Noise Annoyance Reactions of Children in Primary Schools

Feda Negesse*

Received: 10 February 2016; Accepted: 30 March 2018

Abstract: This survey reports annoyance reaction of primary school children to road traffic and students' talk in Addis Ababa, Ethiopia. A questionnaire was used to collect data from randomly selected 2,265 children from 56 primary schools in the city. The analysis of the data showed that the children were more significantly annoyed by students' talk than by road traffic. The analysis also revealed a significant gender difference in noise annoyance, with boys more annoyed than girls irrespective of a type of learning activity and a source of noise. Moreover, a significant difference was also observed among learning activities in road traffic annoyance, with the children more annoyed in listening than in group work and reading, and in group work than in reading. Taken together, the results of the study indicated that noise annoyance in children is significantly related to noise source, gender and type of learning activity children do at school.

Keywords: noise, annoyance, children, learning, gender

*Asst. Prof of Experimental Phonetics, Department of Linguistics, College of Humanities, Language Studies, Journalism and Communication, Addis Ababa University

Introduction

Noise is an intrusive and harmful physical stimulus, which is very often generated by human activities. The adverse impacts of noise include annoyance, hearing impairment, cognitive impairment, sleep disturbance, reduced performance, worsened cardiovascular disease and mental health (Niemann & Maschke, 2004). At schools, children are exposed to noise generated by students' activities in classrooms or from adjacent classrooms, playground, road traffic, air traffic, activities of religious and business organizations (Shield & Dockrell, 2003; Omubo-Pepple, Briggs-Kamara, & Tamunobereton-ari, 2010). Studies have consistently documented that noise can cause a cognitive impairment in children, reducing their academic achievements (Crandell & Smaldino, 2000; Haines et al., 2001; Shield & Dockrell 2008; vanKempen et al., 2009; Klatte et al., 2010; Ferguson et al., 2013; Amram et al., 2011). For instance, a study conducted by Shield & Dockrell (2008) revealed that primary school children in London, who were exposed to internal and external chronic noise had low academic achievements on standardized assessment tests.

One of the most known impacts of noise on children is annoyance. Annoyance is a subjective reaction consisting of fear, displeasure and irritation, originating from the feeling that one is being unfavourably affected (Boman & Enmarker, 2004). It includes a wide range of negative responses such as disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, exhaustion or stress (Bodin, Bjork, Ohrstrom, Ardo, & Albin, 2012). At school, noise annoys children when it competes with speech signals in a verbal interaction and when it distracts their attention while focusing on important classroom activities (Bradley & Sato, 2008; Lam, 2012 ; Wong, Ng, & Soli, 2012). For example, it is known that children who

attend schools polluted by industrial, air and road traffic noise experience a high degree of annoyance (vanKempen et al., 2009).

A degree of noise annoyance is mediated by age, gender, exposure, sensitivity, intensity, and visibility of noise source, attitude, frequency components of noise, type of activities disturbed and benefit obtained from the noise source (vanKamp, et al., 2009; Janssen et al., 2011; Lam, 2012). Regarding the effect of gender, a study documented that annoyance is greater in girls than in boys and heightened annoyance in girls is attributed to the tendency of women to attend to sound due to their roles in child bearing (Dratva et al., 2010). However, a laboratory study (Ma & Gong, 2013), which investigated the impact of gender on sensitivity to noise with different frequency components, concluded that boys are more sensitive to noise with low frequency. In addition, people experience different level of annoyance when exposed to different levels of noise from various sources (Kryter, 2007). A study on noise generated by a wind turbine suggested that a negative attitude to and visibility of noise sources might increase the level of annoyance response (Janssen et al., 2011). Taken together, the studies suggest that noise annoyance is a complex psychological construct, linked to several factors.

There are two theories forwarded to explain how noise affects those exposed to it: arousal theory and attention theory. In arousal theory, noise is considered as a form of stressor, which is an external stimulus that can cause harmful mental arousal or overstimulation (Haines, Stansfeld, Job, Berglung, & Head, 2001). A part of the brain called cerebral cortex needs an optimal level of arousal to detect and process impulses of auditory nerves, but noise can create unnecessarily high level of arousal which the brain has to deal with. In its defense response, the brain increases a neural activity to secrete an

appropriate hormone to fight the stressor, noise in this case. Then, through resistance, or fight, the stressor can be restrained, and a stable mental state can be achieved. However, if the fight continues, the brain may finally run out of resources and get exhausted (Selye, 1976; Ganzel, Morris, & Wethington, 2010). It seems that the brain needs enough resources to effectively deal with noise. Other mental activities during noise exposure may compete with these cognitive resources and increase the negative impacts of noise such as annoyance.

On the other hand, attention theory posits that attention determines how limited cognitive resources are appropriately used and that attention can be directed to unnecessary information (Bridewell & Fbello, 2016). The brain, through the auditory system, continuously scans an acoustic landscape and thus noise can compete for attention and as seen above, the brain should allocate cognitive resources to overcome a harmful effect of noise. In learning spaces, students should direct their attention to useful stimuli such as lectures, group and individual activities. It is hypothesized that background noise in classrooms can interfere with their learning by competing for attention, and the interference can lead to annoyance. This hypothesis is consistent with the findings of noise studies which found that highly annoyed respondents were those whose activities were highly disturbed by noise (Michauda & Keith, 2007).

Statement of the Problem

The negative effect of noise on children is higher because unlike adults, children are less aware of the impact of noise on their health and may not develop suitable coping strategies to minimize the harm (Stansfeld et al., 2005; vanKempen et al., 2009). They are among the

risk groups because of their immature nervous system and growing cognitive system, which cannot effectively deal with the stress caused by exposure to noise (Niemann & Maschke, 2004). There is a paucity of research on the impacts of noise on children in Africa, where the dominant sources of noise can be different from those of the high-income countries (Clark et al., 2006) and where acoustic standards for controlling noise hardly exist (Seabi, 2013). In such part of the world, the urban environmental quality has deteriorated due to an uncontrolled increase of vehicles and a large concentration of these vehicles in big cities (Oloruntoba, 2012). For instance, though Ethiopia is the least motorized country, it largely imports used vehicles aged between 15-20 years and these vehicles are mainly found in Addis Ababa (Team, 2016). Most importantly, little is known about how noise annoyance is related to different learning activities, gender and noise sources.

Objectives

The aim of this survey was to increase our knowledge of noise annoyance reaction of children, particularly in low-income countries such as Ethiopia where enough empirical data are missing in the area. Specifically, the survey was carried out to identify the major sources of noise annoyance in primary schools in Addis Ababa; and to determine if children's ratings of noise annoyance were significantly associated with type of learning activities, gender and type of noise sources.

Methods

Participants

The capital city, Addis Ababa, has mainly two types of primary schools: private and government schools. Children from rich parents are usually

sent to private schools as they can afford ever-increasing education fees. Children from low-income parents go to government schools, which are characterized by a larger class size, more student population, poorly built and furnished buildings. In the city, there are 192 government primary schools with the second cycle, which are attended by 115,002 students and participants of the study were 2,300 children drawn from government second cycle primary schools, which include children in grade eight. The total number of students in the selected primary schools was 41,704, and 10,880 of them were in grade eight (Education Bureau, 2013). Students in the second cycle were chosen because they could relatively understand the questionnaire and fill it out. The number of participants was limited based on a previous study (vanKempen et al., 2009).

Table 1: No. of children who properly filled out and returned the questionnaire in each subcity

Subcity	Schools	Female	Male	Total
Addis Ketama	6	129	107	236
Arada	6	86	83	169
Akaki Kaliti	5	176	205	381
Bole	5	106	120	226
Gullelie	5	92	89	181
Kirkos	6	107	93	200
Kolfe Keranio	6	54	50	104
Ledeta	5	186	151	337
Nefas Silk Lafto	6	123	124	247
Yeka	6	96	88	184
Total	**56**	**1155**	**1110**	**2265**

Multistage sampling was used to select the participants for the survey (Table1). First, government primary schools which have grade eight were identified in each sub-city. Then, from these schools, 56 schools were selected using a systematic simple random sampling. From each sub-city, five to six schools were selected depending on their number of schools. Finally, inclusion criteria were set to identify students who could participate in the study. Age (12-18 years), duration of stay at the schools (at least two years to identify sources of noise at their schools), hearing status (normal hearing to distinctly identify noise sources) were used to select 21.113% of the students (with equal percentage of female male) in grade eight in each selected school. From those who met the criteria, participants of the survey were chosen with a systematic simple random sampling.

To determine a hearing status, self-report hearing questions (e.g., *Do you feel you have a hearing loss in the right ear?*) were employed because an audiometric screening was not feasible given the large number of children (Weiss, et al., 2017). The data collectors were trained to strictly apply the inclusion criteria during the administration of the survey questionnaire. The average, range and standard deviation of age of the children were 14 years, six years and 1.25 respectively. The children did not report any history of hearing loss.The consents of their schools were obtained before the children took part in the study.

Procedures

By completing a questionnaire, the children indicated their annoyance responses to noise during three learning activities(listening, reading and group work), the questionnaire was set in English and translated into Amharic. Amharic is the medium of instruction in primary schools in Addis Ababa and is mother tongue for most children born and brought up in the city. The questionnaire contains 12 items associated with noise sources for each learning activity. The following question

was used in the questionnaire: “Thinking of the last six months, when you are at school [reading in classroom or library], how much does the noise from [road traffic] annoy you? “The children were told to indicate their answers on a scale consisting of five categories (*not at all, slightly annoyed, moderately annoyed, very annoyed and extremely annoyed*) as in vanKempen et al. (2009).

The content validity of the questionnaire was ensured by including noise sources reported by previous studies (Shield & Dockrell, 2003; Omubo-Pepple, Briggs-Kamara, & Tamunobereton-ari, 2010; Birhanu, 2011). The internal consistency reliability for items on each activity was estimated using Cronbach’s alpha and the alpha coefficient was 0.926, indicating collectively very good levels of internal consistency. The children filled out the questionnaire at their schools and could ask data collectors if they were not able to understand items in the questionnaire.

Statistical Analysis

Questionnaires completed by 35 children were not included in the analysis because the questionnaires were not properly filled in but the remaining 2, 265 children properly filled in the questionnaires and returned them. Instead of including all noise sources, factorial analysis was conducted in SPSS version 24 to identify the major ones, and two major noise sources, road traffic and students’ talk, were used in the analysis of noise annoyance reaction of the children. Non-parametric statistical tests such Friedman Test, Chi-Square Test, and Wilcoxon Signed RanksTest were employed to conduct data analyses.

Results

Major noise sources

Instead of examining the annoyance responses of children to many noise sources, factorial analysis was conducted to identify the major ones (Table 2).The survey data had to be converted into an interval scale, following the technique described in Harwell & Gatti (2001) because ordinal data are not suitable for factorial analysis. The factorial analysis was run for each leaning activity as described in Ozer, Firat, & Bektas (2009). The analysis identified two factors with eigenvalues of over 1.0 for each learning activity and these factors accounted for 24 % to 34 % of the variances after rotation (Table 2). Road traffic and students' talk were best loaded on the first and the second factors respectively. The factor loading for road traffic was 0.582 for reading, 0.663 for listening, and 0.699 for group work while that of students' talk was 0.676 for reading,0.718 for listening and 0.715 for group work (Table 2). Finally, an internal consistency for each factor was computed using Cronbach's Alpha, which yielded coefficients from 0.923 to 0. 924. The alpha coefficients show that the annoyance ratings of the two factors identified were internally consistent.

Table 2: Summary of factorial analysis and two factors (in bold type) with highest factor loadings for noise annoyance during learning activities

	Factors					
Sources	Reading		Listening		Groupwork	
	1	2	1	2	1	2
Road traffic	**0.582**	0.171	0**.663**	0.140	**0.699**	0.131
Construction site	0.565	0.136	0.570	0.168	0.613	0.172
Religious organization	0.278	0.187	0.304	0.146	0.366	0.168
Business organization	0.546	0.122	0.564	0.135	0.611	0.146
Playground	0.160	0.364	0.189	0.442	0.174	0.467
Public announcement	0.487	0.219	0.541	0.219	0.620	0.197
Air traffic	0.366	0.160	0.385	0.136	0.417	0.187
Students hanging around	0.139	0.668	0.164	0.708	0.196	0.704
Adjacent classroom	0.223	0.609	0.228	0.679	0.203	0.717
Neighborhood	0.443	0.157	0.444	0.179	0.444	0.192
Student talk	0.174	**0.676**	0.156	**0.718**	0.156	**0.715**
Loose window and door	0.304	0.384	0.287	0.407	0.307	0.417
Cronbach's alpha	0.924	0.924	0.924	0.923	0.923	0.924
% of variance after rotation	29.246	29.246	31.656	31.656	34.000	34.000

Road traffic and learning activities

About one fourth of the children reported no annoyance in listening (26.3%), reading (29.6%) or group work (30.9%) due to noise from road traffic (Table 3). Most of the children reported annoyance, but at

different levels, with those very or extremely annoyed constituting a smaller proportion. Road traffic caused an extreme level of annoyance in 14.9% of the children in listening, and in 10.5 % of the children in reading. Except in the greatly annoyed groups, the proportion of children annoyed decreases as the level of annoyance rating increases.

Table 3: Percentage and number of children annoyed by road traffic during different learning activities (N=2265)

	Levels of Annoyance				
Activities	Not At all	Slightly Annoyed	Moderately Annoyed	Very Annoyed	Extremely Annoyed
Listening	26.3 (595)	24.2 (548)	22 (498)	12.7 (287)	14.9 (337)
Reading	29.6 (670)	25.9 (587)	23.7 (537)	10.3 (233)	10.5 (238)
Groupwork	30.9 (699)	22.7 (514)	21(475)	11 (261)	14 (316)

For instance, the percentage of children slightly annoyed in all learning activities is greater than those moderately annoyed. In reading 27%, in listening 25% and in group work, 23.2 % of the children were slightly annoyed while 24 %, 22.4% and 21.3 % of the children were moderately annoyed in listening, reading and group work respectively. Friedman Test indicated that the children were more significantly annoyed in listening (Mean rank = 2.09) than in reading (Mean rank = 1.92) and group work (Mean rank = 1.99), and in group work than in reading, $\chi 2\ (2, N = 2,265) = 61.82, p<001$. This result is indicative of a significant link between traffic noise annoyance in children and the type of leaning activity disturbed.

Road traffic and gender

The proportions of children annoyed decrease as the level of annoyance increases and this is more obvious in girls (Table 4). The children experienced various levels of traffic noise annoyance, with more proportion of girls (42.6 % or 30.1 % in group work) reporting no or slight level of annoyance. More percentage of boys than girls reported very, or extreme level of annoyance in all learning activities. For instance, 22.8% of the boys were extremely annoyed while 7.5 % the girls reported the same level of annoyance in listening.

Table 4: Percentage and number of girls and boys annoyed by road traffic (N=2265)

		Levels of Annoyance				
Gender	Activity	Not At All	Slightly Annoyed	Moderately Annoyed	Very Annoyed	Extremely Annoyed
Female	Reading	42.6(492)	30.1(348)	17.1(197)	6.1(71)	4.1(47)
	Listening	39.4(455)	28.6(330)	18.2(210)	6.6(76)	7.3(84)
	Groupwork	46.1(533)	24.8(286)	17.1(198)	6.6(76)	5.4(62)
Male	Reading	16(178)	21.5(239)	30.6(340)	14.6(162)	17.2(191)
	Listening	12.6(140)	19.6(218)	25.9(288)	19(211)	22.8(253)
	Groupwork	15(166)	20.5(228)	25(277)	16.7(185)	22.9(254)

Chi-Square Test indicates that there was a significant difference between girls and boys in rating traffic noise annoyance in reading, $\chi 2\ (4,\ N = 2{,}265) = 327.38,\ p<001$, listening, $\chi 2\ (4,\ N = 2{,}265) = 349.37,\ p<001$and group work, $\chi 2\ (4,\ N = 2{,}265) = 373.81,\ p<001.$ It can be concluded that gender is significantly related to children's noise annoyance reaction in learning activity. It seems that boys and girls are differentially affected by noise annoyance caused by road traffic.

Students' talk and learning activities

The greatest proportion of children experienced a slight level of annoyance when noise interfered with reading (25.3%), listening (24.5 %) and group work (24) at school (Table 5). The percentage of children who reported no annoyance in the leaning tasks is less than those who were annoyed at other levels.The difference among those who were slightly, moderately very and extremely annoyed is smaller but the difference between those annoyed and those unaffected is comparatively bigger. The percentage of children who reported no annoyance was very small in all activities compared to those who were annoyed, and the children's ratings of annoyance were similar across the activities (Table 5). In reading 9.9 %, in listening 9.4%, and in group work 10.5% of them responded that they were not annoyed at all. The proportion of those who were very annoyed was relatively the lowest in group work (18.5%).

Table5 Percentage and number of children annoyed by students' talk during learning activities (N=2265).

	Levels of Annoyance				
Activity	Not At All	Slightly Annoyed	Moderately Annoyed	Very Annoyed	Extremely Annoyed
Reading	9.9(225)	25.3(572)	20.5(465)	20.8(471)	23.5(532)
Listening	9.4(213)	24.5(554)	21.5(486)	21.1(478)	23.6(534)
Groupwork	10.5(237)	24(543)	22.2(502)	18.5(4190	24.9(564)

Friedman Test shows that mean ranks of annoyance ratings were not more significantly different in reading (1.98), listening (2.01) and group work (2.01),$\chi 2\ (2,\ N\ =2,265)\ =\ 2.98,\ p=0.23$.This indicates that noise annoyance reaction of children is not significantly associated with the type of learning activities interfered. Noise from students' talk seems to affect all learning activities in a similar way. In other words, the annoyance reaction of children to noise from students' talk does not depend on a type of activity.

Students' talk and gender

More percentage of girls than boys reported no or slight annoyance whereas more proportion of boys than girls reported very or extreme level of annoyance (Table 6). For instance, 28.5 % of the boys were extremely annoyed while 21.5 % the girls reported the same level of annoyance in group work.

Table 6: Percentage and number of female and male children annoyed by road traffic (N=2265)

		Levels of Annoyance				
Gender	Activity	Not At All	Slightly annoyed	Moderately Annoyed	Very Annoyed	Extremely Annoyed
Female	Reading	12.6(146)	29(335)	19.5(225)	17.1(197)	21.8(252)
	Listening	11.9(138)	26.3(304)	21.1(244)	19.7(228)	20.9(241)
	Groupwork	12.8(148)	27.1(313)	22.9(265)	15.7(181)	21.5(248)
Male	Reading	7.1(79)	21.4(237)	21.6(240)	24.7(274)	25.2(280)
	Listening	6.8(75)	22.5(250)	21.8(242)	22.5(250)	26.4(293)
	Groupwork	8(89)	20.7(230)	21.4(237)	21.4(238)	28.5(316)

Girls and boys seem to converge in their ratings of moderate level of annoyance in all learning activities. The ratings range from 19.5 % to

22.9 % for all activities and this implies that the respondents did not greatly differ in their ratings of a moderate level of annoyance. However, overall, there is a significant difference between girls and boys in rating students' talk annoyance in reading, $\chi 2\ (4, N = 2,265) = 50.41,\ p<001$, listening, $\chi 2\ (4, N = 2,265) = 29.01,\ p<001$ and group work, $\chi 2\ (4, N = 2,265) = 44,\ p<001.$ Gender is reliably associated with children's rating of annoyance reaction to noise of students' talk, with boys more annoyed than girls irrespective of type of learning activity.

A comparison of road traffic and students' talk

The last objective of the survey was to identify if the median ratings of the children significantly differed in noise sources such as road traffic and students' talk. The comparison of annoyance ratings of the children shows that the proportion of children who reported no (16 %)or slight (27.2%) annoyance was greater in road traffic while those who reported very (25.3 %) or extreme (24.9%) annoyance was greater in students' talk (Table 7).

Table 7. Percentage and number of children annoyed by road traffic and students' talk (N=2265)

	Levels of Annoyance				
Noise Source	Not At All	Slightly Annoyed	Moderately Annoyed	Very Annoyed	Extremely Annoyed
Road Traffic	16(362)	27.2(616)	28.3(642)	16.7(379)	11.7(266)
Students' Talk	3.5(79)	18.5(418)	27.9(631)	25.3 (574)	24.9 (563)

Once again, the ratings of the children seem to converge at moderate level of annoyance as the ratings in road traffic (28.3 %) and students' talk (27.9%) were almost equal. Wilcoxon Signed Ranks Test shows that the median ratings of the children significantly differed in road traffic (median = 3) and students' talk (median = 4), $Z= 20.\ 47,\ p< 0.001$, with a sizable proportion of children more annoyed by

students' talk than road traffic. Finally, the survey reveals that children's annoyance reaction is linked to the type of noise that interferes with their learning activities.

Discussion

Road traffic and students' talk were identified as major sources of noise annoyance for primary schools in Addis Ababa. It came as no surprise that road traffic, which includes commercial and passenger vehicles, was identified as the major source of noise annoyance. Out of 150,000 vehicles registered in 2014 in Ethiopia, 90,000 and 60,000 of them were passenger and commercial vehicles respectively (Team, 2016). The vehicles are old and mostly found in Addis Ababa where the survey was conducted. Road traffic is also reported as source of noise in primary schools in other countries (Sanz, Garcial, & Garcia, 1993; Oloruntoba, 2012). A survey conducted in primary schools in Ghana revealed that 80 % the children reported traffic noise, which includes road traffic, as a source of noise for their schools (Sowah, Alfred, Carboo, & Adaboh, 2014). Similarly, a survey of sources of noise for primary schools in London showed that 85 % of the respondents considered road traffic as a source of noise for their schools (Shield & Dockrell, 2004). Road traffic may continue to be a major source of noise annoyance for primary schools in Addis Ababa because the import of vehicles increases every year, on average, by two percent (Team, 2016).

Noise generated in classrooms by students while doing learning activities was also identified as a major source of noise annoyance. Previous studies also reported that internal noise, which includes student talk, is a major source of noise in primary schools (Shield & Dockrell, 2003). A similar finding was reported in Debnath, Nath, & Barthakur, (2012) where 40 % of school children considered students'

talk as a major source of noise. Recent teaching methods differ greatly from the traditional lecturing method and teachers are encouraged to employ learner-centred methods where students are more interactive, working in groups. Because of this shift in learning methods, a great deal of noise is likely to come from students' activities. The noise generated in classrooms is related, among others, to number of students per classroom. The ratio is 42 in primary schools in Addis Ababa in 2011 (MOE, 2011), which suggests that classrooms can be noisy when children do activities which involve talking. A noise survey carried out in primary and high schools in Birjand city in Iran indicated that the level of noise pollution in schools is related to number of students per class, with more pollution attested in classes with a greater ratio (Sayadi, Movafagh, Kargar, & Movafagh, 2012).

The current survey reveals the children were more significantly annoyed by road traffic in listening than in reading and group work. Listening and reading involve an active processing of information but reading requires a decoding of textual information while listening requires decoding of auditory information. If concentration is disrupted in reading, the children will have the chance to read again or other time, but the transient nature of spoken information does not allow this chance. In addition, the pace of reading is usually controlled by the children themselves, but they do not have control over the speed with which their teachers and classmates speak. Most importantly, noise seems to affect listening more adversely than reading because noise masks information-bearing cues in speech, reducing its intelligibility (Dubbelboer & Houtgast, 2007; Bradley & Sato, 2008; Wong, Elaine & Soli, 2012). Similarly, empirical data show that interference of activities at school are significantly linked to the level of annoyance, with severe annoyance linked to increased disturbance of activities (vanKempen et al., 2009).

The survey also indicates that children were more significantly annoyed in group work than in reading. Recently, in Ethiopia, teachers employ group work to improve the deteriorating quality of primary education (Fekede Tuli & Fiorucci, 2012) and noise might have caused high level of annoyance in the children when it disturbed this highly-promoted mode of learning. The alternative explanation is that group work is usually timed and competitive, and thus any distraction in the task could produce anger or fear of finishing the task on time. It is also possible that annoyance is higher in group work due to the nature of the task to generate more noise, which may in turn lead to Lombard Effect or Café Effect when children raise their voice to be heard against the background noise (Klatte et al., 2010). Clearly, more research is needed to examine why annoyance is greater in group work compared to reading.

The other finding of the survey is that a significant proportion of boys were more annoyed than girls irrespective of type of noise sources and learning activities, which indicates a significant link between gender and noise annoyance in children. Similarly, some previous studies reported that boys are more annoyed than girls when exposed to noise. vanKempen et al. (2010) conducted a noise survey in 89 primary schools around three European airports and found that boys are more annoyed by noise of air traffic. Belojevic, Evans, Paunovic, & Jakovljevic (2012) also noted that chronic noise exposure from road traffic at home could interfere with activities of only boys in elementary schools. However, the study conducted on 2565 Canadians (aged 15 years and older) showed that women are more annoyed by road traffic (Michaud & Keith, 2007; Michaud et al., 2008; Dratva, et al., 2010). The age of the participants may account for the discord between the two studies; in the current study, the participants are children aged 12 to 18 years.

There are also previous studies which indicate that noise annoyance is similar in both girls and boys, suggesting lack of significant association between gender and noise annoyance in children. For instance, Bockelbrink et.al (2008) investigated noise annoyance in which 652 German children took part and they found no significant difference between boys and girls.One may wonder why the studies have produced contradictory results. Many speculations could be made but sensitivity to different frequency components of noise might have caused the variation. A laboratory study indicated that boys are more sensitive to low frequency noise which may constitute most part of background noise in schools (Ma & Gong, 2013) and sensitivity is known to linked to increased annoyance (Miedema & Vos, 1999; Benfield et al., 2014). More rigorous study is needed to adequately investigate why noise annoyance is different between boys and girls.

Finally, it is found that noise annoyance reaction of children is linked to type of noise, with students' talk causing a higher level of noise compared to road traffic. This finding is consistent with the result of a previous study in which students' talk is reported to be more annoying than noise of vehicles such as lorries, buses and cars (Connolly, Dockrell, Shield, Conetta, & Cox, 2015). Such study also reported that infrequent noise is more annoying and thus road traffic can be less frequent compared to students' talk, causing relatively less level of annoyance in the children in the current study. The significantly higher annoyance caused by students' talk can also be accounted for by intensity, tonality, and informational contents of students' talk because these acoustic factors are known to result in higher annoyance reaction (Sailer & Hassenzahal, 2000).

The survey has investigated noise annoyance in children without measuring levels of noise the children were exposed to, but it has practical and theoretical implications. It provides useful information

about annoyance reaction of children to noise from road traffic and students' talk. Results of the survey calls for a practical step to alleviate noise annoyance in children by improving classroom acoustics and by teaching negative impacts of noise on leaning and health. An unabated higher level of annoyance can result in other health problems and a low academic performance in children.

More importantly, the survey raises a theoretical issue which needs to be addressed. In the literature on noise annoyance, the mechanism that accounts for the association between leaning activity disturbed and annoyance is not clearly known. More specifically, it is not clear how noise causes different levels of annoyance by disturbing different learning activities. What is clear is that children report different levels of annoyance while doing classroom activities in a noisy environment. According to arousal theory, noise affects the brain acting as a stressor, causing higher arousal, which the brain should cope with by mobilizing resources (Selye, 1976; Ganzel, Morris, & Wethington, 2010). Attention theory also posits that attention can be captured and directed to an unwanted stimulus (Bridewell & Fbello, 2016). Thus, it is more likely that depending on its cognitive demands, a learning activity may increase an allostatic load by competing for a limited mental resource or attention. Annoyance is very complex and thus a more robust and comprehensive theory is needed to explain how noise causes annoyance, and why an annoyance level varies with gender, noise sources and type of activities.

Conclusions

Road traffic and students' talk are identified as major sources of noise annoyance in primary schools in Addis Ababa. The children in the survey reported significantly higher annoyance for students' talk than road traffic. They also experienced significantly higher annoyance in listening than in group work and reading, and in group work than in reading for road traffic. Moreover, significantly greater proportion of boys than girls were annoyed by noise from road traffic and students' talk in all learning activities. In sum, the results of the survey demonstrate that noise annoyance in children is linked to noise sources, gender and type of learning activities children do at school.

Acknowledgments

Thanks are due to Addis Ababa University for its financial support and to the children for providing data for the survey.

References

Amram, O., Abernethy, R., Brauer, M., Davies, H., & Allen, R. W. (2011). *Proximity of public elementary schools to major roads in Canadian urban areas.* **International Journal of Health Geographics**, *10*(1), 68. Retrieved from http://doi.org/10.1186/1476-072X-10-68.

Belojevic, G., Evans, G. W., Paunovic, K., & Jakovljevic, B. (2012). *Traffic noise and executive functioning urban primary school children: The moderating role of gender.* **Journal of Environmental Psychology***, 32* , 337 -341. Retrieved from https://www.sciencedirect.com/ science/article/pii/S0272494412000370

Benfield, J. A., Nurse, G. A., Gibson, A. W., Taff, B. D., Newman, P., & Bell, P. A. (2014). *Testing Noise in the Field : A Brief Measure of Individual Noise Sensitivity.* Retrieved from http://doi.org/10.1177/0013916512454430.

Birhanu Aberra. (2011). *Environmental noise pollution in Addis Ababa: Major sources and public reactions in Addis Ababa*. **Forum for Environment** 2011.

Bodin, T., Bjork, J., Ohrstrom, E., Aldo, J., & Albin, M. (2012). *Survey context and question wording affects self reported annoyance due to road traffic noise: a comparison between two cross-sectional studies.* **Environ Health**, *11*(1), 14. Retrieved from http://doi.org/10.1186/1476-069X-11-14.

Bockelbrink, K. et al., (2008). *Environmental Noise and Asthma in Children: Sex-Specific Differences.* **Journal of Asthma**. 45(9). Retrieved from https://doi.org/10.1080/02770900802252127

Boman, E., & Enmarker, I. (2004). *Factors Affecting Pupils' Noise Annoyance in Schools: The Building and Testing of Models.* **Environment & Behavior**, *36*(2), 207–228. http://doi.org/10.1177/0013916503256644.

Botteldooren, D., & Verkeyn, A. (2002). *Fuzzy models for accumulation of reported community noise annoyance from combined sources.* **The Journal of the Acoustical Society of America**, *112*(4), 1496–1508. http://doi.org/10.1121/1.1506366.

Bradley, J. S., & Sato, H. (2008). *The intelligibility of speech in elementary school classrooms.* **The Journal of the Acoustical Society of America,** *123*(4), 2078–2086. Retrieved from http://doi.org/10.1121/1.2839285.

Bridewell, W., & Fbello, P. F. (2016). *A Theory of Attention for Cognitive Systems*. **Advances in Cognitive Systems**, (4) 1-16. Retrieved from https://link.springer.com/book/10.1007/978-3-540-77343-6

Clark, C., Martin, R., Van Kempen, E., Alfred, T., Head, J., Davies, H. W., Stansfeld, S. (2006). *Exposure-effect relations between aircraft and road traffic noise exposure at school and reading comprehension: The RANCH project.* **American Journal of Epidemiology**, *163*(1), 27–37. Retrieved from http://doi.org/10.1093/aje/kwj001

Crandell, C., & Smaldino, J. (2000). *Classroom acoustics for children with normal hearing and with hearing impairment.* **Language, Speech, and Hearing Services in Schools,** *31*(4), 362–370. Retrieved from http://lshss.pubs.asha.org/article.aspx?articleid=1780236.

Connolly, D. M., Dockrell, J. E., Shield, B. M., Conetta, R., & Cox, T. J. (2015). *Students' perceptions of school acoustics and the impact of noise on teaching and learning in secondary schools: Findings of a questionnaire survey*. **Energy Procedia**, *38*, 3114-3119. Retrieved from https://www.sciencedirect.com/science/article/pii/S1876610215024984

Debnath, D., Nath, S., & Barthakur, N. (Year 2012). *Environmental Noise Pollution in Educational Institutes of Nagaon Town, Assam, India.* **Global Journal of Science Frontier Research**, 12(1), 1-5. Retrieved from https://globaljournals.org/GJSFR.../1-Environmental-Noise-Pollution-in-Edu.pdf.

Dratva, J., Zemp, E., Felber Dietrich, D., Bridevaux, P.-O., Rochat, T., Schindler, C., & Gerbase, M. W. (2010). *Impact of road traffic noise annoyance on health-related quality of life: results from a population-based study*. **Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation**, *19*(1), 37–46. Retrieved from http://doi.org/10.1007/s11136-009-9571-2

Dubbelboer, F., & Houtgast, T. (2007). *A detailed study on the effects of noise on speech intelligibility.* **The Journal of the Acoustical Society of America**, *122*(5), 2865–2871. http://doi.org/10.1121/1.2783131

Education Bureau of Addis Ababa. (2013). *Schools data*. Addis Ababa, Ethiopia.

Fekede Tuli., & Fiorucci, M. (2012). *Examining Quality Issue in Primary School in Ethiopia: Implications for Attainment of Education for All.* **ECPS- Journal***, 12(5)*, 1-22. http://www.ledonline.it/ECPS/

Ferguson, K. T., Cassells, R. C., MacAllister, J. W., & Evans, G. W. (2013). *The physical environment and child development: an international review.* **International Journal of Psychology**, *48*(4), 437–68. http://doi.org/10.1080/00207594.2013.804190.

Ganzel, B., Morris, P. A., & Wethington, E. (2010). *Allostasis and the human brain: Integrating models of stress from the social and life sciences. Psychological Review.* **Psychological Review**, 134-174. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/20063966.

Haines, M. M., Stansfeld, S. a, Job, R. S., Berglund, B., & Head, J. (2001). *A follow-up study of effects of chronic aircraft noise exposure on child stress responses and cognition*. **International Journal of Epidemiology**, *30*, 839–845. Retrieved from http://doi.org/10.1093/ije/30.4.839

Haines, M., Stansfeld, S. A., Job, R. F., Berglung, B., & Head, J. (2001). *Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children.* **Psychological Medicine**, 265–277. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/11232914.

Harwell, M. R., & Gatti, G. G. (2001). *Rescaling Ordinal Data to Interval Data in Educational Research.* **Review of Educational Research**, 105-131. Retrieved from https://www.jstor.org/stable/3516068.

Janssen, S. a., Vos, H., Eisses, A. R., & Pedersen, E. (2011). *A comparison between exposure-response relationships for wind turbine annoyance and annoyance due to other noise sources.* **The Journal of the Acoustical Society of America**, *130*(6), 3746. Retrieved from http://doi.org/10.1121/1.3653984

Klatte, M., Hellbruck, J., Seidel, J., & Leistner, P. (2010). *Effects of Classroom Acoustics on Performance and Well-Being in Elementary School Children: A Field Study.* **Environment and Behavior,** *42*(5), 659–692. Retrieved from http://doi.org/10.1177/0013916509336813

Kryter, K. D. (2007). *Acoustical, sensory, and psychological research data and procedures for their use in predicting effects of environmental noises.* **The Journal of the Acoustical Society of America**, *122*(5), 2601–2614. Retrieved from http://doi.org/10.1121/1.2782748

Lam, K. C. (2012). *Final Report for the Provision of Service for the Study of Health Effects of Transportation Noise in Hong Kong*. Retrieved from http://www.epd.gov.hk/epd/english/en.

Ma, H., & Gong, S. (2013). Laboratory study on effects of environment noise on children's short-term memory, *19*, 040119–040119. Retrieved from http://doi.org/10.1121/1.4801063

Michaud, D. S., Keith, S. E., & McMurchy, D. (2008). *Annoyance and disturbance of daily activities from road traffic noise in Canada.* **The Journal of the Acoustical Society of America**, *123*(2), 784–792. Retrieved from http://doi.org/10.1121/1.2821984

Miedema, H. M. E., & Vos, H. (1999). *Demographic and attitudinal factors that modify annoyance from transportation noise.* **The Journal of the Acoustical Society of America**, *105*(6), 3336. http://doi.org/10.1121/1.424662.

MOE. (2011). *Education Statistics: Annual Abstract.* Addis Ababa: MoE.

Niemann, H., & Maschke, C. (2004). WHO/EU, Noise effects and morbidity, 1–20. Retrieved from www.euro.who.int/__data/assets/pdf_file/0015/105144/WHO_Lares.pdf.

Oloruntoba E. O. (2012). *Urban Environmental Noise Pollution and Perceived Health Effects in Ibadan, Nigeria*. **Afr. J. Biomed. Res**., *15*(2), 77–84. Retrieved from https://www.ajol.info/ index.php/ajbr/article/view/95279

Omubo-Pepple, V. B., Briggs-Kamara, M. A., & Tamunobereton-ari, I. (2010). *Noise Pollution in Port Harcourt Metropolis: Sources, Effects, and Control*. **The Pacific Journal of Science and Technology**, 11(2), 592- 598. Retrieved from https://www.facta.junis.ni.ac.rs/walep/walep2010/walep2010-04.pdf

Ozer, Z. C., Firat, M. Z., & Bektas, H. A. (2009). *Confirmatory and Explanatory Factor Analysis of the Caregiver Quality of Life Index Caner with Turkish Samples.* **Quality of Life Research**, 18(7), 913-921.https://www.ncbi.nlm.nih.gov/pubmed/19554474.

Sailer, U., Hassenzahal, M. (2000). *Assessing noise annoyance: an improvement-oriented approach.* **ERGONOMICS**, 2000, VOL. 43, NO. 11, 1920- 1938. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/11105980.

Seabi, J. (2013). *An epidemiological prospective study of children's health and annoyance reactions to aircraft noise exposure in South Africa.* **International Journal of Environmental Research and Public Health**, *10*(7), 2760–2777. Retrieved from http://doi.org/10.3390/ijerph10072760

Stansfeld, S., Berglund, B., Clark, C., Lopez-Barrio, I., Fischer, P., Ohrström, E., Berry, B. F. (2005). *Aircraft and road traffic noise and children ' s cognition and health : a cross-national study*. **Lancet**, *365*, 1942–1949. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15936421.

Sanz, S. A., Garcial, A. M., & Garcia, A. (1993). *Road traffic noise around schools: a risk for pupil's performance?* **Int Arch Occup Environmental Health** , 205-207. Retrieved from https://link.springer.com/article/10.1007/BF00381157

Sayadi, M., Movafagh, A., Kargar, R., & Movafagh, K. (2012). *Evaluation of Noise pollution in the schools of Birjand city and its administrative solutions, in 2011*. **JOHE**, 132-138. Retrieved from https://plu.mx/plum/a/?doi=10.18869/acadpub.johe.1.3.132.

Selye, H. (1976). **The Stress of Life**. New York: McGraw-Hill. Retrieved from https://www.amazon.com/Stress-Life-Hans-Selye/dp/0070562121.

Shield, B. M., & Dockrell, J. E. (2003). *The effects of noise on children at school: A review.* **J. Building Acoustics**, 97-106. Retrieved from https://www.researchgate.net/.../245525976_The_Effects_of_Noise_on_Children_at_Sc.

Shield, B., & Dockrell, J. (2004). *External and internal noise surveys of London primary schools.* **J. Acoust**. **Soc**. *Am*, 730–738. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/15000185.

Shield, B. M., & Dockrell, J. E. (2008). *The effects of environmental and classroom noise on the academic attainments of primary school children.* **The Journal of the Acoustical Society of America**, *123*(1), 133–144. Retrieved from http://doi.org/10.1121/1.2812596

Sowah, R. A., Alfred, Y. A., Carboo, D., & Adaboh, R. K. (2014). *Noise Pollution in Teshie-Nungua Schools.* **Journal of Natural Sciences Research Journal of Natural Sciences Research**, 90-98. Retrieved from https://iiste.org/Journals/index.php/JNSR/article/view/16795

Team, D. R. (2016). **Navigating the African Automotive Sector: Ethiopia, Kenya and Nigeria.** Johannesburg: Creative Services at Deloitte. Retrieved from https://www2.deloitte.com/.manufacturing/.../navigating-the-african-automotive-sect...

vanKempen, E. E. M. M., van Kamp, I., Stellato, R. K., Lopez-Barrio, I., Haines, M. M., Nilsson, M. E., Stansfeld, S. a. (2009). *Children's annoyance reactions to aircraft and road traffic noise*. **The Journal of the Acoustical Society of America**, *125*(2), 895–904. Retrieved from http://doi.org/10.1121/1.3058635

vanKempen, E., van Kamp, I., Nilsson, M., Lammers, J., Emmen, H., Clark, C., & Stansfeld, S. (2010). *The role of annoyance in the relation between transportation noise and children's health and cognition.* **The Journal of the Acoustical Society of America**, *128*(5), 2817–2828. Retrieved from http://doi.org/10.1121/1.3483737

Weiss, A., Sommer, G., Kuonen, R., Scheinemann, K., Grotzer, M., Kompis, M., & Kuehni, C. E. (2017). *Validation of questionnaire-reported hearing with medical records: A report from the Swiss Childhood Cancer Survivor Study.* **PLOS One** , 1-15. Retrieved from https://doi. org/ 10.1371/journal.pone.0174479.

Wong, L. L. N., Ng, E. H. N., & Soli, S. D. (2012). *Characterization of speech understanding in various types of noise.* **The Journal of the Acoustical Society of America,** *132*(4), 2642. Retrieved from http://doi.org/10.1121/1.4751538.