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Assessing aircraft noise-induced annoyance around a major German airport and its predictors via telephone survey – The COSMA study

Susanne Bartels[a,b,*], Daniel Rooney[a], Uwe Müller[a]

[a] Division of Sleep and Human Factors Research, Institute of Aerospace Medicine, German Aerospace Center, Linder Höhe, 51147 Cologne, Germany
[b] Department of Psychology, Technische Universität Darmstadt, Alexanderstr. 10, 64238 Darmstadt, Germany

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ABSTRACT

Background: Despite technological improvements and noise mitigation schemes, annoyance due to aircraft noise remains an ongoing issue for residents near airports, and increasing annoyance has been observed in many affected communities.
Objectives: This study investigates aircraft noise-induced annoyance near a German airport that is particularly busy at night. In addition to established predictors, it examines variables not considered in studies of recent years. Annoyance ratings are compared to the current European standard exposure-response curve and the community tolerance level (L_{ct}) is calculated as described in the 2016 revision of ISO 1996-1.
Methods: A telephone survey was conducted with 1262 residents near Cologne/Bonn Airport (IATA: CGN, Germany) which can be classified as a low-rate change (LRC) airport. Acoustical (L_{dn} in 5 dB-steps, *flight altitude*, and *predominant type of operation*) and non-acoustical variables (e.g., *attitudes*, *noise sensitivity*, *urbanisation level of area*) were recorded for every participant. Respondents assessed their aircraft noise-induced overall annoyance as well as their night-time annoyance using the verbal 5-point ICBEN scale.
Results: The L_{dn} explained 16.5% of variance in the annoyance ratings. The inclusion of non-acoustical variables into the regression model increased the proportion of explained variance to 54.8%. Annoyance prevalence rates at CGN were higher than predicted by the EU-standard curve and the L_{ct} was lower than predicted by recent work.
Conclusion: For a LRC airport, the community around CGN shows an uncommonly high percentage of highly annoyed residents and a low tolerance to aircraft noise exposure. Non-acoustical factors including personal and situational factors seem to have substantial impact on annoyance.

1. Introduction

Air traffic exhibits the largest growth rate among the different transportation sectors worldwide. As a consequence, annoyance due to aircraft noise still is a research field of high societal interest in Europe and Northern America and is currently becoming an issue in emerging countries in many parts of the world (Al-harthy and Tamura, 1999; Janssen and Hong, 2017; Silva et al., 2017; Gjestland et al., 2015; Lim et al., 2007). A number of exposure-response curves quantifying the relationship between noise exposure

* Corresponding author at: Division of Sleep and Human Factors Research, Institute of Aerospace Medicine, German Aerospace Center, Linder Höhe, 51147 Cologne, Germany.
E-mail addresses: Susanne.Bartels@dlr.de (S. Bartels), Uwe.Mueller@dlr.de (U. Müller).

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and annoyance have been established. The standard curve for aircraft noise annoyance currently recommended by the European Commission (European Parliament, 2002; Miedema and Oudshoorn, 2001) is based on data from 1965 up to 1993. The comparison of more recent annoyance data obtained after the year 2000 indicates increased prevalence of highly annoyed residents for a given exposure level (Babisch et al., 2009; Janssen et al., 2011; van Kempen and van Kamp, 2005). In contrast to these findings, Gelderblom et al. (2017) reports that the observed temporal trend in annoyance could be explained by the type of airports studied. According to their analysis, annoyance has not increased when the fact is considered that studies of the recent 20 years have predominantly been conducted around airports experiencing high changes in their operational patterns (either in the recent past or the near future) (Gelderblom et al., 2017). These so-called high rate change (HRC) airports show higher annoyance prevalence rates than low rate change (LRC) airports which experienced no or only gradual changes. For a detailed definition of HRC and LRC airports, see Gelderblom et al. (2017) and Janssen and Guski (in press).

Notwithstanding, the percentage of highly annoyed respondents (% HA) varies strongly among different airports (Janssen et al., 2011; van Kempen and van Kamp, 2005) as well as within an airport community (Job, 1988). It is well known that this variance cannot be sufficiently explained by noise exposure. This does not change completely by considering changes in operational pattern. Even after distinguishing between HRC and LRC airports, the prevalence of high annoyance varies considerably (Gelderblom et al., 2017; Guski, 2017). Non-acoustical variables, such as situational factors (e.g., the time of day when the noise occurs), personal factors (e.g., individual attitudes or traits), and social factors (attitudes towards the noise sources which are shared by the community) strongly contribute to community annoyance (Fields, 1993; Guski, 1999; Lercher, 1996; Miedema and Vos, 1999; Stallen, 1999). According to recent research (Kroesen et al., 2008; Schreckenberg et al., 2010; Wirth et al., 2004) as well as two meta-analyses (Fields, 1993; Miedema and Vos, 1999); *attitudes* and *expectations* are deemed to be the most powerful variables influencing noise annoyance. In addition, the large impact of a person's *sensitivity to noise* has been repeatedly reported (Fields, 1993; Miedema and Vos, 1999). *Demographics* (e.g., age, gender, occupational status, educational level, homeownership, use of the noise source, length of residence, etc.) have, if any, only small effects on noise annoyance (Fields, 1993; Miedema and Vos, 1999).

A new approach that takes the effect of non-exposure factors into account is the *community tolerance level*, L_{ct}, proposed by Fidell et al. (2011) and ISO (2016). Per definition, the L_{ct} – expressed in units of dB – is the day-night level (L_{dn}) at which 50% of a particular community is highly annoyed. That way, the L_{ct} accounts for the aggregate effect of factors other than the exposure level. It is supposed to provide a tool for inter-study comparisons as well as examinations of trends in the prevalence of high annoyance over the years (Gelderblom et al., 2017). However, it cannot explain *how* these non-exposure factors influence the annoyance response (Gjestland and Gelderblom, 2017, p. 29). In order to understand annoyance and the way in which acoustical and non-acoustical factors contribute to annoyance, several theoretical models have been developed in the past (Guski, 1999; Stallen, 1999; Kalveram, 1996, inter alia). Nevertheless, these models usually focus on certain aspects and, thus, may disregard other potentially important variables.

This paper presents a telephone survey that aimed at the examination of aircraft noise annoyance in the community around Cologne/Bonn Airport (abbreviated as CGN), a German airport with a 24 h operation scheme and a particularly high traffic volume at night. Approximately 27% of daily operations occur between 10 pm and 6 am.[1] Night-time operations are not restricted regarding the number or time of operations. Therefore, we did not only focus on overall aircraft noise annoyance but also on annoyance due to night-time operations. Annoyance levels around CGN were compared to the European standard curve. In addition, the L_{ct} was computed in accordance with ISO 1996-1 and compared to L_{ct}-values reported in other studies. Moreover, the contribution of acoustical and non-acoustical factors to the overall annoyance judgment was investigated. For this purpose, we examined the association between the annoyance judgment and a broad range of other variables in addition to the L_{dn}. The range of considered factors included variables which previously had been reported to affect annoyance, such as the respondent's noise sensitivity and attitudes. We furthermore considered situational and personal variables whose contribution to annoyance has not been quantified and/or which have not yet been considered in theoretical annoyance models. Examples of the latter are the degree of urbanisation of an area, the respondent's environmental conscience, and perception of media coverage on noise-related topics.

The study reported in this paper was part of the EU-project COSMA (Community Oriented Solutions to Minimise aircraft noise Annoyance). It aimed at building a basis for the enhancement of current models of community annoyance due to aircraft noise. The results of this telephone survey were used to prepare a subsequent in-depth field study within the COSMA framework with the collective goal to reduce annoyance in airport communities.

2. Material and methods

2.1. Examination areas

CGN is an important German cargo hub operating 24 h a day with busy periods between 11 pm and 1 am as well as between 4 and 5 am. The average number of operations during these times on weekdays is 19–20 operations per hour. CGN can be characterised as low-rate change (LRC) airport following the classification of Janssen and Guski (in press) as the number of operations has been relatively constant or slightly decreasing during the last decade (Köln Bonn Airport, 2017). No major change in operational pattern has been experienced, announced or even discussed during the three years prior to the survey. The airport is located in close proximity (~ 15 km) to the city-centres of Cologne and Bonn. Hence, residents from both rural and metropolitan areas are affected by

[1] Data are based on results of acoustical measurements made between June and November 2011 in the framework of the COSMA field study (cf. Bartels et al., 2015).