 4 **The Unfair Experiment**

Annoyance increase through procedural unfairness

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ABSTRACT

General dosage-response curves typically over- or underestimate the actual prevalence of noise annoyance for specific groups of individuals. The present study applies a social psychological approach to noise annoyance that helps to understand and predict collective deflections from the curve. The approach holds that being exposed to man-made sound is more than mere exposure; it is a social experience, too: You expose Me. In effect, social aspects of the situation, like the evaluation of the sound management procedure, influence the evaluation of sound. The laboratory experiment (*N*=90) investigates the effect of procedural unfairness on noise annoyance. The sound management procedure is varied systematically: Participants are promised they will listen to the sound of their choice (i.e., bird song, radio sound, or aircraft sound) but receive aircraft sound despite their expressed preference (unfair procedure), or they are simply told they will listen to aircraft sound (neutral procedure). All are exposed to aircraft sound (50 or 70 dBA Leq). A collective rise in noise annoyance is predicted in the unfair relative to the neutral procedure conditions. Results show that noise annoyance ratings are significantly higher in the unfair relative to the neutral conditions. Consequences for theory and practice are discussed.

4.1 INTRODUCTION

In the field of noise annoyance, it is not uncommon to find that descriptive dosage-response curves over- or underestimate actual noise annoyance levels. Nevertheless, governmental decisions on the location of airports and highway infrastructures, as well as on the award of large amounts of money to mitigate their noise impacts, rest on such dosageresponse curves. On average, annoyance with aircraft sound is underestimated by general transportation noise curves by over 5 dB (Green and Fidell, 1991, p. 241). A thorough reexamination of the often-used FICON-curve indicates a systematic underestimation of annoyance with aircraft sound, particularly for the range of sound exposure levels that are of practical value (Fidell, 2003).

In the literature, several explanations for the systematic underestimation of noise annoyance (“excess annoyance”) have been given. With regard to the technical aspects of the Schultz curve “the functional form of the relationship, the range of values over which the relationship was developed, and its lack of source-specificity” have been blamed (Fidell, 2003, p. 3010; see also Miedema and Vos, 1998). Attempts to solve the problem have been made by fitting different, or source specific, functions on the data, but still much variance remains unexplained (Fidell *et al.*, 1991; Miedema and Vos, 1998).

In addition to these technical curve-related explanations, psychological explanations have been given. Noise annoyance is related to a range of variables besides the purely acoustical parameters. Analysis of survey data shows that much variance in annoyance scores is attributable to nonacoustic variables [e.g., noise sensitivity, and attitudinal variables like perceived mal- or misfeasance, distrust in authorities, uncertainty regarding the (future) noise environment (e.g., Sörenson, 1970; Staples, 1996; Guski, 1999; Fields, 1993; Job, 1988)]. Considered from a psychological perspective, noise annoyance is not a function of solely the characteristics of the acoustic stimulus, it is a function of a dynamic cognitive process in which the acoustic stimulus *and* a diversity of nonacoustic variables, including the attribution of semantic features, play a role [for an illustration of the cardinal role played by cognition in the evaluation of complex sounds, see Dubois *et al.* (2006); for an experiment illustrating semantic influences on sound evaluations, see Guastavino (2007)]. The World Health Organization (WHO) defines annoyance as “a feeling of discomfort which is related to adverse influencing of an individual or a group by any substances or circumstances” (WHO, 2004, p. 3”) but the influence of circumstances is not incorporated in the dosageresponse curves.

The causal direction of the relationship between nonacoustic variables and noise annoyance is not clear. It is plausible (Job, 1988; Cederlöf *et al.*, 1967) that variations in certain nonacoustic variables have a causal relationship with variations in noise annoyance. Although nonacoustic variables are likely related to stable person-related factors like personality or genetic make-up, it has been argued that they may to a certain extent be influenced by situational factors. For instance, during situations of change, the heightened publicity and media attention may make residents more aware of the (effects of) noise than would be expected in a steady-state situation. Also, resentment with regard to perceived unfairness of the decision-making process (Fields *et al.*, 2000) has been speculated to increase the likelihood of residents' reporting annoyance (e.g., Green and Fidell, 1991). For the prediction of noise annoyance levels it is interesting to know whether a person's sensitivity or attitude toward sound can be influenced by situational variables.

If the majority of people in a community respond in largely the same way to the situational factors that affect noise annoyance, this will cause collective deflections from the dosage-response curve, rather than random variance in individual annoyance scores. There are indications that indeed deflections from the dosage response curve are to some extent collective. Research has shown that descriptive models of noise annoyance explain more variance in annoyance scores when they are enriched with one free parameter to account for collective nonacoustic differences: Up to an additional 47% of variance in annoyance scores is accounted for when a nonacoustic parameter, correcting for data-setspecific elevations or depressions in noise annoyance that cannot be explained by acoustical variables, is included in the mathematical model (Green and Fidell, 1991, p. 237; Fidell *et al.*, 1988; Miedema and Vos, 1999).

Notwithstanding the noteworthy improvement in the power of such enriched models, these models are purely descriptive and therefore neither improve the prediction of deflections from the curve, nor further our theoretical understanding of the psychology of annoyance in general, and the influence of nonacoustic factors in particular (Fidell, 2003). This is unfortunate, as both are needed to improve the abatement and prevention of noise problems (Staples, 1997, 1996). Given the financial and political costs of inaccurate predictions of annoyance and the apparent bother experienced by residents, it is important to further the theoretical understanding of noise annoyance in order to improve the accuracy of its prediction.

In this paper, it is argued that collective deflections from the curve can be understood and predicted when the social nature of noise annoyance is taken into account. Man-made environmental sound is rarely perceived in a social vacuum. People associate a sound they hear with its source (Guastavino, 2006), and in the case of man-made sound they may hold the operators of the source responsible for their exposure. Being exposed to man-made sound is a social experience: You expose Me (Stallen, 1999). The social process that characterizes a social experience influences the evaluation of that social experience as well as its associated outcomes (e.g., Lind and Tyler, 1988). When "You expose Me" to sound I do not like to hear, my judgment of the social process between us likely influences how far I will be annoyed by the fact that you are exposing me, and in how far I will be annoyed by the sound you make (Stallen, 1999; Van Gunsteren, 1999). Hence, the social process can be a situational factor that influences the cognitive process of sound evaluation. This is interesting, because the quality of the social process is, to a certain extent, tractable to the people who are causing the noise. For example, if a person planning a late-night party at their home checks with their neighbors whether the timing of the party matches the neighbors' plans for the weekend, their annoyance with the party noise will likely be lower. Not only the acoustical properties of the sound can be a source of annoyance and discomfort, the social process instigated by the operators of the noise source can be a cause for dissatisfaction, too.

Many dimensions of the social process may be important in determining people's reactions to social experiences and related outcomes. One dimension has dominated social psychological research: The perceived fairness of the social process, in particular the fairness of the procedures used (Lind and Tyler, 1988, p. 1). In social psychology, a procedure is considered fair when people judge it to be fair[17]. Social psychological theories of justice describe an array of procedure characteristics that

[17]In social psychological theories of justice, the concepts fairness and justice are used interchangeably. The semantics of the fairness (or justice) concept are context dependent. Philosophers have studied the concept for centuries, if not millennia, and in a whole range of scientific disciplines (e.g., law, political sciences, anthropology, sociology) research on fairness (or justice) is conducted. "In contrast to other disciplines, social psychology does not take a normative approach [to justice]. It deals with justice in a descriptive rather than a prescriptive way. The aim is not to define what is just and unjust, and how justice can be achieved. The focus on the contrary is on the subjective sense of justice and injustice and its impact on human action and judgment. Social psychologists study what people regard as just and unjust under given circumstances, how people deal with

enhance fairness judgments, identified over years of experimental and survey research. Among other criteria, procedures are generally judged to be fairer when they (1) are transparent; (2) offer opportunities for participation in the decision-making process (e.g., "voice"); (3) are applied consistently across time and across persons; and (4) are applied in a respectful manner (Lind and Tyler, 1988; Mikula, 2001; Greenberg, 1993, for a concise review and meta-analysis of 25 years of social justice research, see Colquitt *et al.*, 2001). Theories of social justice distinguish up to four dimensions of justice (or fairness). Distributive justice (the fairness of outcomes relative to a certain standard, e.g., Adams, 1965; Deutsch, 1975; Leventhal, 1976) is distinguished from procedural justice (the fairness of the processes whereby outcomes are allocated, e.g., Thibaut and Walker, 1975; Folger, 1977; Tyler and Lind, 1992). Interpersonal justice "reflects the degree to which people are treated with politeness, dignity, and respect" (Colquitt *et al.*, 2001, p. 427), and informational justice "focuses on the explanations provided to people that convey information about why procedures were used in a certain way or why outcomes were distributed in a certain fashion" (Colquitt *et al.*, 2001, p. 427; Greenberg, 1993; Bies and Moag, 1986). Research has indicated that the four dimensions of fairness can have interactive effects (Colquitt *et al.*, 2001). In practice, however, these theoretical dimensions may overlap.

Fair procedures have been found to increase outcome satisfaction (the "*fair process effect*") (e.g., Lind and Tyler, 1988), and to decrease psychological stress (Vermunt and Steensma, 2001, 2003, 2005). The fair process effect is stronger when the outcomes are negative, or when physical stress is experienced (Tepper, 2001; Vermunt and Steensma, 2003). Research has also indicated that fair management procedures enhance feelings of trust in authorities, and increase people's support for policies (e.g., Mikula, 2001). Sound management activities by the operators of a sound source can be considered procedures (i.e., the operator allocates the sound to the residents). Hence, it can be expected that the perceived fairness of sound management procedures will influence people's evaluation of the sound. Results from several studies demonstrate the influence of procedures on reactions to noise, but the perceived fairness of these procedures has not been assessed (Glass and Singer, 1972; Cederlöf *et al.*, 1967; Maziul and Vogt, 2002). A theoretical framework has not been proposed that explains or predicts effects of social processes on noise annoyance.

Social psychological theories of justice propose two major explanations why procedural fairness is generally much appreciated and related to higher outcome satisfaction. The *instrumental* explanation holds "that people are concerned about justice because it serves their self-interest of maximizing their outcomes in the long run" (Mikula, 2001, p. 8066, e.g., Thibaut and Walker, 1975). This perspective holds that fair procedures are appreciated because they give more (indirect) control over the process and the related outcomes.

Mediation analysis has shown that perceived control accounts for some but not all of the positive effects of procedural justice (Lind *et al.*, 1990). The *relational* or group value explanation, on the other hand, holds that "people are concerned about their position in groups. They use experiences with their treatment by authorities as a source of information about their social position. The evidence that they are treated justly indicates that they are worthy members of the group" (Mikula, 2001, p. 8066, e.g., Tyler and Lind, 1992). Being treated with an unfair procedure is an indication that one has low status and is given little respect. Hence, unfair procedures and their outcomes are negatively evaluated and may give rise to psychological stress.

The effect of procedural fairness on evaluations of noise has been investigated (Maris *et al.*, 2007a, 2004a, 2004b). In a laboratory experiment, participants are exposed to aircraft sound (50 vs 70 dB A) while they work at a reading task. The preceding sound management procedure is either fair (participants are given "voice" before they are exposed to the sound) or neutral (participants are simply told they will be exposed to the sound). "Within the 70 dB SPL condition, the fair procedure reduces the mean annoyance level to approximately the level in the 50 dB SPL condition. Up to 9% of variance in annoyance scores can be explained by the procedure manipulation" (Maris *et al.*, 2007a). The procedure effect is not found in the 50 dB SPL conditions. The study demonstrates that under laboratory conditions and with rather loud sound, a fair sound management procedure ameliorates noise annoyance. It does not answer the question whether an *unfair* procedure can cause a collective increase in annoyance.

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the concept of justice, how they react to situations that they regard as unjust, and under which circumstances, and why, people care about justice" (Mikula, 2001, pp. 8063–8064). Although it is very likely that substantial cultural differences exist with regard to which procedures people regard as just, the wish to be treated in a just way appears to be an anthropological universal (Montada, 2001).

The present study investigates whether a collective increase of noise annoyance can be due to procedural unfairness. In other words: Can a procedurally unfair interaction with the operators of the sound source cause excess noise annoyance? The present experiment largely replicates the earlier experiment by Maris *et al.* (2007a). Participants go through a noise management procedure before they are to perform a reading task while being exposed to annoying sound (played at 50 or 70 dB A). In the neutral procedure conditions participants are simply told that they will be exposed to aircraft sound. The unfair procedure is nontransparent as well as inconsistent: Participants are promised that they will be exposed to the sound type of their choice (nature, radio, or aircraft sound), which they, on the experimenter's request, have clearly indicated on a form. The experimenter reads the form and gives them aircraft sound without explaining why he or she does not follow the previously described procedure. No word of regret is given. [Giving participants a sincere apology or plausible explanation for the broken promise will give the unfair procedure a fair dimension (Bies and Shapiro, 1988). This is undesirable, as this fairness may exceed, or interact with, the unfairness of the broken promise. Alternatively, ambiguity is avoided because then the fairness of the interaction will lie entirely in the eye of the beholder rather than in the manipulation. Therefore, it is needed that the experimenter interacts in this slightly disrespectful manner.] Sound exposure levels and noise management procedures are varied systematically, and the dependent variables are assessed with a questionnaire. Data from participants who chose aircraft sound is excluded from the analyses.

The model used for the design of the study is a simplified version of the social psychological model of noise annoyance [Stallen, 1999; see Fig. 3.1; for a more detailed description of the experimental model see Maris *et al.* (2007)]. In the model, noise annoyance is represented as an expression of psychological stress, arising when the perceived level of disturbance due to the sound outgrows the perceived level of control over the sound ("internal processes"). People are expected to pay attention to the sound *and* to the sound management procedure; therefore both are included on the stimulus side of the model ("external processes"). The model further holds that the perceived disturbance is a function of the sound, and that the perceived control is a function of the perceived sound management. Whether or not noise annoyance arises depends on the perception and evaluation of the sound in combination with the sound management.

It is expected that acoustical as well as procedural aspects of the noise exposure situation will influence the level of noise annoyance in the experiment. Obviously, it is hypothesized that in the high sound pressure level (SPL) conditions the annoyance levels will be higher than in the low SPL conditions (Hypothesis 1). In addition, it is expected that systematic differences in the sound management procedure will yield systematic and collective differences in noise annoyance. Specifically, it is hypothesized that noise annoyance will be significantly higher in the unfair procedure conditions than in the neutral procedure conditions; that is: Excess annoyance will arise in the unfair procedure conditions (Hypothesis 2). The effects of procedural unfairness can be enhanced by negative outcomes or stress (Van den Bos *et al.*, 1998; Vermunt and Steensma, 2003). In the Maris *et al.* study (2007), a fair process effect was found only when the sound was loud (that is, when the outcome is negative). In the present experiment, it is expected that, to the participants in the unfair procedure conditions, the sound will be a negative outcome whether it is loud or not. Because participants have explicitly requested either nature or radio sound, receiving aircraft sound (of equal loudness) will be considered a negative outcome.

Therefore, an effect of procedural unfairness on noise annoyance is expected in the low SPL conditions *and* in the high SPL conditions (Hypothesis 3). No expectations are formulated regarding the relative strength of the procedure effects in the low and high SPL conditions. It is possible that the sound triggers a stronger procedure effect when it is both unwanted and loud (unfair, high SPL condition) than when it is unwanted but not loud (unfair, low SPL condition). It is also possible that the procedure effect is either triggered or not, and is always of the same strength.

Social psychological theories of justice offer instrumental and relational explanations for an effect of procedural unfairness on evaluations of sound (e.g., Lind *et al.*, 1990). It is explored whether instrumental or relational concerns mediate the procedure effect in the current study. It is hypothesized that if the effect of procedural unfairness on noise annoyance is mediated by instrumental concerns, the perceived control over the sound will mediate the procedure effect on noise annoyance (Hypothesis 4). Alternatively, if relational concerns mediate the procedure effect, the perceived regard of the experimenter to the participant will mediate the procedure effect (Hypothesis 5).

4.2 METHOD

4.2.1 Participants

One hundred and ten students, recruited from all departments of Universiteit Leiden, The Netherlands, are paid 5 Euro each to participate in the experiment, which lasts approximately 50 min. The participants are randomly assigned to each cell of the experimental design. Data from eight cases are excluded because these cases have indicated to have hearing problems. Data from another twelve cases are excluded from the analyses because these cases have chosen aircraft sound (see Sec. 2 D). Data from 90 students [74% female, mean age 21 years (s.d.=2.5)] are analyzed.

4.2.2 Experimental design

The experimental design is a 2 (procedure: neutral versus unfair) x 2 (sound pressure level (SPL): low (50 dB) versus high (70 dB)) complete factorial design.

4.2.3 Laboratory layout and stimulus material

The laboratory consists of four separate cubicles, each of which contains a desk and chair, and a complete PC set with two loudspeakers plus one subwoofer. In each session all participants are exposed to the same sound pressure level and procedure.

The three sound samples used in the introduction are (1) recordings of bird song taken from a CD (nature sound; Korenromp, 2000), (2) recordings of a radio broadcasting show including both music and speech (radio sound), and (3) the sound of an aircraft passage (aircraft sound; an excerpt from the experimental sample). All are played at approximately 60 dB A (1 min Leq).

The experimental sample is composed of self-recorded audio material of aircraft passages of various loudness and duration[18]. The experimental sample is played at either 50 dB A (15 min Leq) (low SPL condition) or 70 dB A (15 min Leq) (high SPL condition), which implies a sound level of quiet background noise in the low condition or of speech interfering loudness in the high condition. The maximal sound pressure level is 68 or 88 dB A Lmax, respectively. All sound pressure levels are measured in the cubicle at the position of the listener's ears.

The reading task (an English text with multiple choice questions, taken from a Dutch exam from pre-university education) is selected to match the cover story (see Sec. 2 D) and because it assures participants' motivation to perform well and closely matches their capacities. With too easy a task the experimental noise may not cause any disturbance and hence not induce annoyance. Too difficult a task may give rise to performance effects and task related frustration, which may cloud the effects of the procedure and/or the SPL manipulation (Smith, 1989).

4.2.4 Experimental procedure and manipulations

Upon their arrival at the laboratory, the experimenter leads the participants to their cubicle. After being seated, participants are left to themselves. Before starting to interact with the computer, participants read and sign an informed consent form, which informs them about their rights, among them the right to terminate their participation in the experiment at any moment. The computer is used for the presentation of the stimulus information and the recording of the dependent variables. (See Fig. 4.1 for a visual representation of the flow of the experiment.)

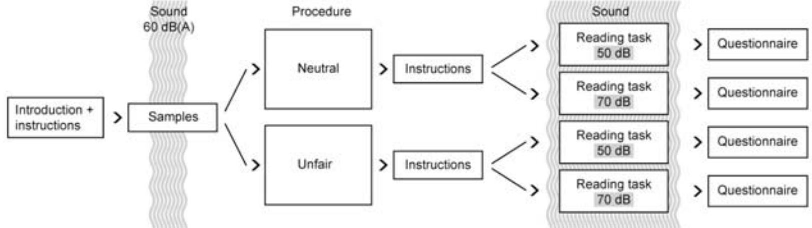

FIGURE 4.1. Visual tree representation of the flow of the experiment.

[18] The audio material is recorded outdoors, with clear weather conditions, on one location in the vicinity of a runway in use for landings only. A professional company has removed ambient sounds from the recordings by a professional company. The 15-min experimental sample is made up of 11 noise events of aircraft passages of various loudness, duration, and aircraft type. The quiet time between two passages (1 min, on average) is shorter than in real life and of variable duration.

As a cover story, participants are told that they are engaged in a study on potential performance effects of disturbing sound during high school exams. As an introduction to the interaction with the computer, a series of three short sound samples dispersed by short questions is presented to the participants. The samples are of birds singing, a radio show, and of an aircraft passage. In fact, this series of samples gives all participants the same frame of reference with regard to the loudness and pleasantness of sounds in the experimental situation, as well as sets the stage for the procedure manipulation.

In the *neutral procedure* conditions, after participants are informed that in the main experiment they will be listen-ing to a 15-min sample of aircraft sound, they are asked to evaluate the three introductory samples before starting the main experiment. “Imagine yourself reading a difficult text hearing one of the three sound types (nature, radio, aircraft) as a background sound. Which sound type would seem the least taxing to you? Please write down your motivated answer.” They write down their, often elaborate, answer on a paper “answering form.”

The computer interface is designed in such a way that the experiment can only continue after the experimenter has entered a password to select either natural, radio, or aircraft sound. The instructions tell the participant to open the door of their cubicle in order to signal to the experimenter that they are ready to proceed. The experimenter enters the cubicle, collects the paperwork (informed consent, and answering form), enters the password for aircraft sound, and says: “I have set the computer to aircraft sound.” The experimenter then leaves the participant to continue with the reading task.

In the *unfair procedure* conditions, participants are informed that in the main experiment they will be listening to a 15-min sample of their choice: nature, radio, or aircraft sound. Their choice is given significance by a remark that earlier research has indicated that participants who have been given the sound of their choice are far less tired after the experiment. Then, they are given the opportunity to indicate their preference: “Imagine yourself reading a difficult text hearing one of the three sound types (nature, radio, aircraft) as a background sound. Which sound type would seem the least taxing to you? Please write down your motivated choice.” They write down their, often elaborate, answer on a paper “choice form”, on which they also have to clearly visible circle the sample type of their choice.

The computer interface is designed in such a way that the experiment can only continue after the experimenter has entered a password to select either natural, radio, or aircraft sound. The instructions tell the participant to open the door of their cubicle in order to signal to the experimenter that they are ready to proceed. The experimenter enters the cubicle, collects the paperwork (informed consent, and choice form), has a look at the choice form, notices the indicated preference, and says “Oh yeah, your preference, well…” enters the password for aircraft sound, and says “I have set the computer to aircraft sound.” The experimenter does not give any explanation for not following the procedure, and leaves the (often protesting) participant to continue with the reading task.

In *all conditions*, participants then start working on the reading task and related questions while being exposed to the aircraft sound sample (played at either 50 or 70 dB A). The reading task and the sound are automatically terminated after 15 min (none of the participants have by then finished the task). The computer then presents the questionnaire, which assesses the dependent variables and the manipulation checks. After the participants have completed the questionnaire, they check with the experimenter who thoroughly debriefs them and pays them.

4.2.5 Measures

Manipulation checks

One question checks the perceived loudness of the experimental sound (“perceived loudness”): “If you were to give a grade for the average loudness of the aircraft sound, what grade would you give?” Participants respond by clicking on one out of ten virtual buttons, shaded from white to black (see Fig. 4.2). The intensity of the greyscale indicates the intensity of the sound, and the first and the last button are labelled verbally (white = “the softest sound I have ever heard,” black = “the loudest sound I have ever heard”). The scores are coded into numbers ranging from 1 (white) to 10 (black)[19]. The mean score on this measure [M(s.d.) =6.92 (1.77)] is significantly higher than the

[19]For the perceived loudness measure, a ten-point scale is used (deviant from the annoyance measure, which uses a seven-point scale) to prevent participants from ticking the exact same number on the annoyance measure and the perceived loudness measure, aiming to give a consistent (socially desirable) rather than a faithful answer. In earlier experiments the

scale's midpoint 5.5 [$t(89)=7.63$, $p<0.001$], which indicates that on average participants considered the sound to be loud.

FIGURE 4.2. The greyscale of the manipulation check for perceived loudness of the sound. Participants respond by clicking on one out of ten virtual buttons, shaded from white to black. The intensity of the greyscale indicates the intensity of the sound; the first and the last button are verbally labelled (white = "the softest sound I have ever heard," black= "the loudest sound I have ever heard").

One question checks the perceived procedural fairness ("perceived procedural fairness"): "In my opinion, the procedure used by the researcher to select the sound I got to listen to, is…" Verbal labels are given for the end points of the scale (1= "very unfair" to 7= "very fair."). The mean score on the scale is M(s.d.) = 4.04 (1.56).

Three explorative measures of task performance, to be used as a check for unintended performance effects, are automatically registered by the computer [(Time:" Time in seconds taken to read the first text and answer the first question, M(s.d.)=88.26 (40.04), 5% trimmed mean=86.03; "Correct:" Total number of correct answers, M(s.d.)=10.20 (3.64); "False:" Total number of false answers, M(s.d.) =4.19 (2.86)].

Dependent variables

The questionnaire includes three items that assess the participant's noise annoyance ("noise annoyance") with the experimental sound: (i) "To what extent did the sound annoy you while you were working at the task?," (ii) "How did you experience the aircraft sound while answering the exam questions?," (iii) "How pleasant did you feel the aircraft sound was while working on the exam?" Answers are given on a seven-point numerical rating scale, with verbal labels at the end points: (i) 1="not at all annoying," 7=" highly annoying," (ii) 1= "very positive," 7= "very negative," (iii) 1= "very pleasant," 7= "very unpleasant." A noise annoyance scale is constructed by averaging the scores on the three items (Cronbach's α =0.73). The mean noise annoyance score is 5.65 (s.d.=0.97). The Pearson's correlation between noise annoyance and the manipulation check perceived loudness is r = 0.38 ($p < 0.001$).

Instrumental concerns. One item assesses the participant's perceived control over the experimental sound: "During the task, to what extent did you feel to have (had) control over the sound you were being exposed to?" Answers to this "perceived control" item are given on a seven-point numerical rating scale, with verbal labels at the end points: 1 = "not at all" to 7= "to a great extent." The average score on the perceived control item is M=2.56 (s.d.=1.74).

Relational concerns. Two items assess the perceived regard of the experimenter to the participant: (i) "The experimenter made an effort not to tax me unnecessarily with the sound," and (ii) "In your opinion, how respectful have I, the researcher, treated you?" Answers are given on a seven-point numerical rating scale, with verbal labels at the end points: (i) 1= "totally disagree" to 7= "completely agree," and (ii) 1= "very disrespectful," 7= "very respectful." No relational concern scale is constructed because the two items share relatively little variance (r = 0.35; p < 0.001). The two items, (i) effort [M(s.d.)=3.87 (1.77)] and (ii) respect [M(s.d.)=5.10 (1.53)], are analyzed separately.

Finally, some general questions [e.g. gender, self-reported hearing impairments ("Do you have any hearing impairment?," response categories (i) "yes," (ii) "somewhat," (iii) "no")] are included. Participants who indicate to have (slight) hearing impairments (categories "yes:" N=0, and "somewhat:" N=8) are identified as having hearing impairments.

4.3 RESULTS

All analyses have been performed with and without the self-reported hearing impaired cases. The reported results are exclusive of the hearing impaired cases. Unless noted otherwise, the results

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exact same manipulation of sound pressure levels was applied (Maris et al., 2007, 2004). In these experiments, a numerical scale (ranging from 1 to 10) has been used. This numerical scale has indicated that the SPL manipulation induces very stable and strong differences in perceived loudness. In the current experiment, instead of a numerical scale, a discrete greyscale is used. It is expected that compared to numbers, visual intensity may be a more natural representation of auditory intensity.

are not notably different when the hearing impaired cases are included. By default, all reported significance levels are given for two-tailed tests with an alpha value of α =0.05. A statistical test for homogeneity of error variances is reported for all analyses of variance, because the experimental design is slightly unbalanced (since data from participants who chose aircraft sound is not included in the analyses). When error variances are nonhomogeneous, a more conservative statistic is reported in addition to the common *F*-statistic.

4.3.1 Manipulation checks

Perceived loudness

Analysis of variance (ANOVA) with perceived loudness as the dependent variable and sound pressure level (SPL) and procedure as the independent variables shows a main effect of SPL [$F(1,86)=55.05$, $p < 0.001$, $\eta^2=0.39$]. Levene's test for equality of error variances [$F(3,86)=5.03$, $p < 0.005$] indicates that equal variances between groups cannot be assumed. The more conservative Welch' variance-weighted ANOVA (one-way) indicates that significant differences between groups exist [$F(3,41.94)=20.40$, $p < 0.001$], and a post-hoc contrast test (equal variances not assumed) indicates that the mean loudness scores of the high SPL and low SPL conditions are significantly different [$t(51.96) = -6.92$, $p < 0.001$]. The aircraft sound in the high sound conditions is perceived to be significantly louder [*M*(s.d.)=8.00 (1.17) than in the low sound conditions *M*(s.d.)=5.80 (1.58)], indicating that the SPL manipulation was successful. No other significant effects are found [procedure: $F(1,86)=0.26$, n.s.; SPL * procedure: $F(1,86)=0.05$, n.s.], which indicates that the procedure manipulation did not influence perceived loudness.

Perceived procedural fairness

ANOVA with perceived procedural fairness as the dependent variable and SPL and procedure as the independent variables indicates that the unfair procedure [*M*(s.d.) =3.56 (1.64) is perceived to be significantly less fair than the neutral procedure (*M*(s.d.)=4.71 (1.18); $F(86)=13.41$, $p < 0.001$, $\eta^2 = 0.14$); equal error variances can be assumed: Levene's $F(3,86)=1.76$, $p=0.16$, n.s.]. The deviation from the neutral score (4) is significant for the neutral condition [$t(37)=3.70$, $p < 0.01$] and marginally significant for the unfair condition [$t(51) = -1.95$, $p = 0.06$]. Strictly, the unfair procedure is not unfair in an absolute sense, but relative to the neutral condition it is significantly less fair. It is concluded that the procedure manipulation has been successful.

The main effect of SPL on perceived procedural fairness [$F(1.86)=4.06$, $p < 0.05$, $\eta^2 = 0.05$] indicates that the perceived fairness of the procedure is influenced by the sound pressure level. In the high sound condition the procedure is evaluated as more fair [*M*(s.d.)=4.35 (1.70)] than in the low sound condition [*M*(s.d.)=3.73 (1.35)]. No interaction of SPL and procedure on perceived procedural fairness is found [SPL * procedure: $F(1,86)=0.87$, n.s.].

Performance measures

Multivariate analysis of variance with the performance measures time, correct, and false as the dependent variables and SPL and procedure as the independent variables is performed to check for unintended performance effects, and shows no significant multivariate effects [SPL: $F(3,84) = 0.20$, n.s.; procedure: $F(3,84)=0.46$, n.s.; SPL * procedure: $F(3,84)=0.46$, n.s.; equal error variances can be assumed: Box's $M=14.24$, $F(18, 21118.37)=0.74$, $p=0.77$, n.s.]. The manipulations have not induced differences in performance.

4.3.2 Dependent variables

ANOVA with noise annoyance as the dependent variable and SPL and procedure as the independent variables is performed to test Hypotheses 1–3. Marginal means and cell means are summarized in Table 4.I. The effects are described in the remainder of this section. Correlations between the dependent and independent variables are given in Table 4.II.

It has been hypothesized that higher sound levels will result in higher noise annoyance levels (Hypothesis 1). The ANOVA shows a significant main effect of SPL on noise annoyance, indicating that participants who have been exposed to high sound are more annoyed than those receiving low sound [$F(1,86)=9.94$, $p < 0.01$, $\eta^2=0.10$; equal error variances can be assumed: Levene's $F(3,86)=1.93$, $p = 0.13$, n.s.; see Table 4.I for marginal means]. This finding confirms Hypothesis 1: The high sound level induces higher noise annoyance levels than the low sound level.

In the ANOVA, the main effect of procedure on noise annoyance [$F(1,86)=5.32$, $p < 0.05$, $\eta^2=0.06$] shows that participants who have been confronted with a broken promise with regard to their noise exposure (unfair procedure), report more noise annoyance [*M*(s.d.)=5.85 (0.91)] than those who have simply been told they will be hearing aircraft sound (neutral procedure) [*M*(s.d.)=5.41 (1.01)]. This finding confirms Hypothesis 2: The unfair procedure yields higher noise annoyance levels than the neutral procedure.

TABLE 4. I. Noise annoyance scores (1= "not annoyed at all," 7= "highly annoyed") arranged by conditions of sound pressure level (SPL: low or high) and procedure (neutral or unfair). Cell means and marginal means (*M*), standard deviations (S.D.), and number of cases per cell (*N*) are given.

SPL	Procedure	*M*	*SD*	*N*
Low	Neutral	5.07	1.12	18
50 dB	Unfair	5.55	0.91	26
	Total Low	5.34	1.02	44
High	Neutral	5.72	0.83	20
70 dB	Unfair	6.14	0.83	26
	Total High	5.96	0.85	46
Total	Neutral	5.41	1.01	38
	Unfair	5.85	0.91	52
	Total	5.66	0.97	90

TABLE 4.II. Pearson's correlations and point-biserial correlations between the dependent variables and the independent variables. Procedure and sound pressure level (SPL) are dichotomous variables (procedure: 1=neutral, 2=unfair; SPL: 1=50 dB, 2=70 dB).

N =90	SPL	Noise Annoyance	Perceived Control	Effort	Respect
Procedure	-0.03	0.22 *	-0.09	-0.32 **	-0.52 ***
SPL		0.31 **	-0.06	-0.31 **	0.12
Annoyance			-0.10	-0.25 *	-0.16
P. Control				0.23 *	0.09
Effort					0.35 ***

* correlation is significant at the 0.05 level (2-tailed)
** correlation is significant at the 0.01 level (2-tailed)
*** correlation is significant at the 0.001 level (2-tailed)

No interaction effect of procedure by SPL on noise annoyance is found [$F(1,86)=0.02$, $p = 0.89$, n.s.]. The effect of procedure on noise annoyance is found for the participants who have been exposed to 50 dB as well as for those who have been exposed to 70 dB, which confirms Hypothesis 3. The absence of an interaction effect also indicates that the procedure effect has the same strength in both SPL conditions. The effects of procedure and SPL on noise annoyance are additive and independent. The effect sizes of the two effects indicate that the effect of SPL is somewhat stronger than that of procedure. The proportion of variance in annoyance scores uniquely explained by SPL is 10%, for procedure this proportion is 6%.

The effect of the SPL and procedure manipulations on the variables perceived control, effort, and respect, the proposed mediators of the procedure effect, is investigated with three separate ANOVAs (the results are reported in Table 4.III). For the actual mediation analyses, the indirect effects are estimated with a bootstrapping method (Shrout and Bolger, 2002) using the SPPS-macro provided by Preacher and Hayes (2004). This approach to mediation analysis is stated to be more accurate than traditional mediation analysis approaches (e.g., MacKinnon *et al.*, 2007). The SPSS-macro provides an estimate of the true indirect effect and its bias-corrected 95% confidence interval. In addition, the SPSS-macro generates the necessary output to assess the mediation using the traditional Baron and Kenny (1986) criteria, as well as a Sobel test of the observed indirect effect (Sobel, 1982). (The output of the mediation analyses is given in Table 4.IV.)

TABLE 4.III. Perceived control, effort, and respect scores (higher scores indicate higher perceived control, effort, respect) arranged by conditions of sound pressure level (SPL: low or high) and procedure (neutral or unfair). Cell means and marginal means (*M*), standard deviations (s.d.), and number of cases per cell (*N*) are given.

Potential mediator variable	SPL	Procedure	*M*	SD	*N*
Perceived	Low	Neutral	2.72	1.90	18
Control	50 dB	Unfair	2.62	1.65	26
		Total Low	2.66	1.74	44
	High	Neutral	2.75	2.02	20
	70 dB	Unfair	2.23	1.51	26
		Total High	2.46	1.75	46
	Total	Neutral	2.74	1.94	38
		Unfair	2.42	1.58	52
		Total	2.56	1.74	90
Effort	Low	Neutral	5.17	1.15	18
	50 dB	Unfair	3.92	1.74	26
		Total Low	4.43	1.63	44
	High	Neutral	3.95	1.50	20
	70 dB	Unfair	2.85	1.78	26
		Total High	3.33	1.74	46
	Total	Neutral	4.53	1.47	38
		Unfair	3.39	1.83	52
		Total	3.87	1.77	90
Respect	Low	Neutral	5.72	1.02	18
	50 dB	Unfair	4.35	1.41	26
		Total Low	4.91	1.43	44
	High	Neutral	6.30	0.80	20
	70 dB	Unfair	4.50	1.66	26
		Total High	5.28	1.62	46
	Total	Neutral	6.03	0.94	38
		Unfair	4.42	1.53	52
		Total	5.10	1.53	90

ANOVA with perceived control as the dependent variable and SPL and procedure as the independent variables indicates that the manipulations have not induced group differences in perceived control [SPL: $F(1,86)=0.23$, $p=0.64$, n.s.; procedure: $F(1,86)=0.70$, $p=0.41$, n.s.; SPL * procedure: $F(1,86)=0.30$, $p=0.58$, n.s.; equal error variances can be assumed: Levene's $F(3,86) =1.33$, $p=0.27$, n.s.; for cell means, see Table 4.III]. The Baron and Kenny (1986) criteria indicate no indirect effect of procedure on noise annoyance through perceived control. The total effect of the procedure on noise annoyance [indicated as $b(YX)$ in Table 4.IV] is statistically significant ($p < 0.05$). However, neither the effect of the procedure on perceived control [indicated as $b(MX)$ in Table 4.IV, $p = 0.40$, n.s.] nor the effect of perceived control on noise annoyance, controlling for the effect of procedure [indicated as $b(YM.X)$ in Table 4.IV, $p=0.45$, n.s.] are significant. The Sobel test of the indirect effect is highly insignificant ($p=0.67$, n.s.). The bootstrapped estimation of the true indirect effect of procedure on noise annoyance through perceived control is 0.01 [95% confidence interval (CI): −0.04 to 0.10; n.s.]. Hypothesis 4 that perceived control mediates the effect of procedure on noise annoyance is rejected. There is no indication that instrumental concerns explain the effect of procedural unfairness on noise annoyance.

ANOVA with effort as the dependent variable and SPL and procedure as the independent variables indicates that group differences in effort are induced by SPL as well as by procedure [SPL: $F(1,86)=11.23$, $p < 0.002$, $\eta^2=0.12$; procedure: $F(1,86)=11.77$, $p < 0.002$, $\eta^2 = 0.12$; SPL * procedure: $F(1,86)=0.04$, $p=0.84$, n.s.; equal error variances can be assumed: Levene's $F(3,86)=1.30$, $p=0.28$, n.s.]. The perceived effort made by the experimenter not to tax the participants unnecessarily is lower in the high SPL conditions than in the low SPL conditions [M(s.d.)high=3.33 (1.74) vs M(s.d.)low=4.43 (1.63)], and lower in the unfair procedure conditions than in the neutral procedure conditions [M(s.d.)unfair = 3.39 (1.83) vs M(s.d.)neutral = 4.53 (1.47); for cell means, see Table 4.III]. The Baron and Kenny (1986) criteria indicate an indirect effect of procedure on noise annoyance through effort. In addition to the significant effect $b(YX)$, both the effect of the procedure on effort [$b(MX)$, $p < 0.01$], and the effect of effort on noise annoyance, controlling for the effect of procedure [$b(YM.X)$, $p = 0.07$, one-tailed test: $p < 0.05$], are significant. Finally, the direct effect of procedure on noise annoyance, controlling for effort [indicated as $b(YX.M)$ in Table 4.IV; p=0.15] is reduced relative to the direct effect $b(YX)$. However, the Sobel test of the indirect effect of procedure on noise annoyance through effort is not significant (p=0.12). The bootstrapped estimation of the true indirect effect is 0.13, but it is only marginally significant from zero (95% CI: −0.01 to 0.32, $p > 0.05$; 90% CI: 0.004 to 0.29, $p < 0.10$). It is concluded that the indirect effect of procedure on noise annoyance through effort is not significant at $p < 0.05$.

TABLE 4. IV. Output of the SPSS procedure (Preacher and Hayes, 2004) for estimating the indirect effect of procedure on noise annoyance through the respective proposed mediators perceived control, effort, and respect. The results are organized by proposed mediator variable. For the observed direct and total effects among the independent (*X*), the dependent (*Y*), and the mediator variable (*M*), the *B* coefficients (*B* coeff) and standard error (s.e.), *t*-statistic, and two-tailed *p* values are given. For the indirect effect of the independent on the dependent through the mediator, a Sobel significance test for the observed indirect effect, and a bootstrap estimation and confidence intervals of the true mean are given. The sample consists of 90 records. For each bootstrap estimation 3000 resamples are taken.

Proposed Mediator Variable	Statistics for direct, total, and indirect effects between Procedure (X), Noise Annoyance (Y), and proposed mediator variable (M)				
Perceived Control	*Direct and total effects*				
	Effect	B-coeff.	s.e.	*t*	*p*
	b(YX)	0.43	0.20	2.13	0.04
	b(MX)	-0.31	0.37	-0.85	0.40
	b(YM.X)	-0.04	0.06	-0.76	0.45
	b(YX.M)	0.42	0.21	2.05	0.04
	Indirect effect and significance using normal distribution				
		value	s.e.	z	*p*
	Sobel	0.01	0.03	0.42	0.67
	Bootstrap results for indirect effect				
		mean	s.e.	LL95%CI	UL95%CI
	effect	0.01	0.03	-0.04	0.10
Effort	*Direct and total effects*				
	Effect	B-coeff.	s.e.	*t*	*p*
	b(YX)	0.43	0.20	2.13	0.04
	b(MX)	-1.14	0.36	-3.18	0.00
	b(YM.X)	-0.11	0.06	-1.85	0.07
	b(YX.M)	0.31	0.21	1.45	0.15
	Indirect effect and significance using normal distribution				
		value	s.e.	z	*p*
	Sobel	0.13	0.08	1.54	0.12
	Bootstrap results for indirect effect				
		mean	s.e.	LL95%CI	UL95%CI
	effect	0.13	0.09	-0.01	0.32

To be continued...

TABLE 4. IV. Continued.

Proposed Mediator Variable	Statistics for direct, total, and indirect effects between Procedure (X), Noise Annoyance (Y), and proposed mediator variable (M)				
Respect	*Direct and total effects*				
	Effect	B-coeff.	s.e.	*t*	*p*
	b(YX)	0.43	0.20	2.13	0.04
	b(MX)	-1.60	0.28	-5.72	0.00
	b(YM.X)	-0.04	0.08	-0.48	0.63
	b(YX.M)	0.37	0.24	1.56	0.12
	Indirect effect and significance using normal distribution				
		value	s.e.	z	*p*
	Sobel	0.06	0.13	0.47	0.64
	Bootstrap results for indirect effect				
		mean	s.e.	LL95%CI	UL95%CI
	effect	0.06	0.13	-0.20	0.32

ANOVA with respect as the dependent variable and SPL and procedure as the independent variables indicates that group differences in respect are induced only by procedure [SPL: $F(1,86)=1.70$, $p=0.20$, n.s.; procedure: $F(1,86)=32.08$, $p < 0.001$, $\eta^2=0.27$; SPL * procedure: $F(1,86)=0.57$, $p=0.45$, n.s.; due to unequal error variances with the higher error variance in the groups with a larger N, the F statistic is more conservative [Levene's $F(3,86)=4.01$, $p < 0.02$]. The perceived respectfulness of the treatment by the experimenter is lower in the unfair procedure conditions than in the neutral procedure conditions [M(s.d.)unfair=4.42 (1.53) vs M(s.d.)neutral = 6.03 (0.94); for cell means, see Table 4.III]. In none of the conditions, the treatment by the experimenter is perceived to be disrespectful. The Baron and Kenny (1986) criteria indicate no indirect effect of procedure on noise annoyance through respect. The effect $b(YX)$, and the effect of the procedure on respect [$b(MX)$, $p < 0.01$, see Table 4.IV] are significant, but the effect of respect on noise annoyance, controlling for the effect of procedure [$b(YM.X)$, $p = 0.63$, n.s.] is not significant. The Sobel test of the indirect effect of procedure on noise annoyance through respect is insignificant, too ($p=0.64$, n.s.). The bootstrapped estimation of the true indirect effect is 0.06, but it is highly insignificant (95% CI: −0.20 to 0.32; n.s.).

Hypothesis 5, which holds that relational concerns mediate the effect of procedure on noise annoyance, has not been tested with the intended scale for relational concerns. Instead, two separate analyzes have been used to test the indirect effect of procedure on noise annoyance through the two individual items (effort and respect). Both analyses have failed to find a significant indirect effect. Considering the results of these two mediation analyses, hypothesis 5 is rejected.

4.4 CONCLUSIONS

In the present paper, a social psychological approach to noise annoyance, rooted in theory, is proposed and experimentally tested. The core idea is that any sound is indissolubly associated with its source and that therefore being exposed to man-made sound is a social experience. A person's evaluation of the sound is affected by the social process between themselve(s) and the operator(s) of the source. The results from the laboratory experiment confirm that the unfairness of the sound management procedure influences the evaluation of the sound. Relative to a neutral sound management procedure, an unfair procedure is found to yield collective excess annoyance. Defining exposure to manmade sound as a social experience furthers the theoretical understanding of noise annoyance, which may well inspire new approaches to the abatement and prevention of noise annoyance.

The current results indicate that both the sound pressure level and the unfairness of the sound management procedure affect noise annoyance. The two effects are independent and additive. In the earlier studies on procedural fairness and noise annoyance (Maris *et al.*, 2007; 2004) the procedure effect interacted with the sound pressure level. For the current experiment, no expectation has been formulated regarding an interaction effect of SPL and procedure. It is found that the procedure effect has the same strength in both SPL conditions. The sound has not triggered a stronger procedure effect when it is both unwanted and loud (unfair, high SPL condition) than when it is unwanted but not loud (unfair, low SPL condition). What explains the absence of an interaction effect in the present study? One explanation is that outcome negativity is a dichotomous rather than a continuous variable:

An outcome is then perceived to be either negative or not, and hence no intensities of negativity are discerned. An-other explanation is that the increase (or decrease) of noise annoyance due to a procedure effect is limited to about half a scale point. It is most likely, however, that due to a ceiling effect in the unfair-high SPL conditions no increased procedure effect has been found. The average annoyance score in the unfair-high SPL condition [M(s.d.)= 6.14 (0.83)] indicates that most participants already scored either 6 or 7 on the seven-point scale.

Some issues of validity need to be addressed. With regard to the fairness manipulation, it appears to be difficult to create a truly unfair procedure in a lab situation. Although the unfair procedure is significantly less fair than the neutral procedure, in an absolute sense the unfair procedure is perceived to be only marginally unfair. Possibly, in an experimental setting, the participants expect not to receive voice, causing its absence not to be felt as a salient violation of an (implicit) fairness norm. Given the significant effect of the procedure on noise annoyance it can be argued that it is the level of (un)fairness relative to a collective norm, and not so much the exact point on the fair—unfair continuum, that matters. Further research is needed to study the effect of strongly unfair procedures, as well as the effects of other procedural fairness criteria on noise annoyance.

The manipulation check for the perceived fairness of the procedure indicates that the sound pressure level of the aircraft sound has influenced the perceived fairness of the sound management procedure. When participants have listened to the 70 dB sample, they perceive the procedure to be fairer than the participants who have listened to the 50 dB sample. Since higher procedural fairness is associated with lower noise annoyance levels, this effect can have reduced the strength of the annoying effect of the SPL manipulation. The effect of SPL on the perceived fairness of the procedure is no alternative explanation for the effect of the procedure manipulation on noise annoyance.

Third, in the laboratory the interpersonal distance between the exposed and the operators of the source is relatively small. One may wonder whether effects of social processes on evaluations of noise can be replicated when the interpersonal distance between the exposed and the operators of the source is big (as is often the case in field settings), or when a real person to interact with is lacking altogether (e.g., when the noise source is an institution). There is, however, evidence that people have a strong tendency to attribute social meaning to situations. For instance, research has shown that most people spontaneously and effortlessly ascribe motivations, intentions, and interactive behaviors to geometrical shapes moving about in a silent cartoon animation (e.g., the shapes are said to chase each other, or play, and to get frightened or elated) (e.g., Heider and Simmel, 1944; Klin, 2000). Other studies have shown that it is common for users of mass media to form so-called parasocial relationships with media figures (like celebrities, but also cartoon characters, or even magazines), in which the user responds behaviorally and cognitively to the media figure as though in a typical social relationship (e.g., Giles, 2002; Horton and Wohl, 1956; Cohen, 2004). Open interviews with people annoyed by the sound of wind turbines in Sweden illustrate that people perceive some kind of social relationship with the owner of the wind turbine, and perceive its annoying sound as a violation of social norms (Pedersen, *et al.*, 2004). In sum, it is important to consider the difference between laboratory and field setting but it seems warranted to make careful generalizations from the current results to field settings.

With regard to the quality of the sound manipulation, some remarks need to be made. The recording and play back of the sound will not have created an optimal soundscape. Still, it is not likely that sound quality issues endanger the conclusions drawn from the data. The sound quality has been identical for all participants, ruling out the possibility that the effects found are due to artefacts of sound quality differences. In addition, research has indicated that the cognitive responses to “source events” (as opposed to “background sound” where the source is not easily identifiable) are rather robust to changes in sound reproduction method (Guastavino *et al.*, 2005). The current authors have no reason to expect that the effect of procedural fairness on noise annoyance found in the experiment will be an artefact due to the quality of the sound reproduction.

A surprising number of participants have indicated not to dislike aircraft sound. (In total 10.9% of the participants choose aircraft sound, against 13.6% radio sound and 75.5% nature sound.) A preliminary exploration of the arguments participants give for choosing aircraft sound indicates that they are used to hearing aircraft sound in their home situation, or they expect that its presumed monotony will not distract them as much as the spoken words audible in the radio sample or the twittering bird song in the nature sample.

Based on the results of the explorative mediation analyses, it cannot be concluded whether instrumental or relational concerns mediate the effect of procedural fairness on noise annoyance. Some remarks can be made. The proposed mediation by instrumental concerns is not confirmed by the data. The perceived control scores indicate that participants in general experienced very little control over the sound, and that neither of the manipulations has induced differences in perceived control. Given the fact that many studies have demonstrated an influence of perceived control on evaluations of noise (e.g., Glass and Singer, 1972), it seems advisable not to discard perceived control as a mediator of procedure effects too aptly. To investigate whether procedure effects on noise annoyance can be mediated by instrumental concerns, future studies need to apply manipulations of procedural fairness designed to induce differences in perceived control, and assess perceived control in a more advanced way.

The explorative analysis of mediation of the procedure effect on noise annoyance by relational concerns has yielded mixed results. First, the two items intended to assess the regard of the experimenter (effort and respect) appear not to tap one and the same concept. The procedure manipulation has induced strong differences in perceived respect, but those differences do not translate into differences in noise annoyance. The procedure-induced differences in effort, on the other hand, are considered a mediator of the procedure effect on noise annoyance according to the Baron and Kenny (1986) criteria. Even though the indirect effect of procedure on noise annoyance through effort is only marginally significant, it seems premature to discard relational concerns as a mediator of procedure effects on noise annoyance. Future research is needed to construct a reliable and valid relational concern scale.

Noise annoyance is not solely a function of the characteristics of the acoustic stimulus. In the experiment, the fairness of the sound management procedure is an important determinant of noise annoyance besides the sound pressure level. Therefore, instead of marginalizing deflections from the dosage-response curve as “response bias,” such deflections need to be recognized as a key to a better understanding of the psychology of noise annoyance that can be a guide toward innovative abatement strategies. As a practical consequence, inventories and action plans aiming at the prevention or abatement of noise annoyance need to search for and address the social processes that influence the sound evaluation [for practical suggestions, see Fields *et al.* (2000)]. It is important to know whom people perceive to be the operators of the source, how the sound management procedures are evaluated, and according to which criteria. Social psychological theories of justice offer a range of procedural fairness criteria that may be of practical use. There will be cultural differences with regard to which type of procedure people regard as just, but the wish to be treated justly seems to be universal (Montada, 2001). Unsound management is best avoided.

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CHAPTER 5 **Combining the Results**

(Un)Sound Management, a co-determinant of annoyance[20]

5.1 INTRODUCTION

5.1.1 The central aim of this thesis

In the introductory chapter of this thesis, I have posed the statement that annoyance with man-made sound is the response to a social experience. The central aim of this thesis is to test this ‘social hypothesis of noise annoyance’ by showing that the social process between the person(s) operating the sound source and the person(s) being exposed to the sound influences the latter’s evaluation of the sound. In social scientific research, the perspective taken on noise annoyance commonly is psychological rather than social. Even though psychological models of annoyance may address attitudes about the social process (e.g., perceived misfeasance), the social process itself is not represented, and can therefore not be subject of study. In this way, possibly relevant information is easily overlooked, both in theory and in practice. The chapters following the introduction have described a series of experiments in which a social psychological model has been applied to study the presumed social side of sound. In this concluding chapter, I will integrate and discuss the experimental results, with regard to the central aim of the study.

5.1.2 What has been done?

Based on the social psychological model of noise annoyance (Stallen, 1999) and social psychological theories of procedural justice (e.g., Lind and Tyler, 1988; Greenberg, 1993; Thibaut and Walker, 1975), I have developed an experimental design to study the presumed causal relationship between the fairness of the sound management procedure and noise annoyance. Chapter 2 describes the pilot carried out to refine the experimental design.

The design is as follows: participants are asked to perform on a linguistic task while they are exposed to disturbing sound (of either 50 or 70 dB A (15 min Leq) sound pressure level). The experimenter manages the sound exposure in a fair, or less fair, manner. For instance: in the fair procedure conditions, participants are asked to ‘voice’ their preference for a certain sound type, while in the neutral procedure conditions they are not. Noise annoyance with this sound is assessed after 15 minutes of sound exposure. (In the pilot study, as an exception, annoyance is assessed after one minute of exposure, too).

Chapter 3 describes the ‘Fair experiment’, a refined replication of the pilot study. In this experiment, the effects of a fair and a neutral procedure on noise annoyance are contrasted. The main result shows that the fair procedure reduces noise annoyance relative to a neutral procedure when the sound pressure level (SPL) is high (70 dB), but not when SPL is low (50 dB).

Chapter 4 describes the ‘Unfair experiment’. It investigates the effect of unfair sound management on noise annoyance, relative to a neutral procedure. The main finding shows that the unfair procedure increases noise annoyance relative to a neutral procedure for both sound pressure levels (70 dB, as well as 50 dB).

In Chapter 5, the current chapter, firstly, I will bring together the findings of both experiments, and to a lesser extent the pilot study, and will integrate and discuss the results. I will draw conclusions with regard to the central hypothesis and aim of the thesis. Where relevant questions remain unanswered by the data, I will make theory-based speculations about potential answers. Next, additional results of the series of studies will be described. The meaning of the results, in the light of both the social psychological model of noise annoyance and the theory field of procedural justice, is subject of discussion. In conclusion, the strengths and limitations of the studies are considered, as well as the extent to which generalizations from the experimental findings to field settings can be made.

[20] Earlier versions of this chapter have been published: Maris, E., Stallen, P.J., Steensma, H., & Vermunt, R. (2006) *(Un)Sound management. Three laboratory experiments on the effects of social nonacoustical determinants of noise annoyance,* Paper presented at the 35th. International Congress and Exposition on Noise Control Engineering (Inter-Noise), December 3-6, Honolulu, Hawaii, USA; and Maris, E. Stallen, P.J., Steensma, H. & Vermunt, R. (2007). Geluidhinder: Decibels of onrechtvaardige procedures? De bijdrage van Social (in)Justice Theory aan de verklaring van geluidhinder, *Gedrag & Organisatie,* 20(4), pp. 445 – 460.

Some suggestions for further research on the social side of sound are given, and implications for practice of the current results are indicated.

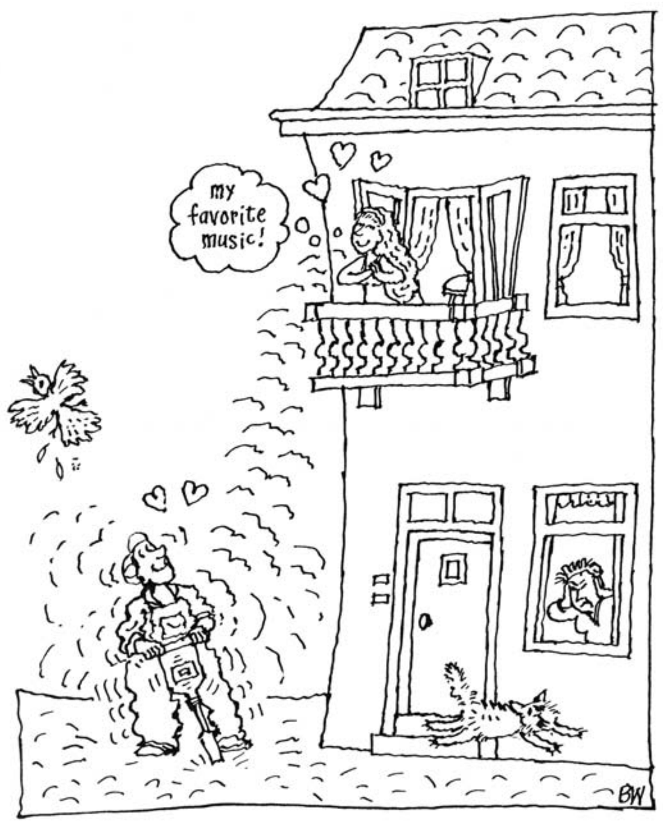

FIGURE 5.1 The social side of the evaluation of sound.

5.2 THE MAIN RESULT

5.2.1 Exposure to man-made sound a social experience?

In both experiments, the manipulated differences in procedural (un)fairness have induced predictable differences in the level of noise annoyance expressed by the participants (relative to the neutral procedure). This implies that the way the participants thought, felt and behaved in response to the sound has been influenced by the fairness manipulation. This finding is a strong indication that exposure to man-made sound is a social experience, but a few critical questions need answering.

Does a procedure trigger the ‘real or imagined presence of another person’? All of the participants had, upon their arrival in the laboratory, been shown to their cubicle by the experimenter. Once the experiment had started, imaginative interaction continued through the computer interface. In the Unfair experiment, the experimenter even entered the cubicle halfway the experiment to select the sound type. Moreover, taking part in an experiment does not make much sense without assuming the existence of a person awaiting the data. It is very unlikely that any of the participants doubted the presence of the experimenter.

Can we be sure that it was the experimenter’s *presence*, real or imagined, that influenced the level of noise annoyance of the participants? This almost philosophical question is more difficult to answer. Effects of procedural and distributive fairness are considered social effects in the social psychological justice literature. Many, but not all of the items used to assess fairness judgments include a reference to a second party, or an activity that suggests the presence of a second party (Lind and Tyler, 1988, see Appendix, pp 243-247). In the current experiments, items measuring cognitions concerning the experimenter’s efforts not to tax the participant, or their respect towards the participant strongly correlate with the fairness manipulation and its perceived fairness. Even though exploratory mediation analysis (Unfair experiment) shows but a marginal mediation of the procedure effect by cognitions about the experimenter, the surprisingly constant average annoyance scores in the neutral procedure conditions suggests that non-social variations in the procedure do not translate into differences in annoyance. These findings sustain the social psychological definition of procedural fairness effects being *social* effects.

5.2.2 Social hypothesis confirmed

Considering the results of the experiments, it is concluded that being exposed to man-made sound is a social experience. The social hypothesis of noise annoyance has been confirmed: Annoyance with man-made sound is a response to a social experience. Noise annoyance is an evaluation of the sound *exposure situation*, which is considered explicitly as an interactive or social event.

5.3 ADDITIONAL RESULTS AND DISCUSSION

5.3.1 The dynamic pattern of the procedural (un)fairness effect

The dynamic pattern of the effect of the management procedure on noise annoyance differs between the Fair and the Unfair experiment. (For the readers' convenience, the results of the two experiments are shown side by side in Figure 5.2.) The effect of procedural *fairness interacts* with the effect of sound pressure level on noise annoyance, but the effect of procedural *unfairness is independent* of SPL. This may indicate that different mechanisms are at work in the Fair and Unfair experiment, and it makes curious what these mechanisms could be. The interactive result pattern suggests moderation, either of the procedure effect by the SPL, or of the SPL effect by procedure. The independent main effect of procedural unfairness suggests two direct relationships, between on the one hand side SPL and procedure, and on the other hand noise annoyance.

In the following section, to begin with, available theoretical explanations for an *interaction effect* of procedure on annoyance are discussed. Secondly, available theoretical explanations for an *independent main effect* of procedure on annoyance are discussed. Subsequently, the possibilities for integrating explanations, such that both dynamic patterns can be explained, will be explored.

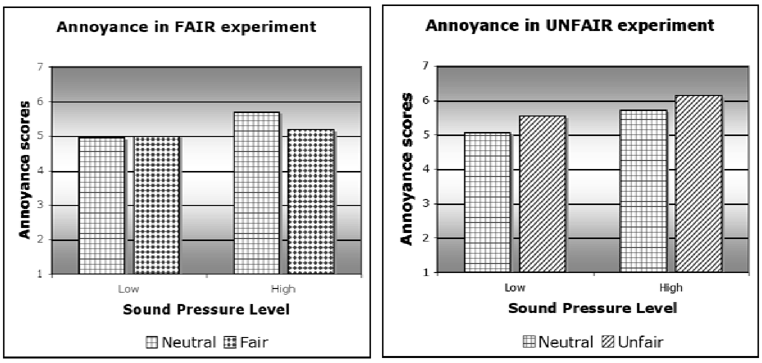

FIGURE 5.2. Noise annoyance after fifteen minutes of exposure. The left hand figure (Fair experiment, Chapter 3) shows a significant main effect of SPL and a significant interaction of SPL by procedure, the right hand figure (Unfair experiment, Chapter 4) shows two significant and independent main effects: one of SPL and one of procedure.

Interaction effect

The fair procedure decreases the level of noise annoyance in the 70 dB but not in the 50 dB SPL conditions (Fair experiment, Chapter 3). This interaction effect is in line with predictions. In this section, explanations for this interaction from two different theory fields will be discussed. The discussion starts with cognitive theory of stress and coping, continues with a social justice perspective, and ends with a comparison of both explanations.

Explanation: the Cognitive Theory of Stress and Coping

According to the cognitive theory of stress and coping, a person experiences psychological stress when the threat value of a situation exceeds its available coping resources, which include physical, social, psychological, and material assets. The 'primary appraisal' of the threat value of a situation precedes the conditional 'secondary appraisal' of available coping resources. Only when a sense of threat to well-being is appraised, coping resources are considered. In other words, if no threat is encountered in the primary appraisal, coping resources do not have an effect on psychological stress (Folkman, 1984). By deduction, it is predicted that the stress-inducing effect of the appraised threat interacts with the stress-reducing effect of the coping resource. The link between this theory and the current research topic has been argued in Chapter 3: annoyance can be regarded an expression of psychological stress, and a fair procedure is regarded a (social) coping resource.

The interaction found in the Fair experiment can be explained by assuming that in the 50dB conditions no secondary appraisal has been triggered. Apparently, the threat value of 50 dB (primary appraisal) is too low to trigger secondary appraisal. In the 50 dB conditions, the fair management procedure, a social coping resource, is not taken into account, and hence it has no effect. The primary appraisal of the threat value of the 70 dB sound triggers the secondary appraisal of coping resources. Once the fair procedure is appraised, it can have its stress-reducing effect (relative to the neutral procedure), and thus decreases the level of noise annoyance.

Explanation from a Social Justice perspective

Explanations for interaction effects in social justice literature are much in line with the explanation above: they stem from the same idea that the effect of procedural fairness is triggered by a sense of threat. Although generally independent main effects of procedural fairness on outcome evaluation are reported (e.g., Lind and Tyler, 1988), research has shown interactions of fairness dimensions (e.g., distributive, procedural, interpersonal and informational). Sometimes, procedures have an effect only when outcomes are unfair. One study reports an interaction of the fair process effect and distributive fairness: the fair process effect is far stronger when the distribution of outcomes is unfair (Tepper, 2001). Based on the cognitive theory for stress and coping, Tepper argues that the unfair distribution of outcomes is perceived as a threat during primary appraisal, which triggers secondary appraisal of coping resources, i.e., the fair procedure. Vermunt and Steensma (2001, 2003, 2005) have theorized and shown that fair procedures can reduce stress. They conclude that a fair treatment reduces the threat value of an event, for instance by providing options for control. The effect of procedural fairness has also been found to be stronger when a person is actually experiencing stress (Vermunt and Steensma, 2003), or when they have been thinking about threatening things (Miedema, 2003, 2006).

An interesting question raised by Tepper's (2001) explanation is whether in the Fair experiment the 70 dB SPL may have triggered secondary appraisal because it has been perceived as an unfair outcome. However, the distribution of SPL is not likely perceived as unfair relative to other participants, because all participants within each time slot have been exposed to the same SPL. Nevertheless, the outcome can have been perceived as unfair relative to the bogus hearing test of 60 dB, somewhat earlier during the experiment. No assessment has been made of the perceived fairness of the outcome. From the current data, it cannot be derived whether the fair process effect in the Fair experiment has been moderated either the *loudness* of 70 dB, or a perceived *distributive unfairness* of the 70 dB sample, in regard of the earlier 60 dB sample.

Conclusion

The findings in the Fair experiment, and the explanations described above, corroborate the idea that a fair procedure can be considered as a (social) coping resource, which can reduce the threat value of an event. The assumption that the appraisal of procedural fairness is conditional on a primary appraisal of threat has also been corroborated by the findings. However, it is unclear whether the sense of threat has been caused by the loudness of the sample, or by a perceived distributive unfairness.

Either one or the other, the interaction in the Fair experiment can be explained as follows: a fair procedure is a coping resource, which stress-reducing effect is conditional upon a primary appraisal of a sense of threat. This sense of threat may be due to loudness of the sound, or perceived distributive unfairness of the sound. For the purpose of discrimination in this discussion, I name this the 'coping resource explanation' of the fair process effect on noise annoyance.

Independent main effect

In field situations, the average annoyance level in a community often exceeds the level predicted by dosage-response curves. Can such excess annoyance be due to a reversed fair process effect: an effect of an inverted coping resource? This question motivated the Unfair experiment.

The results of the Unfair experiment show that the unfair procedure manipulation increased the level of noise annoyance in the 70 dB as well as the 50 dB SPL conditions. The strength of the effect is independent of SPL (Chapter 4). In this section, two explanations for this independent main effect of procedural unfairness will be discussed. First, the 'coping resource explanation', used to explain the interaction in the previous section, is applied, considering the unfair procedure as an inverted coping resource (taken into account during secondary appraisal). Secondly, an alternative explanation is explored, in which the unfair procedure manipulation has an effect on annoyance through primary appraisal, that is, by creating a sense of threat due to outcome unfairness. The latter explanation, I will name the 'threat value explanation'.

'Coping resource explanation'

The 'coping resource explanation' holds that an effect of procedure can be found only when secondary appraisal of coping resources is triggered by a sense of threat to well-being. In the Unfair experiment, an effect of the procedure manipulation is found in the 50 dB as well as the 70 dB SPL conditions. This finding implies that in both SPL conditions, a sense of threat to well-being has been appraised (primary appraisal). This finding contrasts with the data from the Fair experiment, which suggest that the 50 dB SPL does not have threat value. However, it was expected that both SPL conditions would have threat value to the participants in the Unfair experiment. All participants had, before being exposed to the experimental sound sample, spent some time motivating in writing why they believed nature, or radio sound to be least taxing (compared to aircraft sound) to them as background sound during a difficult reading task. By doing this, they had themselves labeled the aircraft sound as a threat to their well-being in the context of being engaged in a reading task. The 'coping resource explanation' for the main effect of the procedural fairness manipulation is that, during primary appraisal, the negatively labeled aircraft sound raised a sense of threat to all participants because of its content, and not its loudness. The primary threat appraisal triggers the secondary appraisal of coping resources. Procedural unfairness, as an inverse coping resource, increases the stress level (reversed fair process effect), and hence annoyance rises in both the 50 dB and the 70 dB SPL conditions (relative to the neutral procedure conditions).

One observation argues against this explanation: the average noise annoyance scores in the neutral procedure conditions are surprisingly similar to the scores in the neutral procedure conditions in the Fair experiment. Even though no statistical analysis can be done on data of two unrelated experiments, this observation raises doubt with regard to the threat induced by the presumed negative label of the aircraft sound in the Unfair experiment.

'Threat value explanation'

In the section addressing the interaction effect, it is noted that a perceived distributive unfairness can be appraised as a threat. It is conceivable that, for the participants in the unfair procedure conditions, the aircraft sound was an unfair outcome, 50 and 70 dB SPL alike. They had been promised the sound type of their choice, and had indicated to choose nature or radio sound. The unfair procedure manipulation may have induced differences in perceived outcome unfairness. (Unfortunately, no measures of perceived outcome unfairness have been taken). Outcome unfairness alone can explain the main effect of the procedure manipulation on noise annoyance: In the unfair procedure conditions, the presumed outcome unfairness has threat value, which during primary appraisal leads to a sense of threat to well-being. This triggers the secondary appraisal of coping resources. The unfair procedure does not provide compensatory coping options, and the appraised threat value of the unfair outcome translates into a rise in stress in both SPL conditions. This rise in stress causes an increase in annoyance. This, I call the 'threat value explanation' for the main effect of the unfairness manipulation on noise annoyance.

The 'threat value explanation' can account for the main effect of the unfairness manipulation without assuming an effect of an inverted coping resource. Secondary appraisal of the procedure is not needed to explain the elevated annoyance levels (relative to the neutral procedure conditions). It is possible, still, that the unfair procedure causes an additional rise in noise annoyance in the unfair conditions. However, with the current data no discrimination can be made between annoyance caused by the presumed unfair outcome distribution, and annoyance caused by the unfair procedure. Practically, the presumed unfair outcome and the unfair procedure are too intertwined to be considered as separate concepts: one would not exist without the other. Therefore, in the remainder of this chapter, I will refer to the unfair procedure with both dimensions in mind.

An argument in favor of the 'threat value explanation' can be found in the absence of an interaction effect on top of the main effect of procedural unfairness. In the cognitive theory of stress and coping, a coping resource moderates stress. Hence, it is expected that its effect grows stronger when stress increases. Likely, stress is higher in the high SPL conditions. The effect of the unfair procedure, however, is not stronger in the high SPL conditions (i.e., no interaction effect). This pattern suggest no moderation of stress by means of a coping resource, but instead additional stress due to a threat of some sort. (Note: the absence of an interaction effect could be due to a ceiling effect: annoyance levels in the high SPL, unfair conditions approach the top end of the measurement scale.)

Unfortunately, the data of the Unfair experiment does not allow for discrimination between annoyances due to primary or secondary appraisal processes. The question could have been answered if annoyance had been assessed shortly after the onset of the sound (like in the pilot study) as well as after 15 minutes of exposure. Finding the effect of procedural unfairness on annoyance after one minute of exposure already would be an indication that the effect is fast: a primary appraisal process, in support of the 'threat value explanation'. Not finding the unfairness effect after only one minute, would be an argument for the 'coping resource explanation'. (The data from the pilot study suggest that the fair process effect is depending on secondary appraisal, which is in line with the 'coping resource explanation').

Conclusion

Considering all of the above, at this point in the discussion of the results, no conclusive argument has been presented to choose either one or the other explanation for the effect of procedural unfairness on noise annoyance (Chapter 4). In the following section, the two explanations will be considered from a social justice perspective, and with regard to both procedure effects (fair and unfair) in combination.

Comparison of the two explanations

The interaction effect of the fair procedure (Chapter 3) can be accounted for by the 'coping resource explanation'. The independent main effect of the unfair procedure (Chapter 4) can be accounted for by the 'coping resource explanation', as well as the 'threat value explanation'. From a perspective of parsimony, it could be opted to discard the latter explanation. In the following section, I will argue the additive value of keeping the 'threat value explanation' beside the 'coping resource explanation'.

The essential difference between the two explanations is that, in the 'coping resource explanation' the unfair procedure exerts its effect on noise annoyance during the secondary appraisal (as a negative coping resource), whereas in the 'threat value explanation' it exerts its effect during primary appraisal (as a threat value). This distinction is reminiscent of the two major explanations in social justice literature for why procedural fairness is generally much appreciated and related to higher outcome satisfaction. The *instrumental explanation* is similar to the 'coping resource explanation'. It holds that fair procedures give more (indirect) control over the process and the related outcomes (Mikula, 2001, Thibaut and Walker, 1975). Similarly, in the cognitive theory of stress and coping, perceived control is considered a secondary appraisal of situational factors (Folkman, 1984). The *relational or group-value explanation* shares some characteristics with the 'threat value explanation'. It holds that procedural fairness provides people with information about their status in a social group. A fair treatment signals a high status, which provides the group member with two vital coping resources: a social support system and a sense of self-efficacy (Tepper, 2001; Tyler and Lind, 1992). It follows that an unfair treatment signals a low status. Given the social needs of people, having low status has threat value. An unfair treatment can be a negative in its own right, and a threat to well-being.

The mediation of the unfair process effect by instrumental or relational concerns has been explored with three items in the Unfair experiment (Chapter 4). Although the results are inconclusive, they lean toward the relational end. The procedure induced strong differences in perceived respect ('In your opinion, how respectful have I, the researcher, treated you?'), which did not translate into differences in noise annoyance. The item "The experimenter made an effort not to tax me unnecessarily with the sound" is a significant mediator according to the lenient Baron and Kenny (1986) criteria, but not when following the more accurate bootstrapping method (Shroud and Bolger, 2002). The correlation between the two relational concern items 'respect' and 'effort' is highly significant. No differences have been induced on the perceived control-item: 'During the task, to what extent did you feel to have (had) control over the sound you were being exposed to?', which discards instrumental concerns. Even though these results are far from conclusive, they signal that the exploration of relational aspects of procedural unfairness effects on noise annoyance may shed a new light on noise annoyance and procedural fairness research.

A common-sense argument in favor of retaining the ‘threat value explanation’ for the explanation of the unfair procedure effect is that the theoretical concept of a negative, or inverted, coping resource has little practical value. It is difficult to conceive what it is like to be having less than no access to a coping resource. The concept of the unfair procedure as a threat to social needs, on the other hand, is less hard to imagine.

I conclude that the ‘coping resource explanation’ and the ‘threat value explanation’ of effects of procedural fairness or unfairness on noise annoyance are complementary to each other. They are both rooted in the cognitive theory of stress and coping, but they address different contextual mechanisms that can increase of decrease the stress level, and hence the annoyance a person experiences in response to sound. The ‘threat value explanation’ cannot explain the interaction effect found in the Fair experiment, but has additional value in addressing the potential threat value of an unfair procedure with regard to social needs. Together they can do both.

5.4 IMPLICATIONS FOR THE MODEL OF ANNOYANCE

5.4.1 Surplus value of a social psychological model

In the introduction of this thesis, I have argued that the perspective commonly taken in social scientific research on noise annoyance is psychological rather than social. I have explained that I consider this a problem, because I believe that noise annoyance with man-made sound is a response to a *social* experience.

The results of the experiments described in this thesis confirm my belief: they show that the social process between the person(s) operating the sound source and the person(s) being exposed to the sound influences the latters evaluation of the sound. Exposure to man-made sound can be considered a social experience.

To study this social side of noise, a model of noise annoyance that represents the social process between exposer and exposee is needed. As the experiments demonstrate, using such a model has the advantage of creating a link to social psychological knowledge, in particular knowledge on social justice. In this way, relevant information both for the theory of noise annoyance as well as the practice of annoyance abatement can be added.

5.4.2 Amendments to the social psychological model

In this section I will relate the above discussion to the social psychological model of noise annoyance (Stallen, 1999; see Figure 1.4 for the original model and Figure 3.1 for the simplified model used for the design of the current studies). First, I will relate the terminology used in the previous sections to the terminology used in the social psychological model of noise annoyance. Then, I will describe the amendments to the model that I think are required to account specifically for the current findings. In this manner, I intend to summarize the implications of the results for a social psychological model of noise annoyance. For clarification purposes only, a visual representation of the tentative amended model is included in addition to the verbal description of the suggested amendments (see Figure 5.3).

The equation of terminology starts with relating the two external process variables to the manipulations in the experiments. ‘Sounds at source’ becomes ‘SPL’, and ‘noise management by source’ becomes ‘(un)fairness of sound management’. Because the external variables have been manipulated orthogonally, the arrow connecting them is left out. The internal variables ‘perceived disturbance’ and ‘perceived control’ are equated to ‘primary appraisal of threat value’ and ‘secondary appraisal of coping resources’. The behavioral activity ‘coping with annoyance’ is not adopted in the amended model, because coping behavior has not been studied in the reported experiments. The same holds for ‘sensory disturbance’ and ‘other (non-noise related) attitudes’, which have not been addressed in these studies. Unidirectional arrows, for matters of simplicity, replace the two-directional arrows between the appraisal processes and ‘annoyance’. Finally, the response variable ‘annoyance’ is replaced by ‘noise annoyance’ in the amended model.

To (more clearly) account for the findings and their theoretical explanations, some amendments to the model are required. Firstly, the model does not clearly illustrate the theoretical assumption that ‘secondary appraisal of coping resources’ has an inhibiting effect on ‘primary appraisal of threat value’ rather than a direct effect on ‘noise annoyance’. The arrow from ‘secondary appraisal of coping resources’ to ‘noise annoyance’, is replaced by an inhibiting arrow to ‘primary appraisal of threat value’.

Furthermore, the model needs to illustrate that the threat reducing influence of coping resources depends on the appraised threat value. For this purpose, an arrow marked with an asterisk is inserted, going from 'primary appraisal of threat value' to 'secondary appraisal. The asterisk is added as a reminder that a higher threat value does *not increase the capacity* of coping resources, it just triggers secondary appraisal of the available coping resources.

The results of the Fair experiment suggest that the fairness of the sound management procedure can function as a coping resource. This mechanism is much in line with the original model by Stallen (1999) and the cognitive theory of stress and coping (Lazarus and Folkman, 1984). The activating arrow from '(un)fairness of sound management' to 'secondary appraisal op coping resources' illustrates this instrumental function of fair sound management.

The main effect of procedural unfairness on noise annoyance (Unfair experiment) has been explained by the assumption that the unfair procedure manipulation threatens social needs. The original model cannot account for this explanation. The relational function of procedural fairness, and specifically the suggested threat value of unfair management, is illustrated by an activating arrow connecting '(un)fairness of sound management' to 'primary appraisal of threat value'.

The data of the Fair experiment does not offer a clear-cut answer to the question whether procedural fairness moderates the threat value of the SPL, or whether the SPL moderates the threat-reducing effect of procedural fairness. In the social justice literature, it is quite common to consider a perceived outcome (i.e., SPL) as a moderator of the fair process effect (e.g., Folger, 1977; Tepper; 2001). In the sound literature, however, it is more common to consider a nonacoustical variable (i.e., procedural fairness) as a moderator of the effect of sound (e.g., Fields and Walker, 1975; Fidell et al., 2002; Miedema and Vos, 2003). The cognitive theory of stress and coping circumvents this problem by defining stress (the precursor of annoyance, in our model) not as an outcome, but as an ongoing relationship between the person and the environment. Stress arises when this relationship 'is appraised by the person as taxing or exceeding his or her resources and as endangering his or her well-being' (Folkman, 1984, p. 840). The appraisal process is supposed to be on-going, hence over time each variable is a moderator of the other. The primary appraisal of threat moderates the effect of coping resources, and vice versa. The amended model is in line with this idea.

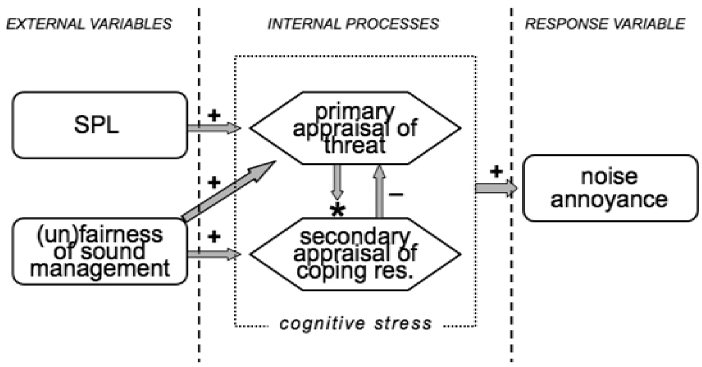

FIGURE 5.3. A visual summary of the findings and their proposed explanations. The independent variables SPL (sound pressure level) and the (un)fairness of the sound management are represented as external variables. The dependent variable, noise annoyance, is represented as the response variable. The reported effects of the independents on the noise annoyance are explained by assuming an internal process of increasing or decreasing levels of cognitive stress. Variations in cognitive stress are due to differences in primary appraisal of threat and secondary appraisal of coping resources. These differences are induced by the independent variables. For the original social psychological model of noise annoyance by Stallen, see FIG 1.4; for its simplified version used for the design of the experiments, see FIG 3.1.

The amended model, as noted before, is intended firstly and mainly to provide a visual summary of the findings and their proposed explanations. Secondly, this summary may facilitate discussion by contrasting the explanations with the original social psychological model of noise annoyance. Thirdly, the model may inspire future studies on the relation between fairness and noise annoyance.

5.5 FAIR VS. UNFAIR: OPPOSITES OR DIFFERENT CONCEPTS?

Fairness and unfairness, as they have been manipulated in the studies, may be distinctly different concepts, and not merely each other's opposite, or two positions on a fairness continuum. The notion that positive and negative are no simple opposites on a psychological level, is not new. A variety of theories and studies illustrate this asymmetry: winning is not the opposite of losing (Tversky and Kahneman, 1981; Harinck, Van Dijk, Van Beest, and Mersmann, 2007), satisfiers are not the opposite of dissatisfiers, and deprivation is not the opposite of gratification (Herzberg, Mausner, and Snyderman,1959; Maslow, 1970).

Interestingly, an asymmetry similar to the one in the result pattern of the Fair and Unfair experiment is found in a recent noise annoyance survey (Schreckenberg, 2007). In the survey, the influence of positive and negative attitudes (towards the operator of the sound source) on noise annoyance is studied. The positive attitudes are found to have an annoyance reducing effect that is stronger with higher SPL. The negative attitudes are found to have an annoyance increasing effect, which strength is comparable for all SPLs studied. Possibly, positive attitudes function as, or are related to, coping resources, while negative attitudes are related to, or function as, threat increasing variables. This similarity in asymmetric results pattern suggests that the pattern found in the current studies may be more than a peculiarity of the present studies.

Therefore, it is advisable to be aware of, and investigate the possibility that fairness and unfairness may have differential effects. As a start, it would be good to discriminate explicitly between *fair* and *unfair* process effects in the scientific vocabulary. To the best of my knowledge, this is as yet not a common practice.

As a consequence of the differential effects of fair and unfair procedures, the impact of procedural unfairness could, at low threat levels (or low SPL), be much stronger than the impact of fair procedures. An unfair procedure may be a nuisance in itself, capable of creating noise annoyance at relatively low sound exposure levels, whereas a fair procedure may ameliorate annoyance due to moderate sound exposure.

5.6 VALIDITY, AND GENERALIZATIONS

Several issues of validity are being addressed in detail in the discussion sections of the Chapters 3 and 4. Here, I will refer to and summarize the major points.

5.6.1 Experimental population

The data has been gathered among students only. Students may be more sensitive for procedural (un)fairness than the average public because they may have a higher need for autonomy compared to the average adult (Avery and Quiñones, 2004). This peculiarity of the experimental population compels cautiousness in generalizing the findings to the general population. Notwithstanding, in the general public substantial variation in need for autonomy will be present, and hence the current findings will likely apply to a significant proportion of the general public. For people less sensitive for procedural (un)fairness, the strength of the procedural fairness effect may be lower. In addition, situational and individual differences may influence the value of fair procedures. It is known that people value voice more when the situation is uncertain, or when trust in authorities is low. Personality differences influence whether or not a situation is perceived as disturbing, and hence whether coping resources are appraised. Even though the strength of the effects may differ, the social psychological mechanisms influencing noise annoyance will not be different.

5.6.2 Generalizations from lab to field

Generalizations from the current findings to situations outside the lab may be restricted in several respects. Firstly, in the lab, participants are well aware that their exposure will not last longer than the course of the experiment. In field situations, people often are far more concerned about their sound situation than the participants in the lab. The social effects of procedural fairness can be stronger in field settings than the current findings suggest: if people are more concerned, their level of threat, stress of perceived outcome unfairness is higher, and hence a procedural fairness effect can be stronger.

Secondly, outside of the lab, people may not be very attentive to the sound management of operators of the noise source. However, when annoyance problems get media attention, the policies of the sound source often become subject of discussion, are paid attention to in public debates, protests, and media. Together, these sociological processes have been found to exert a significant influence on people's ideas about the fairness of sound management (Wirth and Bröer, 2004; Bröer, 2006, 2007).

It is a question whether effects of social processes on evaluations of noise can be replicated when a real person to interact with is lacking altogether (e.g., when the noise source is an institution). There is, however, evidence that people have a strong tendency to attribute social meaning to situations (e.g., Heider and Simmel, 1944; Klin, 2000). Other studies have shown that it is common for users of mass media to form so-called parasocial relationships with media figures (like celebrities, but also cartoon characters, or even magazines), in which the user responds behaviorally and cognitively to the media figure as though in a typical social relationship (e.g., Giles, 2002; Horton and Wohl, 1956; Cohen, 2004).

In sum, it is important to consider differences between laboratory and field settings, but it seems warranted to make careful generalizations from the current findings to field settings. Although it cannot simply be assumed that the social psychological processes will be identical in the field, results from survey studies confirm that social variables like trust and attitudes towards the source play a significant role (Guski, 1999). Experiences with e.g. community consultation and transparent communication around Heathrow airport (Flindell and Witter, 1999) and Sydney airport (Southgate, 2002), illustrate the practical value of fair noise management.

5.7 ADDITIONAL REMARKS

5.7.1 Suggestions for further research

The finding that noise annoyance has a social side raises more specific, and new questions. For instance: how precisely do social processes relate to (nonacoustic) individual difference variables? Does procedural fairness influence people's attitudes towards the source, or does it make people less (or more) attentive to the sound? Do relational or instrumental concerns, or both, mediate the procedure effect on noise annoyance? More research, also of a qualitative nature (e.g., Pedersen, Persson Waye, Hallberg, 2004), is needed for an in-depth exploration of the social psychology of noise.

An interesting question that can be addressed with an experimental design similar to the one applied in this thesis, is whether the effect of procedural fairness continues to grow stronger with increasing SPL, or not. If secondary appraisal is either triggered or not, then it can be predicted that for higher SPL, the fair process will show an independent main effect, rather than an interaction. This could be studied by studying the fair process effect for a larger number of SPL-conditions. The effect of procedural (un)fairness for extreme SPL's could be another interesting research focus. Can an unfair procedure transform a benign sound into noise? If such studies are carried out, it is advisable to include measures of perceived distributive fairness.

In another vein, it would be interesting to see what happens if the annoying sound is natural rather than man-made. Do procedural fairness effects occur when the experiment is carried out at a location with a lot of annoying, naturally occurring sounds, or sounds over which the experimenter has no control? If the experimenter plays a recording of natural sounds on an audio installation, is it then perceived as man-made, or natural? And, do procedural, and other nonacoustical variables then influence noise annoyance?

Future research could address the effect of other procedural and distributive fairness characteristics on noise annoyance. In addition, influences of other dimensions of the social process could be studied: e.g., social comparison, social exclusion, or relative deprivation). The current experimental design could be improved by adding valid and reliable scales of instrumental and relational mediators of fairness effects.

In field situations, the 'person operating the sound source' often is not an individual, but a company or institution. Field studies are needed to investigate whether the relationship between a noise exposed person and an institution is comparable to the relationship between experimenter and participant. Knowledge in the domain of para-social relations may be a useful in this respect (e.g., Giles, 2002; Horton and Wohl, 1956; Cohen, 2004). Two other studies are of interest in this respect. The first investigates the relationship between public policy and the cultivation of trust (Breeman, 2006), the second examines how trust and acceptance of the general public are affected by decision making procedures (i.e., "voice") in the context of the implementation of a new technology (Terwel, Harinck, Ellemers, and Daamen, 2007).

Finally, physiological research is needed to investigate whether, and under which conditions, a reduction in verbalized annoyance indicates a reduction of physiological stress. Several studies point out that a reduction of reported annoyance can also indicate that people suppress their annoyance (Fields and Walker, 1982), or compensate by adjusting their aims (Staples, 1997; Tafalla, Evans, and

Chen, 1988). One study reports a negative correlation between expressed annoyance and physiological stress levels, suggesting that a suppressed expression of annoyance results in an increase of physiological stress (Miyakawa et al., 2004).

5.7.2 Implications for practice

The present studies provide scientific proof of what many a worker in the practice of noise annoyance abatement knows by experience: unsound management can be a source of dissatisfaction (e.g., when it is perceived as mis- or malfeasance, procedural unfairness) that worsens noise annoyance issues. Having this proof has practical implications.

Firstly, it can be used to create a sense of urgency needed to raise the funds and mobilize the people necessary to address this side of the noise issue. The research shows that the sound management procedure is a predictable source of systematic nonacoustic differences, and this makes some nonacoustic influences manageable. Individual differences in reactions to noise seem to be less relevant when one focuses on management procedures.

Secondly, the clarified link with social psychology may inspire new, nonacoustic ways for abating or preventing excess noise annoyance. In particular, the social justice literature provides a substantial body of tips and tricks for fair management. But also other knowledge on the management of social relationships, for instance mediation techniques, may be of use when dealing with environmental nuisances.

Thirdly, the data suggest that valuable information can be gained by a regular investigation of people's evaluation of the sound management. This information can help notice resistance at an early stage, and react to it in a constructive manner.

Fourthly, the Fair experiment shows that the social process instigated by the operators of the source can be a form of social support when the exposed perceives that the operator is receptive to their needs (e.g., public consultation, procedural fairness).

Last but not least, noise annoyed citizens and organized groups can possibly benefit from taking a *social* perspective in their negotiations with policy makers in urban planning, officials from airports and other noise-producing enterprises. Annoyance due to nonacoustic aspects of a noise problem really is annoyance just the same. It requires due consideration and a respectful solution.

5.7.3 Value of the reported research

"Working out improved social relationships between airports and their neighborhoods is an important aspect of noise alleviation" (Goodman and Clary, 1976, p.467). Nevertheless, limited use is being made of the existing knowledge of nonacoustical variables that influence the relationship between acoustical metrics of unwanted sound and noise annoyance, yet. In a recent review of the modeling of noise and its effects it is suggested that "[a]lthough there is some insight in other factors, such as noise sensitivity, that influence noise annoyance beside noise exposure, this knowledge is currently not developed sufficiently to form the basis for policies targeted at such nonacoustical factors aimed at reducing noise annoyance through nonacoustical measures" (Miedema, 2007, p. 53). This thesis shows that consideration of the social side of sound in noise annoyance research can help work out the social relationship between exposer and exposee. Application of a social psychological model of annoyance creates the possibility to draw from the extensive social psychological literature. This can further the theoretical understanding of noise annoyance, including the development of existing knowledge on nonacoustic factors. Social scientific research on noise annoyance needs to address noise annoyance as a *social* problem. Being exposed to man-made sound is a social experience.

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Samenvatting (Summary in Dutch)

De Sociale Kant van Geluidhinder

Geluidhinder is een zeer wijdverbreid probleem. Mensen ondervinden de meeste geluidshinder van burengerucht, verkeerslawaai, en geluiden van fabrieken of bouwwerkzaamheden. Opvallend is dat al deze geluiden door mensen worden veroorzaakt. Het valt te verwachten dat blootstelling aan geluid dat door mensen veroorzaakt wordt, een sociale ervaring is: voor de beleving van het geluid doet het er toe wie het geluid maakt, en waarom. Dit proefschrift gaat over dit sociale aspect van geluidhinder.

Akoestische en niet-akoestische factoren

In dit proefschrift is geluidhinder gedefinieerd als "een gevoel van onbehagen dat samenhangt met een negatieve beïnvloeding van een individu door ongewenst geluid en omstandigheden". (vgl. WHO, 2004, p.3). Geluidhinder is dus een reactie op ongewenst geluid. De mate van geluidhinder hangt af van zowel *akoestische factoren* (zoals volume en frequentie) als *niet-akoestische factoren* (omstandigheden die niet direct met het geluid te maken hebben). Voorbeelden van niet-akoestische factoren zijn: (een gevoel van) controle over het geluid, de zinvolheid van het geluid, individuele gevoeligheid voor geluid, en het sociale proces tussen geluidmaker en gehinderde.

Interactie tussen geluidsmaker en gehinderde

Wanneer ongewenst geluid door mensen wordt veroorzaakt, is het waarschijnlijk dat het *sociale proces* tussen de geluidmaker en de blootgestelde de ervaren hinder beïnvloedt. Met het sociale proces wordt de interactie tussen twee (of meer) mensen bedoeld: hoe zij elkaar beïnvloeden. Een voorbeeld van een sociaal proces is goed overleg tussen de geluidmaker(s) en de aan het geluid blootgestelde persoon (of personen). Ook als goed overleg ontbreekt, is er sprake van een sociaal proces.

Uit onderzoek is bekend dat wanneer een sociaal proces mensen een uitkomst (bijv. een bepaalde beslissing, salarishoogte, etc.) oplevert, hun evaluatie van die uitkomst mede afhangt van hun waardering van het sociale proces. Als het overleg prettig verloopt zijn mensen meer tevreden met de genomen beslissing, het overeengekomen salaris, etc. En andersom: een onprettig sociaal proces kan ontevredenheid met de uitkomst veroorzaken.

Procedurele (on)rechtvaardigheid

Het sociale proces tussen geluidmaker en geluidblootgestelde heeft vele interessante kanten. Voor dit onderzoek is ervoor gekozen om de *rechtvaardigheid* van het sociale proces te bestuderen. Onderzoek heeft aangetoond dat procedurele rechtvaardigheid van invloed is op de evaluatie van uitkomsten, en op het stressniveau van mensen. Deze effecten van procedurele rechtvaardigheid worden toegeschreven aan de mate van controle over de uitkomst die de procedure biedt (*instrumentele* verklaring), of aan de respectvolheid van de procedure (*niet-instrumentele* verklaring).

Waarom dit onderzoek?

Wetenschappelijk onderzoek naar geluidhinder richt zich vooral op de akoestische factoren van geluidhinder. Dat is jammer, want het is al lange tijd bekend dat niet-akoestische factoren een aanzienlijk deel van de ervaren hinder verklaren. Met name de invloed van het sociale proces op geluidhinder blijft onderbelicht. De invloed van het sociale proces op geluidhinder is interessant om twee redenen. Enerzijds is het voor geluidsveroorzakers interessant om te weten hoe zij hinder kunnen verminderen door hun interactie met de mensen die zij aan geluid blootstellen aan te passen. Anderzijds draagt het onderzoek bij aan het theoretische begrip van hinder, in het bijzonder van de invloed van het sociale proces op de hinder. Niet eerder is er onderzoek gedaan naar het effect van procedurele (on)rechtvaardigheid op geluidhinder.

Doel en onderzoeksvragen

Dit proefschrift heeft als doel om de wetenschappelijke kennis over de sociale kant van geluidhinder te vergroten. Het wil een antwoord geven op de volgende vragen:

1. Kan procedurele rechtvaardigheid hinder verminderen?
2. Kan procedurele onrechtvaardigheid hinder verergeren?

Hoofdstuk 1 geeft een algemene inleiding op het proefschrift. Het beschrijft kort de omvang en consequenties van omgevingsgeluid, en illustreert de afwezigheid van een sociaal perspectief op het geluidhinderprobleem in sociaal-wetenschappelijk onderzoek. Ook beschrijft het de theorie op basis waarvan de sociale kant van geluidhinder in dit proefschrift onderzocht is.

Onderzoeksopzet

Om bovenstaande vragen te beantwoorden is gekozen voor een experimentele aanpak, omdat die het meest geschikt is om oorzakelijke verbanden op te sporen. Er is een onderzoeksopzet ontworpen (beschreven in hoofdstuk 2) waarin geluidhinder wordt veroorzaakt door mensen bloot te stellen aan vliegtuiggeluid van 50 of 70 dB. Vooraf krijgen de mensen te maken met een rechtvaardige, een onrechtvaardige of een neutrale procedure.

In de rechtvaardige procedure condities vroeg de onderzoeker aan de mensen die deelnamen aan het experiment om hun voorkeur uit te spreken voor één van drie geluidsamples. De onderzoeker zei erbij: “deze inspraak geeft geen garanties, maar er wordt indien mogelijk rekening mee gehouden”. In de onrechtvaardige procedure condities vroeg de onderzoeker de deelnemers om hun voorkeur, en beloofde dat hun wens vervuld zou worden. Uiteindelijk bleek die belofte niets waard: ze kregen het geluid dat ze niet wilden horen. In de neutrale procedure condities werd aan de deelnemers verteld dat er verschillende geluidsamples waren, en dat de onderzoeker voor hen bepaalde welk geluidsample zij te horen kregen. Overigens, alle deelnemers kregen dezelfde geluidsample te horen (alleen het volume varieerde: 50 of 70 decibel).

In totaal waren er dus 6 combinaties mogelijk: hard geluid in combinatie met een neutrale, een rechtvaardige, of een onrechtvaardige procedure, en zacht geluid in combinatie met deze drie procedures. Aan iedere combinatie van geluidsniveau en procedure werden ongeveer 25 mensen blootgesteld. Door de gemiddelde hinderscore over deze 25 mensen te berekenen, wordt de invloed van andere niet-akoestische factoren uitgevlakt. Om te zien of de rechtvaardigheid van de procedure een verschil in geluidhinder veroorzaakt, worden de zes gemiddelde hinderscores met elkaar vergeleken.

Minder hinder door rechtvaardigheid

In het ‘rechtvaardige experiment’ (hoofdstuk 3) wordt het effect van een rechtvaardige procedure op geluidhinder vergeleken met het effect van een neutrale procedure. Het rechtvaardige experiment laat een aantal dingen zien. Allereerst blijkt dat de gemiddelde hinder bij een geluidsniveau van 70 dB een half schaalpunt hoger ligt dan bij een geluidsniveau van 50 dB. (De geluidhinder werd gemeten op een schaal van 1 (*‘geen hinder’*) tot 7 (*‘ernstige hinder’*). Als het geluid zacht is (50 dB), beïnvloedt de rechtvaardigheid van de procedure de geluidhinder niet. Maar, als het geluid hard is (70 dB) veroorzaakt de rechtvaardige behandeling een gemiddelde daling van de geluidhinder van een half schaalpunt (vergeleken met de neutrale conditie). Het is tot slot interessant dat de procedurele rechtvaardigheid geen invloed heeft op de waargenomen luidheid van het geluid. Dit alles illustreert dat zowel akoestische als niet-akoestische factoren de ernst van de geluidhinder bepalen. Het rechtvaardige experiment toont aan dat procedurele rechtvaardigheid de hinder van hard geluid kan verlagen.

Meer hinder door onrechtvaardigheid

In het ‘onrechtvaardige experiment’ (hoofdstuk 4) wordt het effect van een onrechtvaardige procedure op geluidhinder vergeleken met het effect van een neutrale procedure. Het experiment laat zien dat procedurele onrechtvaardigheid de geluidhinder verergert (vergeleken met een neutrale procedure) ongeacht het geluidsniveau. In de onrechtvaardige condities ligt de gemiddelde hinder iets minder dan een halve schaalpunt hoger dan in de neutrale condities. Dit effect treedt op bij 50 dB en bij 70 dB. (De rechtvaardigheid van de procedure heeft wederom geen effect op de waargenomen luidheid van het geluid.)

In het onrechtvaardige experiment is ook onderzocht of instrumentele of niet-instrumentele overwegingen het effect van procedure op geluidhinder kunnen verklaren. Een eenduidig antwoord op deze vraag is niet gevonden.

Verklaringen voor de bevindingen

Het is opvallend dat de effecten van rechtvaardigheid en onrechtvaardigheid verschillende patronen hebben: rechtvaardigheid heeft alleen effect bij hard geluid, onrechtvaardigheid zowel bij hard als zacht geluid.

Een verklaring voor het feit dat procedurele rechtvaardigheid alleen effect bij hard geluid effect heeft kan zijn dat rechtvaardigheid werkt als een *‘coping resource’*: een hulpbron die je controle geeft over je moeilijkheden. Hoe harder het geluid is, hoe belangrijker de hulpbron is. Dit is een instrumentele verklaring.

Het patroon van procedurele onrechtvaardigheid is te begrijpen met een niet-instrumentele verklaring. Onrechtvaardigheid werkt dan als een *bedreiging van sociale behoeften*, bijvoorbeeld de behoefte aan respect. Sociale behoeften staan los van het geluidsniveau. Dit verklaart waarom het effect van onrechtvaardigheid onafhankelijk is van het geluidsniveau.

Betekenis van de resultaten

Uit het onderzoek blijkt dat de (on)rechtvaardigheid van de procedure een invloed heeft op de mate van de ervaren geluidhinder. De gemiddelde hinderscores variëren tussen de procedurecondities, ook bij gelijkblijvend geluidsniveau. Hieruit blijkt dat het sociale proces de beleving van het geluid beïnvloedt. Dit is een aanwijzing dat blootstelling aan door mensen veroorzaakt geluid een sociale ervaring is. Voor een goed begrip van geluidhinder is het dus nodig om ook het sociale proces tussen geluidmaker en blootgestelde mee te nemen.

Op theoretisch vlak betekent dit dat het sociale proces opgenomen kan worden in modellen van hinder. Hierdoor wordt sociaal-psychologische theorie toepasbaar in hinderonderzoek en -beleid. Dat kan leiden tot nieuwe inzichten over geluidhinder, zoals het inzicht dat onrechtvaardig beleid een oorzaak van verhoogde hinder kan zijn. Niet alleen kennis over procedurele rechtvaardigheid kan van nut zijn, maar ook andere sociaal-psychologische kennis, zoals bijvoorbeeld kennis over bemiddeling bij conflicten.

Het onderzoek is gedaan onder studenten in het lab. Bij de vertaling van de resultaten naar de praktijk is daarom voorzichtigheid geboden. Studenten kunnen bijvoorbeeld sterker reageren op onrechtvaardigheid dan andere groepen in de samenleving. Toch kunnen we voorzichtig aannemen dat de onderliggende psychologische mechanismen in het lab en in het veld hetzelfde zijn.

Voor de praktijk betekenen de onderzoeksresultaten dat wanneer omwonenden meer hinder ervaren dan op basis van het geluidsniveau te verwachten is, de geluidsmaker er goed aan doet om na te gaan of het eigen gedrag (of beleid) een bron van deze verhoogde hinder is. Het is belangrijk om onderscheid te maken tussen hinder van het geluid, en hinder van het beleid, opdat de oplossing voor de hinder in de juiste hoek wordt gezocht.

Conclusie

Veel mensen ondervinden hinder van geluid dat wordt veroorzaakt door andere mensen. Dit proefschrift toont aan dat deze hinder wordt veroorzaakt door meer dan het geluid alleen: een onrechtvaardige blootstellingsprocedure is een oorzaak van verhoogde hinder. En, een rechtvaardige procedure kan de hinder verzachten. Dit betekent niet dat deze hinder ‘tussen de oren’ zit en dus niet ter zake doet. Het betekent dat blootstelling aan door mensen gemaakt geluid een sociale ervaring is. Het verdient daarom aanbeveling dat onderzoekers, beleids-, en herriemakers rekening houden met de sociale kant van geluidhinder.

Curriculum Vitae

Eveline Maris werd geboren in Amsterdam op 12 augustus 1972. Ze volgde haar vwo-opleiding aan het St.-Vituscollege in Bussum. Na haar eindexamen begon ze in 1991 met de studie biologie aan de Universiteit Utrecht. Nadat ze het propaedeutisch examen behaalde, stopte ze met deze studie. Ze was toen al begonnen aan de studie psychologie aan de Universiteit Leiden. Tijdens de winter van 1997 liep zij een onderzoeksstage in de omgevingspsychologie aan het Institute for Housing and Urban Research (IBF, Uppsala University) in Gävle, Zweden. In 2001 behaalde ze haar doctoraal examen in de psychologie. Tussen 2002 en 2007 deed zij promotieonderzoek bij de secties sociale psychologie en cognitieve psychologie aan de Universiteit Leiden. Tijdens deze periode was zij ook bestuurslid van het Leids Promovendi-overleg (LEO) en lid van de Universiteitsraad, en richtte zij het Promomovendinetwerk voor Mens en Omgeving op. Op dit moment is zij werkzaam als adviseur bij NOK-n BV in Gouda. Met ingang van 1 januari 2009 wil zij zich vestigen als zelfstandig adviseur-onderzoeker op het gebied van mens-omgevingsvraagstukken. Zij is bereikbaar via email@evelinemaris.nl.

English translation:

Eveline Maris was born in Amsterdam, on the 12th of August, 1972. She received her vwo-education at the St.-Vitus college in Bussum, The Netherlands. After graduation, she began studying biology in 1991 at the Universiteit Utrecht. However, after passing the propaedeuse exam in 1995, she ended this study. By that time she had started studying psychology at the Universiteit Leiden. During the winter of 1997, she fulfilled an internship in environmental psychology at the Institute for Housing and Urban Research (IBF, Uppsala University) in Gävle, Sweden. In 2001 she earned her Master's degree in psychology. Between 2002 and 2007 she conducted her PhD-research at the sections for social psychology and cognitive psychology at Universiteit Leiden. During this period of doing research, she was board member of the Leidse Promovendi-overleg (LEO) and member of the University Council, and founded the Promovendinetwerk voor Mens en Omgeving. Currently, she is working as a consultant at NOK-n BV in Gouda. As from Januari 1st 2009, she will set up as a freelance consultant-researcher in the field of people-environment issues. For info email@evelinemaris.nl