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Ettien Koffi
St. Cloud State University

BENJAMIN WITTS

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SOCIO-ACOUSTIC SURVEY RESPONSES TO INFANT CRY SAMPLES: WHY INTENSITY IN dBA MATTERS THE MOST

ETTIEN KOFFI AND BENJAMIN N. WITTS

ABSTRACT

Infant cry researchers, Fairbrother et al. (2019), Collardeau et al. (2019), Rahman et al. (2023), among others, have reported that crying alone triggers unwanted and intrusive thoughts in some postpartum parents, including thoughts of harming their babies. Barr (2014) states unambiguously that crying is the main trigger of Shaken Baby Syndrome (SBS), also referred to as Abusive Head Trauma (AHT). Yet so far, there is no consensus in academic circles as to which acoustic correlate is responsible for triggering these thoughts or actions. Most work to date is concentrated on F0/pitch, though findings about its influence are conflicting. Meanwhile Koffi (2022) and Koffi (2023) contend that intensity as measured in dBA is very likely the most aversive correlate. The current study reports on the findings of a socio-acoustic survey of 50 adults who heard and ranked four sample cries of varying intensity levels: ≤ 70 dBA, 71-75 dBA, 76-80 dBA, and ≥ 81 dBA. The findings indicate that the participants ranked cries whose decibel levels are ≥ 76 dBA as the most annoying. The paper explains why.

Keywords: Infant Cry, Cry Annoyance Scale, Tolerable Cry, Annoying Cry, Aggravating Cry, Maddening Cry, Intrusive Thoughts, Hyper-annoyance, Hypo-annoyance, Annoyance Score, Intermittence Penalty, Nocturnal Penalty

1.0 Introduction

Socio-acoustic surveys are routinely carried out in noise and vibration research when airport, railroad, or highway projects that pass through, over, or in the vicinity of residential areas are being considered. Interested parties are asked to participate in such surveys to help gauge the levels of noise annoyance that can be tolerated. In 1993, the International Commission on the Biological Effects to Noise (ICBN) standardized a four-point scale to be used in such surveys. Koffi (2023) adapted the ICBN model and created a cry annoyance scale to elicit the reactions of adults exposed to infant crying. In fall 2022 and spring 2023, he and Author 2 carried out a socio-acoustic survey in which 50 adults participated. The survey generated a wealth of valuable data. This paper reports only on the participants' rankings of intensity levels in four cry samples. Subsequent publications will consider ancillary issues at the interface between gender, age, parental status, and babysitting experience and infant crying. The present paper is subdivided into four installments. The first provides some background information on the survey. The second describes the participants' reactions to four cry samples. The third explains why ≥ 76 dBA is a very important threshold. The fourth follows up with recommendations for mitigating the undesirable effects of high decibel crying.

1.1 The Survey Instrument and Background Information

Koffi (2023) proposed a four-point cry annoyance scale which was used to elicit the reactions of 50 adults who heard four cry samples. This socio-acoustic survey began in fall 2022

and concluded in spring 2023.[1] The survey instrument is displayed below. Permission was obtained from the Institutional Review Board (IRB) at St. Cloud State University, our home institution, prior to the administration of the survey. Author 2 wrote the protocols and the Informed Consent, and Author 1 administered the survey to all participants, except one. Author 1 and 2 explained the instructions verbally to each participant or to groups of participants.

1.2 Survey Instructions

The instructions and all other materials in the survey are exactly as they appear below:

1. You are going to hear four cry samples.
2. You will hear them 3 times.
3. You are asked to rank them on a Likert scale.
4. Do not rank them the first time you hear the cry samples. Just listen to all of them.
5. You can start ranking them the second and third times around.
6. Rank them as follows: **1**=Tolerable, **2**=Annoying, **3**=Aggravating, **4**=Maddening.
7. The cries are in a random order.
8. Do **NOT** use a ranking number twice.

Cry Audio	Cry Index
Cry 1	
Cry 2	
Cry 3	
Cry 4	

Please, provide us with the following sociometric information:

1. What is your gender? _____
2. How old are you? _____
3. Are you a parent now or have you been a parent before? _____
4. Are you a babysitter now or have you babysat before? _____

The order in which the cry samples were presented to participants was counterbalanced. The intensity levels heard by the survey takers are listed below. They represent the four indices on the cry annoyance scale:

1. An index of 1 means "Tolerable" and corresponds to intensity levels ≤ 70 dBA.
2. An index of 2 means "Annoying" and corresponds to intensity levels of 71-75 dBA.
3. An index of 3 means "Aggravating" and corresponds to intensity levels of 76-80 dBA.
4. An index of 4 means "Maddening" and corresponds to intensity levels ≥ 81 dBA.

The intensity thresholds on the annoyance scale are not arbitrarily selected. They are found in many sound level meters, including Roy and Siebein's (2019) popular SoundPrint App. As

[1]The responses were sent to the Statistical Consulting and Research Center of St. Cloud University on May 17, 2023, and the results were made available on May 31st, 2023. We are grateful to **Dr. Ibrahim Soumare**, the director of the Center, for working with Author 1 and explaining the significance or lack thereof of elements of the survey results.

explained in Koffi (2023), Authors 1 and 2 met and agreed on the terms to be used for each index. The four indices "Tolerable," "Annoying," "Aggravating," and "Maddening" are gradable in severity, from the least annoying to the most annoying cry. No participant had any trouble understanding the scalar nature of the indices even though seven of them were non-native speakers of English. The seven nonnative speakers' proficiency is very high because they were all enrolled in an MA program at St. Cloud State University. Their native languages are as follows: Spanish, Ukrainian, Japanese, and Uzbek. One participant is a native speaker of English from New Zealand. All in all, 42 participants were born in the USA, while eight are nationals from other countries. Native language and citizenship were not considered important variables because we operated under two assumptions. The first is that the complex auditory and nervous system (CANS) of all human beings processes infant cry the same. The second is that all human infants cry similarly and that their crying produces similar effects on the human ear. No participant reported any hearing impairment.

Finally, and importantly, the four cry samples were extracted from the same infant, Baby 1F, a five-week-old whose cry bout lasted 23 minutes (Koffi 2023:40-42). Author 1's research assistant, Ms. Megan Dell'Acqua, extracted and prepared the four cry samples for use in the socio-acoustic survey. Each cry sample lasted approximately 15 seconds, which means that the cry episode that each participant heard is about 1 minute long. Collectively, the 50 participants listened to 200 cry samples (50 x 4 cry samples).

1.3 Working Hypotheses

The responses of the participants will be scrutinized in the minutest of details later in the paper. For now, let's highlight the four working hypotheses that we had prior to the administration and analysis of the survey.

1. **Hypothesis 1:** Most respondents will classify cry samples with intensity levels at ≤ 70 dBA as "Tolerable."
2. **Hypothesis 2:** The responses of most respondents will be diffuse when the intensity ranges are between 71 and 75 dBA, but most will classify it as "Annoying."
3. **Hypothesis 3:** The responses of most respondents will be diffuse when the intensity ranges are between 76 and 80 dBA, but most will classify it as "Aggravating."
4. **Hypothesis 4:** Most respondents will classify cry samples with intensity levels at ≥ 81 dBA as "Maddening."

We did not anticipate that the responses to the survey would unveil that ≥ 76 dBA would be a very important threshold that would allow us to categorize crying into **hypo-annoying** and **hyper-annoying** cries.[2] Author 1 coined these terms in analogy to hypo-speech and hyper-speech that Thomas (2011:260-1) uses in his sociophonetics textbook to classify speech rate into two main types. These two coinages are helpful because, all things being equal, crying with intensity levels ≤ 76 dBA are only mildly annoying (**hypo-annoyance**), while crying at ≥ 76 dBA is very annoying (**hyper-annoyance**). More will be said about this in 4.0.

[2] This threshold becomes even more important in subsequent publications when gender information is correlated with how men and women reacted to the four cry samples.

1.4 Survey Demographics

We already learned from 1.2 that seven participants are non-native speakers of English, and that the remaining 43 participants, except one, are native speakers who were born and raised in America. We also learned that the 50 participants speak a total of five languages, including English. There are other demographic information worth knowing. In fact, a total of 53 people were surveyed. Three were excluded because they did not follow the ranking instructions to the letter. So, their responses were thrown out. One male respondent ranked all four samples as 1, 1, 1, 1. Another male ranked the four audio samples as 1, 2, 3, 3. A 16-year-old boy took part in the survey. His mother signed an informed consent form for him to do so. She wanted him to learn about infant cry because he was about to babysit. However, since we did not make room in our IRB application for an underage participant, we had no choice but withdraw his responses. Of the remaining 50 participants, 36 self-identified as female, 13 self-identified as male, and one as transgendered. The age groups are as follows:

1. 14 respondents were 18 to 25 years old.
2. 18 respondents were between 26 to 50.
3. 17 respondents were 51 and older.

The average age of the participants is 39.79. One male participant failed to report his age. The oldest participant was a 77-year-old woman, and the youngest respondents were two males and a female who were 18 years old. All this demographic data is not particularly relevant to this paper because the focus is squarely on how the participants experienced the intensity (in dBA) levels in the four cry samples. In other words, the rankings are accounted for irrespective of the responders' age, gender, parental status, or babysitting experience.

2.0 A Quick Review of the Annoyance Scale

Before reporting on the results of the survey, an overview of the key arguments about intensity is in order for those who have not read Koffi (2020), Koffi (2022), or Koffi (2023). The 2020 paper deals with intensity and its linguistic and paralinguistic applications. In the 2022 paper, it is hypothesized that intensity in dBA was most likely the most aversive correlate in infant cry because more than 50 years of research devoted to the frequency domain (F0/pitch, formants, Center of Gravity, dysphonia, and jitter) have led to inconclusive and often contradictory findings. In his 2023 paper, Koffi provided additional evidence from noise and vibration studies that intensity could in fact be the most aversive correlate in infant cry because researchers in noise-induced annoyance have singled it out as the source of annoyance. In assessing the annoyance level caused by highway, air traffic, or railroad noises, experts do not look to the frequency domain for answers. In fact, the annoyance scale created and standardized by ICBN discusses intensity almost exclusively. The frequency domain is only mentioned sporadically and infrequently. For all these reasons, the ranking I**ntensity > Duration > Frequency** in Koffi (2022:20) still applies. The contribution of the duration correlate is often taken for granted because it is self-evident that noises that last longer cause the most annoyance. As for the duration of infant cry, Barr (2014) and many of his other papers indicate that a typical cry bout lasts 40 minutes. Some may be shorter, but others may be longer.

In contrast, the participants in our survey were exposed only to one minute of crying noise. We recognize that this duration is woefully inadequate and does reflect the everyday reality of

parents of infants who endure longer bouts of crying. No experiment can ever replicate or match the true emotions that parents feel when their infants are crying for over a long period of time. In Fairbrother et al. (2019) for example, pre and postpartum parents were recruited to listen to 10 minutes of recorded infant crying. Even though the crying is longer than ours, it still falls short of the average cry bout of 40 minutes. In other words, no cry experiments can ever match or portray accurately what goes on in the real world when an infant is crying. This caveat is important because we want the reader to know that one minute exposure to four cry samples is no match to what parents and caregivers may have to endure during one hour or more of "prolonged, hard-to-soothe, unpredictable, unexplained, uncontrollable, alarming, inconsolable" crying (Barr 2014:560). Fairbrother et al. (2019:134) report that these are the types of crying that cause 44% of parents to entertain intrusive and unwanted thoughts of "hitting, throwing, smothering, shaking, abandoning, slapping, stabbing, strangling, stepping on, and yelling at the baby." Barr notes that crying is the main event that triggers SBS/AHT. Authors 1 and 2 are reminded of the fact that intense crying can be distressing and frustrating because they have had their share of incontrollable and alarming cry bouts when their children were infants. Even though they acknowledge that one minute exposure to infant crying is very short, they are still confident that the results of their socio-acoustic survey will shed some light on why parents and caregivers experience some cries as being more distressing than others.

2.1 Cry Levels and Auditory Penalties

There are myriad reasons why a baby might cry. Similarly, there are myriad reasons why many parents and caregivers perceive infant crying as annoyance. Yet, we will highlight only two. The first is **intermittence penalty** and the second is **nocturnal penalty**. First, infant cry is highly intermittent. Bursts of short cries alternate with bursts of long cries. Manigault et al. (2022) have provided standard measurements that help account for the rhythmic groups (RGs) in cries. Any RG that is ≤ 500 msec is deemed short, while those that are ≥ 500 msec are long. These thresholds are also useful for calculating intermittence in cries. When this metrics is applied to Baby 1F's cry bout of 23 minutes, we see that it contains a total of 434 RGs, of which 73 last from 504 to 1031 msecs. In other words, long RGs account for 16.82% of the entire duration of the cry. Approximately 84% of the RGs in Baby 1F's cry bout are short because she was only 5 weeks old at the time of the recording. The alternation between short and long RGs causes the cry to be highly intermittent, and therefore more aversive to the naked ear. Some experts claim that intermittent noises carry a penalty of 10 dBA, but others estimate the penalty to be only 5 dBA. The standard intermittence penalty used in Koffi (2022) is 5 dBA. An additional penalty of 10 dBA is assessed if the cry happens at night. This penalty has been accepted as uncontroversial by the World Health Organization (WHO) for many decades. To summarize, intermittence and/or nocturnal penalties are some of the reasons why infant crying is aversive. If a sound level meter records that an infant is crying at 65 dBA during the day, parents and caregivers actually perceive it as 70 dBA loud because of the intermittence penalty. If that same cry happens at night, it carries a nocturnal penalty of 10 dBA. However, as explained in Koffi (2023:49) because the human ear perceives noise on a logarithmic scale (not on an arithmetic/linear scale), the cry ends up being perceived as 77 dBA loud. Acoustically speaking, an increase of 7 dB is huge because, according to Schnitta (2016:55), it translates into a sound power increase of 87%.

3.0 A Closer Scrutiny of the Four Cry Samples

With the overview in the preceding sections, even if readers have not read Koffi (2020), Koffi (2022), or Koffi (2023), they have enough background information to follow the interpretations of the results of the survey. We proceed with the analyses by first examining the participants' auditory perception of cries whose intensity levels are ≤ 70 dBA. Thereafter, we deal with samples cry whose intensities are 71-75 dBA, followed by 76-80 dBA, and we conclude with cries whose intensity levels are ≥ 81 dBA.

3.1 Auditory Responses to Cry Sample of ≤ 70 dBA

Roy and Siebein's (2019) SoundPrint App measures indoor noise levels. The decibel guidelines indicate that a reading of ≤ 70 dBA means that the place is "quiet," which means that the locale is "Safe for hearing, great for conversation." As explained in Koffi (2023), the adjective "quiet" was replaced by "Tolerable" on our cry annoyance scale because, no infant cry is "quiet." Even if the sound level meter reads 70 dBA, the intermittence of the cry, the time of day, its overall duration, and the cry acts of the infant may make it grate on the nerves of parents and caregivers. Even so, we hypothesized that this level of crying is very likely to be "Tolerable" by most responders. Figure 1 confirms our hypothesis.

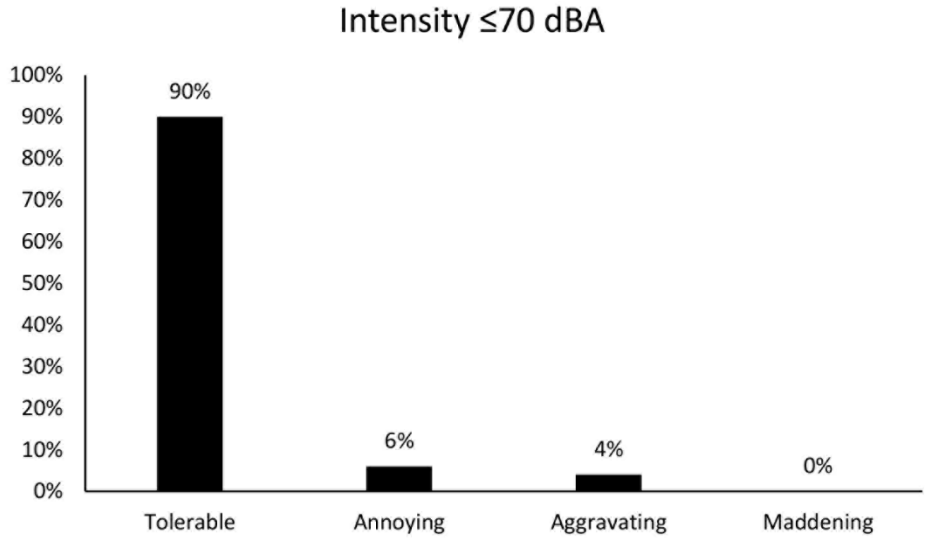

Figure 1: Auditory Responses to ≤ 70 dBA Cry Sample

An overwhelming majority of participants, 45 out of 50; 90% reported that this cry sample was "Tolerable." Only three respondents (6%) overestimated this intensity level to be "Annoying." Two other people (4%) overestimated it to be "Aggravating." No participant deemed this cry sample to be "Maddening."

3.2 Auditory Responses to Cry Sample of 71-75 dBA

Roy and Siebein's (2019) decibel guidelines suggest that there is a categorical perception of intensity in this range. They describe this noise level as "moderate," which means that it is "Safe for hearing, conducive to conversation." We hypothesized that cries within this range would elicit diffuse responses from the participants, but most will perceive it as "Annoying." Our working hypothesis is confirmed, but barely, as shown in Figure 2:

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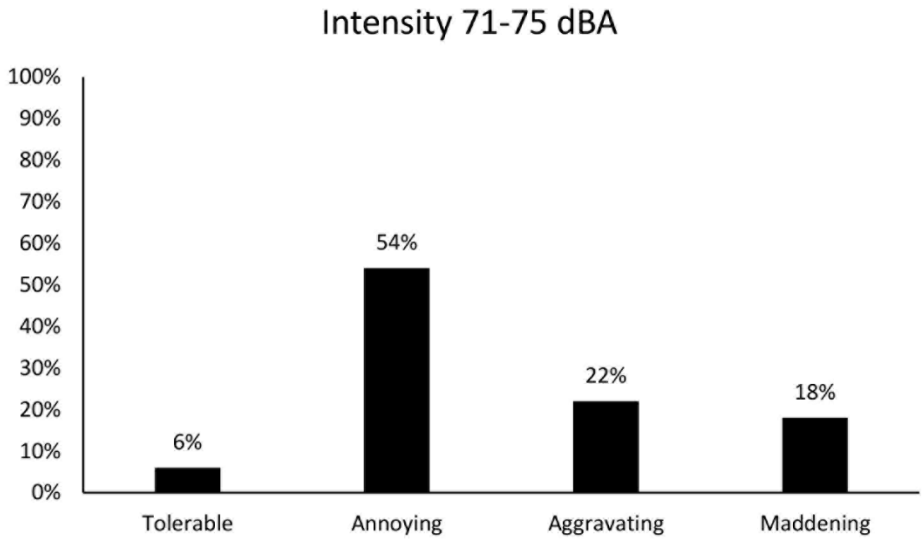

Figure 2: Auditory Responses to 71-75 dBA Cry Sample

Only a slight majority, 54% (27 out 50) perceived this cry sample exactly as "Annoying." Three respondents underestimated it as "Tolerable," eleven overestimated it "Aggravating," and nine others overestimated as "Maddening." All in all, 40% of the respondents (20 people) overestimated this sample as more than simply "Annoying."

3.3 Auditory Responses to Cry Sample of 76-80 dBA

Roy and Siebein (2019) classify noises within this range as "loud," meaning that "It is likely safe for hearing, [but] difficult for conversation." We hypothesized in 1.3 that this cry sample would elicit diffuse responses, but most will perceive it as "Aggravating." Figure 3 shows that our prediction is correct, but barely.

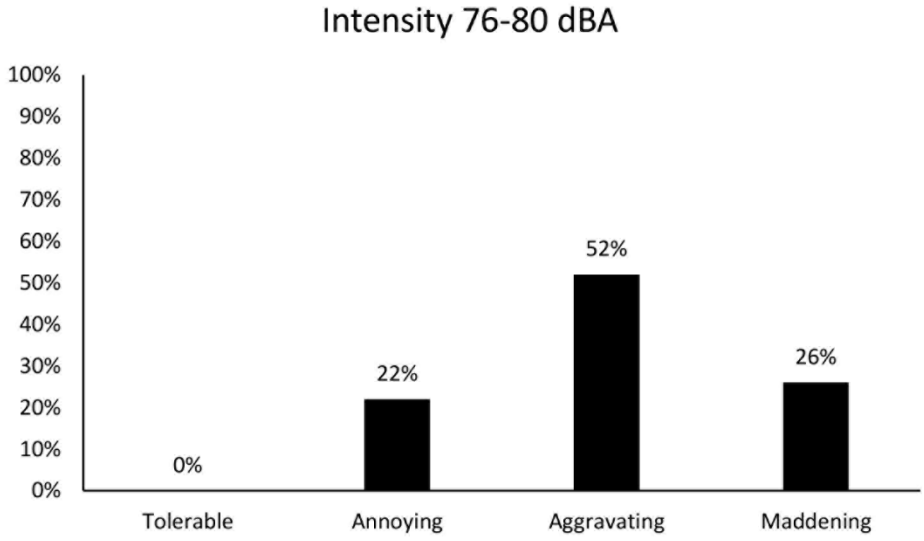

Figure 3: Auditory Responses to 76-80 dBA Cry Sample

The responses are diffuse because only 26 out of 50 (52%) respondents ranked this cry sample accurately as "Aggravating," while 13 others (26%) overestimated it as "Maddening." Eleven participants (22%) underestimated it. It seems that when the intensity levels in cries are between 71-75 dBA or between 76-80 dBA, the respondents do not perceive them as accurately as when cry samples are ≤ 70 dBA.

3.4 Auditory Responses to Cry Sample of ≥ 81 dBA

In Roy and Siebein's (2019) decibel guide, any noise that is ≥ 81 dB is labeled as "very loud" and is accompanied by the following warning, "Long exposure can cause hearing loss." We hypothesized that most respondents would perceive this cry sample as "Maddening." Our prediction is only mildly correct, as shown in Figure 4:

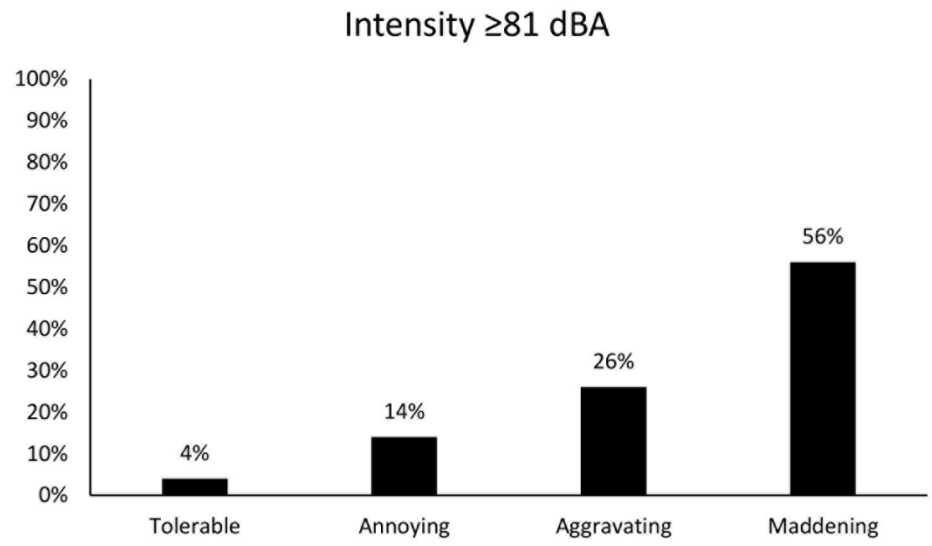

Figure 4: Auditory Responses to ≥ 81 dBA Cry Sample

The responses to this cry sample were more diffuse than we expected, with only 28 out of 50 perceiving it accurately as "Maddening." The main take-away of this section is that 41 of the 50 participants (82%) perceived cry levels of ≥ 76 dBA as aversive.

3.5 Differential Perception of Noise-Induced Annoyance

All four working hypotheses turned out to be correct. Yet, the analyses have uncovered patterns of overestimation and underestimation of cry levels. How can this be? We turn to WHO (1980:12) for an answer:

> Noise annoyance may be defined as a feeling of displeasure evoked by a noise. The annoyance-inducing capacity of a noise depends upon many of its physical characteristics including its intensity, spectral characteristics, and variations of these with time. However, annoyance reactions are sensitive to many non-acoustic factors of a social, psychological, or economic nature and *there are considerable differences in individual reactions to the same noise* [italics added for emphasis].

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The last sentence of the quote is very revealing. Fidell (2015:30) adds that "Assuming that noise exposure is the sole cause of annoyance ignores the obvious differences between people and sound level meters." Dornic and Laaksonen (1989:17) concur and add that there are "large individual differences in annoyance susceptibility, which are frequently reported in the literature." The participants in our socio-acoustic survey responded as others have done in noise annoyance studies. They too experienced cry noises differently because they had different sensitivity and tolerance levels. Yet, our survey did not take into account psychological or economic factors because we operated under the same assumption as Fidell (2015:30) did with regard to exposure airplane noise. He observed that "After all, airplanes fly over everyone: introverts and extroverts, young and old, male and female, and sensitive and insensitive." Koffi (2023:10) paraphrased this quote and applied it to infant cry as follows, "After all, infants will cry whether their parents or caregivers are introverts or extroverts, young or old, male or female, and sensitive or insensitive."

4.0 Auditory Threshold in Cry Noise Annoyance

The participants' reactions have shown that 76 dBA is the dividing line between **hypo-annoying** cries and **hyper-annoying** ones (see in 1.2 and Figure 6.) Let's re-examine the data to see why ≥ 76 dBA is such a pivotal threshold. But first, we must understand that the terms hypo-annoyance and hyper-annoyance cries do not describe a lack of annoyance. Instead, they underscore gradient levels of annoyance on a continuum. Cries that are ≤ 76 dBA are annoying but are deemed less annoying than those that are ≥ 76 dBA. The latter is more likely to invite intrusive and unwanted thoughts such as "hitting, throwing, smothering, shaking, abandoning, slapping, stabbing, strangling, stepping on the baby" that cross the minds of postpartum parents (Fairbrother et al. 2019:134). Cries with decibel levels of ≥ 76 dBA are also more likely elicit visceral responses that can lead to SBS/AHT, especially if they are "prolonged, hard-to-soothe, unpredictable, unexplained, uncontrollable, alarming, and inconsolable." Figure 6 presents data on how participants reported their levels of annoyance. Fifty-eight percent of responders divided their rankings at the 76 dBA demarcation point. Another 28% were close to the demarcation point. In other words, 86% tended to rank loud cries as more aggravating and quieter cries as less aggravating. The remaining 14% of participants might seem to be anomalous, but this likely speaks to the idiosyncratic nature of how adults view infant crying. It is here, in the 14%, where additional interesting questions might be asked, inviting further investigations. However, this line of inquiry is not pursued in the current paper because our goal is simply to uncover the tipping point at which parents and caregivers become annoyed with infant crying. Yet, Figure 5 offers various combinatorial possibilities.

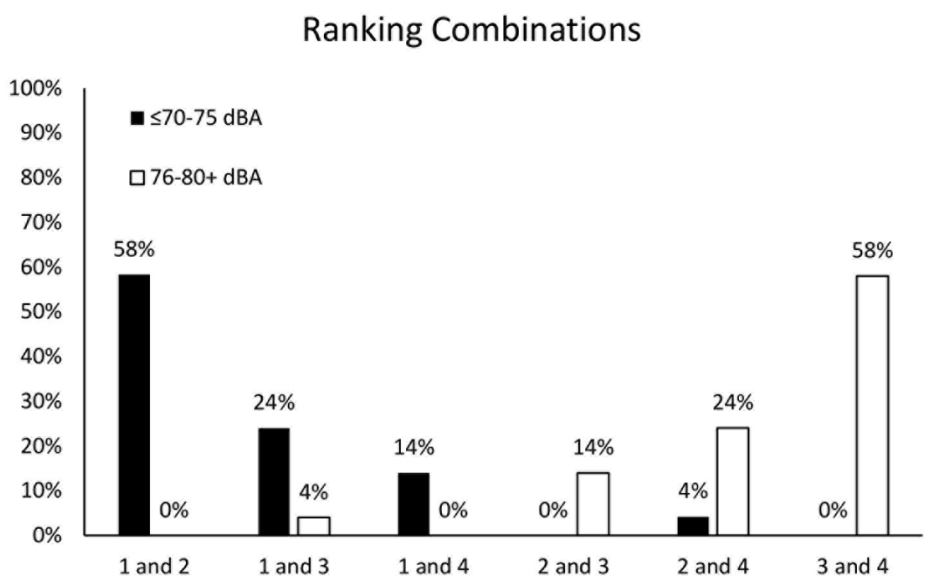

Figure 5: Ranking Combinations

The evidence that 76 dBA is an important threshold comes from the survey data itself. When the participants listened to the cry sample whose intensity levels are less than 70 dBA and 71-75 dBA, 94% and 60% of the respondents rated them respectively either as "Tolerable" or simply "Annoying." So, the averaged annoyance rate of these two cry samples is 77%. When the same respondents listened to the cry samples whose intensity levels are 76-80 dBA and ≥ 81dBA, they ranked them respectively 78% and 82% as "Aggravating" and "Maddening," yielding an average of 80%. In other words, decibel levels of ≤76 dBA were deemed to be "Tolerable" or "Annoying" by 77% of respondents, while those with decibel levels of ≥ 76 dBA, were perceived as "Aggravating" or "Maddening" by 80% survey takers. These insights are summarized and diagrammed as follows:

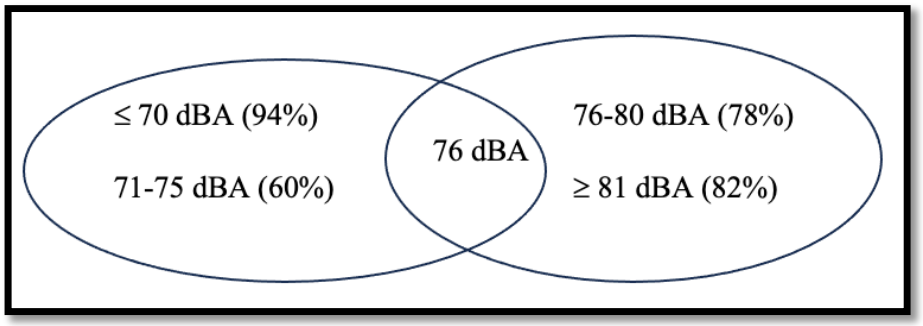

Figure 6: Critical Threshold of Annoyance

Figure 6 shows that annoyance responses crystalized around ≥ 76 dBA, making it an important threshold between hypo-annoying or hyper-annoying cries. This conclusion was reached simply by analyzing the distribution of the responses. Author 1 arrived at this conclusion several weeks prior to reading in Fink (2019:43) that the auditory threshold at which people perceive noise levels as injurious lies between 75-78 dBA. This offers an independent confirmation that ≥ 76 dBA is indeed a significant threshold in the auditory perception of infant

cry. This also confirms that the results of our survey are in the mainstream. We conclude therefore that parents and caregivers are very likely to react negatively to infant crying when decibel levels reach ≥ 76 dBA.

5.0 Infant Cry and Parental/Caregiver Well-being

When intermittence is factored in, if a sound level meter displays 76 dB as the intensity of a cry, the auditory-nervous system of parents and caregivers actually perceive 81 dBA. If the same crying takes place at night, the nocturnal penalty of 10 dBA raises the crying level to 88 dBA.[3] Since these levels are beyond the marker at which auditory pain occurs, it means that the auditory-nervous system of parents and caregivers is literally being assaulted by the high intensity levels in the cry. As reported by Barr (2014), during the first six months of a typical infant, parents are exposed to pain-inducing cries, some for one and a half hours per day, others for two to three hours, and yet for others for five hours or more per day. This means that on average, postpartum parents and caregivers should expect to be exposed to 800 to 1,000 hours of hurtful crying for the first six months of their baby's life. By the time infants go through the terrible twos, typical parents and caregivers would have sat through and attended to more than 2,500 hours of intense crying. No wonder that some parents and caregiver experience depression, anxiety, and other mental health issues during this period (Soltis 2014). No wonder also that crying alone triggers intrusive and unwanted thoughts and, in some unfortunate cases, SBS/AHT.

5.1 Intensity as Cause and Panacea

Over the past 50 years or so, pediatric researchers have been searching for the acoustic correlate that is most aversive in infant crying. Author 1 has argued elsewhere that the search has not borne as much fruit as anticipated because past researchers put all their eggs in the basket of the frequency domain (F0/pitch, dysphonia, jitter). The lack of conclusive results have led some researchers to look to shimmer. Rahman et al. (2023:8) have found a strong correlation between frustration and shimmer:

> Finally, mothers rated cries that were higher in shimmer to be more frustrating. We also previously found shimmer to be positively correlated with adult male ratings of infant cry aversiveness. Interestingly, one study found that the cries of irritable infants were higher in shimmer than the cries of non-irritable infants. It is important to emphasize that each of these acoustic variables made independent contributions to predicting maternal frustration ratings.

The connection between shimmer and frustration is worth highlighting. However, since shimmer is but a derivative of intensity, why not look directly to intensity itself instead of querying ancillary phenomena such as shimmer which is nothing more than a cycle-by-cycle variation in intensity. Instead of gazing into incremental variations of shimmer, why not turn to intensity (dBA) itself and measure decibel levels in all the RGs that make up a cry episode or a cry bout? In their 2023 paper on infant cry, Cornec et al. observe that intensity is worth investigating:

> Interestingly, beyond pitch, the majority of participants reported that they perceived loudness as the most important acoustic parameter for differentiating between boys' and girls' crying. Due to methodological constraints in standardising recording conditions, especially in the

[3] It must be borne in mind at all times that intensity is perceived on a logarithmic scale.

> field, most studies conducted on babies' cries (including this study) have traditionally controlled for loudness in favor of spectral and temporal characteristics, not allowing for tests of its potential predictive power nor effects on listeners' judgments. However, this acoustic parameter is clearly essential for a full understanding of the information encoded in cries and represents an important acoustic parameter for further research in nonverbal vocal communication.[4]

Cornec et al.'s statement confirms the evidence that Author 1, an acoustic phonetician, has been producing over the past few years to demonstrate that intensity is in all likelihood the most aversive correlate in infant cry. Indeed, psychological states such frustration, depression, anxiety, and various mental health conditions have a very long history of being associated with exposure to high intensity noises. Rylander (2004) published an entire paper on the physiological responses to high intensity noises. More recently, Fink (2019:40) lists physical ailments such as hearing loss, faster heart rate, tinnitus, and hypertension as a result of exposure to high intensity levels of noises. Table 1 of his paper correlates various health conditions with various intensity levels. On page 39, he offers the following explanation for why exposure to high intensity levels cause health hazards:

> These involuntary physiological responses involve two primitive systems, the autonomic nervous system and the neurohormonal or hypothalamic-pituitary axis. Noise causes almost instantaneous increases in blood pressure and pulse via the sympathetic nervous system. It takes a little longer, but noise causes release of adrenocorticotropic hormone that, in turn, causes the release of steroid hormones from the adrenal gland and increases in serum epinephrine and norepinephrine levels.[5]

More often than not, noise annoyance researchers do not associate infant crying with being capable of producing the physiological ailments mentioned above. However, pediatric researchers have linked crying to postpartum depression and anxiety. Parents and caregivers of infants do experience similar physiological responses to crying, as indicated by Soltis (2014:452):

> The physiological connection between distress and high-pitched crying is mediated by the vagus, in particular the branch of the vagus linking the nucleus ambiguus to the larynx. During acute stress (e.g., pain or fear), the sympathetic nervous system is activated and the para- sympathetic nervous system is attenuated. As part of the parasympathetic withdrawal, vagal tone is lowered, fostering a multitude of physiological reactions including an increase in heart rate.

Medical researchers have identified several cry characteristics as being related to the more serious effects of exposure to infant crying; infant abusive head trauma. These cry characteristics include acoustical features, prolonged exposure, and inconsolability of the infant, to list a few. Indeed, as Barr (2014:1) summarized, "It is clear that these crying characteristics — and caregiver responses — are the predominant, and potentially modifiable, risk factors for abusive head trauma."

[4] The quote appears on page 8 of the preprint version that was made available to Author 2.
[5] WHO (1980:45-48) goes into great details about human stress responses to noise. World Health Organization (1980). Environmental Health Criteria 12: Noise. Geneva: Switzerland.

5.2 Mitigation and Solutions

The socio-acoustic survey has uncovered that ≥ 76 dBA is an important threshold at which respondents perceive crying as "Aggravating" and "Maddening." With this knowledge, one can propose a low-tech mitigating solution to alleviate the negative effects of crying on parents and caregivers. This solution consists in making use of manufactured earplugs to reduce the impact of indoor, outdoor, and occupational noises. Parents and caregivers should be encouraged to use these inexpensive and readily available products to reduce the decibel levels of infant crying. These devices do not cancel out crying altogether but reduce its intensity level to Tolerable levels, i.e., ≤ 70 dBA. Therefore, a cry that would otherwise be perceived as "Aggravating" or "Maddening" becomes tolerable just by using earplugs before a parent or caregiver interacts with a crying infant. Hospitals and pediatric clinics should encourage widespread use of such devices. They could even offer them as "gifts" upon discharging postpartum parents. These devices are so readily available that no extensive training is required. A simple explanation from a healthcare professional, highlighting the benefits of such devices, would give parents and caregivers the encouragement they need to use them without feeling awkward or guilty. Since the devices do not completely cancel noises, postpartum parents would not feel like they are neglecting their infants by wearing them. These inexpensive ear plugs can help reduce annoyance by reducing the intensity levels in cries. Pediatricians should have an abundant supply of earplugs and renew parents' depleted stocks at subsequent child welfare visits.

6.0 Summary

The socio-acoustic survey has revealed that the respondents tended to perceive crying levels of ≥ 76 dBA as "Aggravating" and "Maddening." Coincidentally, this is also the threshold which previous noise annoyance studies have found as the trigger of auditory pain. This insight is a useful piece of information that can lead to a possible low-tech solution to SBS/AHT. Specifically, encouraging parents and caregivers to make abundant use of inexpensive and readily available otoprotective devices can reduce the intensity levels in cries. They are advantageous because they do not cancel the crying altogether but simply reduce the pain-inducing decibel levels. This way, parents and caregivers can still interact with their infant without being adversely impacted by the harmful physiological effects that high decibel levels in crying can cause. Since infant crying triggers unwanted and intrusive thought, the inexpensive solution proposed in this paper can help parents not feel guilty for letting repugnant thoughts of harming their infants cross their minds when their babies are crying too much. Moreover, this low-tech solution that can potentially help reduce, if not eliminate, instances of SBS/AHT.

ABOUT THE AUTHORS

Ettien Koffi, Ph.D. linguistics (Indiana University, Bloomington, IN) teaches at Saint Cloud State University, MN. He is the author of five books and author/co-author of several dozen articles on acoustic phonetics, phonology, language planning and policy, emergent orthographies, syntax, and translation. His acoustic phonetic research is synergetic, encompassing L2 acoustic phonetics of English (Speech Intelligibility from the perspective of the Critical Band Theory), sociophonetics of Central Minnesota English, general acoustic phonetics of Anyi (a West African language), acoustic phonetic feature extraction for application in Automatic Speech Recognition (ASR), Text-to-Speech (TTS), voice biometrics for speaker verification, and infant cry bioacoustics. Since 2012, his high impact acoustic phonetic publications have been downloaded **68,201** times (**47,355** as per Digital Commons analytics), (**20,846** as per Researchgate.net analytics), and several

thousand downloads from Academia.edu, as of **February 2024**. He can be reached at enkoffi@stcloudstate.edu.

Benjamin Witts, PhD, IBA, BCBA-D behavior analysis (University of Nevada, Reno) teaches at St. Cloud State University, MN. He spent the first half of his career studying the variables responsible for prolonged and problematic gambling. After experiencing first-hand the aversive nature of colicky crying, he turned his attention to studying this phenomenon. He can be reached at bnwitts@stcloudstate.edu.

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