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Recollection, Identification and Perceived Urgency of the Temporal-Three Evacuation Signal

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ABSTRACT: In North America, it is now required that buildings equipped with a fire alarm system sound the Temporal-Three (T-3) pattern as the evacuation signal. It is intended that the T-3 pattern will become the standardized alarm signal heard around the world that will unequivocally mean "evacuate the building immediately". Since new and refurbished buildings are now equipped with this new signal, we need to ascertain if the public recognizes this sound as an evacuation signal. The objectives of the study were to assess the public's recollection, identification and perceived urgency of the T-3. Data was collected through a field study in public buildings in the Ottawa area with 307 participants. Results showed that participants often reported that they had heard the T-3 before, although they could rarely correctly identify it as a fire alarm or evacuation signal. In fact, the T-3 was usually associated with domestic signals such as a busy phone signal or the sound of an alarm clock. Further, the T-3 was not judged as a signal conveying urgency. The findings suggest that considerable public education is necessary to improve the public's identification of the T-3 signal. It is also suggested that it is unrealistic to expect that occupants will immediately start evacuation upon hearing such a signal and that further information provided to the occupants will always be necessary to prompt evacuation movement.

KEY WORDS: fire alarm, audible signal, perceived urgency, temporal-three signal

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INTRODUCTION

Since July 1996, NFPA 72 and the National Building Code of Canada (1995) require that any building equipped with a fire alarm system should sound the Temporal-Three (T-3) pattern as defined by ISO 8201 “Acoustics – Audible Emergency Evacuation Signal” [1]. Before these requirements came into effect, the fire alarm signal in buildings could sound a large variety of continuous or temporal signals delivered through various devices such as bells, horns, chimes or electronic apparatuses. This variety resulted in occupants experiencing difficulty in recognizing the sound of a fire alarm signal among other signals. Interviews by Tong and Canter [2] have shown that over 45% of a small sample of building occupants were unable to distinguish fire alarms from other types of alarms. This identification problem can partially explain why occupants tend to ignore and disregard fire alarms as genuine emergency warnings [3, 4]. Another reason to discredit fire alarm signals is the large number of nuisance alarms investigated by Karter [5] and the problem of audibility studied in previous projects [6, 7].

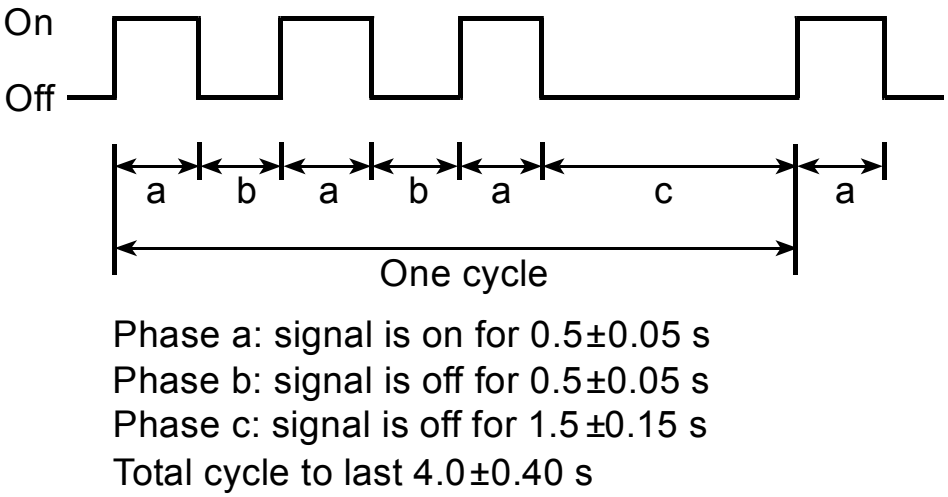

Figure 1. Temporal-Three Evacuation Signal

The need to devise a unique fire alarm signal that could be used and recognised universally was acknowledged many years ago. Since the 1970s, numerous discussions to develop a standard signal have taken place [8, 9]. In the end, experts finally agreed not to limit the fire alarm signal to any one sound but instead to support recognition of the signal through the use of a specific sound pattern. The T-3 pattern, described in ISO 8201, and presented graphically in Figure 1, is expected to become the universal standard evacuation signal. It is intended to be used around the world and to unequivocally mean, “evacuate the building

immediately". The standard essentially addresses the signal's length, sound pressure level and temporal aspects.

Major fire alarm system distributors in the United States and Canada have been systematically installing the T-3, as the fire alarm signal, in all new and refurbished public, institutional, and office buildings for the past 3 years. According to the National Fire Protection Association's Public Education department, as of 2002 no formal public education has taken place to inform building users of this new signal, its meaning or the response expected from occupants upon hearing this signal. Discussions are ongoing regarding how to develop a public education campaign on the subject of this new evacuation signal. Discussions are also taking place as to whether or not an automatic recorded message should follow the signal to prompt the public to evacuate. Some people are suggesting that the temporal content of this alarm might be sufficient to trigger an evacuation response. Researchers in psycho-acoustics have demonstrated that urgency can be indicated by the acoustical structure of an alarm signal [10, 11]. As a first step, we need to ascertain if the public already recognizes this sound as the evacuation signal and if people associate some level of urgency to this signal that would prompt them to move during an emergency.

BACKGROUND LITERATURE

Warning signals are commonly used to convey information, both urgent and inconsequential. The existing relationship between warning signals and their significance has been of interest for many researchers. Over the past decade, the works of Edworthy and collaborators have led to a better understanding of how human beings interpret audible warning signals presented in their daily environments [12, 13]. Design criteria for audible warning signals have been proposed for the purpose of improving their appropriateness and suitability, which will ultimately govern if a set of warnings is actually effective [13, 14]. Scientists agree on two vital elements: firstly, when an audible signal is perceived, it must be recognized as a warning signal; secondly, the signal's significance must be understood and the response appropriate.

In order to ensure the recognition of audible warning signals, many researchers have proposed design criteria to standardize their intensity, spectral content, length, temporal aspects etc. [12, 15, 16, 17]. An international standard (ISO 7731, 1986) [18] is currently available for audible warning signals in the workplace. The international standard for an evacuation signal (ISO 8201, 1987) [1], commonly referred to as the T-3, also addresses some of the acoustic parameters necessary to ensure the recognition of this type of signal. It does not, however,

specify the signal's spectral content. It exclusively addresses the signal's length, sound pressure level and temporal aspects.

The ISO 8201 standard stems from the works of the National Academy of Sciences, Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) [19, 9]. The members were given the objective of suggesting an audible evacuation signal that would be, *"specific and simple so that it would be universally recognized and easily distinguished from other alarm signals"*. Two specific considerations guided their choice of audible signal. First, the signal had to be evident and easily perceived by the occupants of a building. In fact, the signal had to be detectable in any ambient noise. The second consideration was that the characteristics of the signal had to clearly be different from a variety of other alarm signals. It was important to limit the amount of confusion occupants felt when the alarm sounded. The evacuation alarm must be instantly recognizable.

Acknowledging that the alarm would be activated in a variety of environments, where the level and spectral content of the ambient noise could vary tremendously, the members of the committee opted for a standard that addressed the temporal aspects of the signal, as opposed to one that addressed its spectral content. According to the members, this approach has the following advantages. First, the signal could be designed for any environment by matching the signal to the existing background noise to optimize its perception. Second, having specific temporal characteristics would avoid any confusion of the signal with other audible warning signals, particularly those used outside. Third, the distinct temporal pattern allowed for easy adaptation of the signal to sight and touch alarms. Finally, the problems surrounding the adaptation of existing evacuation alarm systems to this temporal signal are minimized because it is much easier to install a temporal switch into the current circuitry than it is to replace the entire system with new signals. Consequently, the time and money involved in updating existing systems with the temporal signal would be limited.

The temporal characteristics proposed by the CHABA committee differ somewhat from that of the ISO 8201 standard but they are closely related. Nonetheless, it was the committee's belief that the audible signal would undoubtedly be recognized by its temporal characteristics. It is questionable, however, whether the temporal characteristics proposed are sufficient enough to exclusively guarantee the association of the alarm to a specific meaning and adequate response, assuming a well-adjusted intensity level.

In general, the concepts of perceived hazard and auditory affordance are referred to by the same studies that address the significance and the adequate response to audible signals [14, 20, 21]. It is acknowledged that a warning signal should not only communicate the

presence of a danger, but also the level of hazard related to that danger. When warning signals vary in their level of urgency and are adequately associated with the level of danger involved in a situation, they gain a behavioural advantage [11, 22]. This process, referred to as "hazard matching", is the object of the recommendations that are made for implementation of warning signals [13, 23, 12, 24]. It is known, for example, that the fundamental frequency, harmonic series, amplitude envelope shape, delayed harmonics, speed, rhythm, pitch range, and melodic structure all have clear and consistent effects on perceived urgency. A signal's perceived urgency is therefore related to several acoustic parameters.

OBJECTIVES OF THE STUDY

This research project endeavours to answer three fundamental questions about the T-3 signal. These questions are associated with recollection, identification and urgency.

- The first objective of this project is to assess whether or not people can recall the T-3 signal. It is essential to know if people believe that they have previously heard the T- 3 to ascertain their previous exposure to the signal.
- The second objective is to evaluate if people can correctly identify the meaning of the signal. It is one thing to say that you have heard a signal before, and something entirely different to correctly identifying the meaning of that signal.
- The third objective is to measure the degree of urgency that people associate with the T-3. Building occupants may not be able to identify the T-3 or they may not have even been previously exposed to the signal. It is expected, however, that if they attach a high level of urgency to the signal they will feel compelled to act if they unexpectedly hear it in a public building. The perceived urgency is particularly important to assess whether or not the signal will prompt action in a fire situation where no other occupants or fire cues are there to indicate a fire situation.

METHODOLOGY

To investigate the recollection, identification, and perceived urgency of the T-3, an experimental study was conducted. Early in the study it was determined that it would be impractical to activate the T-3 in a number of public buildings to observe occupant's response. Instead, it was considered more appropriate to approach a sample of individuals and conduct interviews to obtain the data that would achieve the study objectives.

Participants

A sample of participants was interviewed in public buildings. The sample was representative of the Canadian population in terms of gender and age distribution, as reported by Statistics Canada for the year 2000 [25]. It is a recognized methodology when evaluating auditory warning signals to focus on the real users, measuring their capacity to make an association between sound and meaning [14]. The general public constitutes the real users of the T-3 and it is essential that the research and subsequent development of the T-3 be based on actual building occupants.

People were approached in public buildings such as shopping centers, libraries, and airports. All of the buildings were places where the T-3 signal could be heard if the fire alarm system had been installed or upgraded in the last few years. There was no information suggesting that the public buildings selected could influence the findings of this study.

Apparatus/Materials

Although the objective of this project was to study the T-3, it was decided to test it among five other warning signals. A total of six signals seemed sufficient for the participants to understand the context of the task while keeping the whole test under 5 minutes for each participant. Experience in previous field studies in public buildings suggests that 5 minutes is the maximum time you could expect participants to be prepared to answer questions. The six signals selected were all warning signals. The signal selection was carefully made to include signals that were expected to obtain a range of recollection and identification from very good, such as for the Car Horn or the alarm Bell, and very poor performance such as for the industrial Buzzer. It was expected that the T-3 would perform within that range. It was also interesting to compare the performance of the T-3 with two other fire alarm signals: the Slow Whoop which has many advocates in the United States and the alarm Bell which is used extensively in institutional buildings in Canada.

Three CDs were prepared which presented the six signals in different orders. The T-3 signal was presented first, third and last among five other signals. The exact presentation order of the signals on each CD can be seen in Table 1.

Table 1. Signal Presentation Order on Each CD

CD	Signals Order					
1	T-3	Car Horn	Reverse	Slow Whoop	Buzzer	Bell
2	Slow Whoop	Car Horn	T-3	Bell	Reverse	Buzzer
3	Bell	Car Horn	Buzzer	Reverse	Slow Whoop	T-3

The signals were presented in different orders on each CD so that order effects could be counterbalanced. Presenting one signal before another could affect the opinion a participant would have had about following signals. For instance, having heard the Bell first, and identifying it as a fire alarm, participants' later interpretation of the T-3 signal may be coloured. By changing the order of the signals so that the Bell is not always heard before the T-3 signal, this colouring can be accounted for. This is why the T-3 was presented first, third and last, to determine whether hearing the signal "out of the blue" as the first signal would provide comparable recollection, identification and degree of urgency as listening to the T-3 after hearing other warning signals.

An analysis of the acoustic characteristics of each of the signals has been conducted in order to document the main parameters, such as the spectra and temporal patterns [26]. All signals had an overall duration of 12 seconds. The Car Horn had a fundamental frequency of 350 Hz with harmonics up to 2 kHz. It was sounded four times during the 12- second interval. The Slow Whoop is characterized by a frequency sweep between 875 and 4000 Hz, and each sweep lasted approximately 2 seconds. The Buzzer had a wide spectrum between 500 Hz and more than 8 kHz. The Reverse alarm was an intermittent signal with a 400 msec ON period followed by a 350 msec OFF period. The fundamental frequency was 1302 Hz with harmonics significantly lower in level. The Bell was composed of three main frequencies (1244, 1866 and 2527 Hz). The T-3 is a 500 msec ON-500 msec OFF signal repeated three times followed by an OFF period of 1.5 second. The fundamental frequency is 505 Hz with the odd harmonics (3^{rd}, 5^{th}, 7^{th}, etc.). The T-3 used in the study was recorded from Simplex 1996, 4100 Fire Alarm Audio Demonstration CD.

Procedure

The signals were played on a CD Walkman and both the experimenter and participant had a set of headphones to listen to the signals. Three experimenters collected the data. Participants were approached when alone and inactive in public buildings. The person was

asked to participate in a five-minute sound recognition study. It was heavily emphasized that the sounds heard on the CD were from in and around large buildings, such as the one they were in at the time of the interview. After listening to each sound the participant was asked three questions; "Have you heard this sound before?" "What do you think this sound means?" and finally, "How urgent do you feel this sound is on a scale from 1 to 10? 1 being not urgent at all and 10 extremely urgent." The first question tested the recollection of the signal, the second tested the ability to correctly identify the signal and the last question rated the perceived urgency of the signal. The experimenters recorded the participants' answers on a data sheet that the participant could view at the time of the survey.

RESULTS

A total of 307 participants ranging in age from 15 to 85 years old were interviewed (mean = 38.45, SD = 17.22). The sample contained 164 women (53%) and 143 men (47%). People who worked in large buildings composed the majority of the respondents with 173 participants (56%), 69 were students (22%), 45 people were unemployed or retired (15%), and 20 people worked outside or in small buildings (7%).

In total, 101 participants listened to CD1, 103 to CD2 and 103 to CD3. There were significant differences between the three CDs for the T-3 in recollection H(df 2)=9.87, $p < .01$, and urgency H(df 2)=11.14, $p < 0.01$. Both of these statistics were computed using the Kruskal-Wallis one-way analysis of variance. CD3 where the T-3 was presented last was the one that obtained the higher recollection and urgency. Interestingly, there were no significant differences found in recollection or urgency for the alarm Bell, which was placed in the first, fourth and last positions, χ^2 (df 2)= 1.9242. The differences found when the T-3 was presented last can be ignored since the different presentation order was introduced to counterbalance any possible order effects. Thus the method successfully eliminated any systematic bias arising from order of presentation and the data from the 3 CDs could be merged.

Recollection of the T-3

The first question participants were asked after listening to each signal was "Have you heard this signal before?" The answer to this question on recognition was either "yes" or "no". Figure 2 presents the percentage of positive and negative answers to each of the signals.

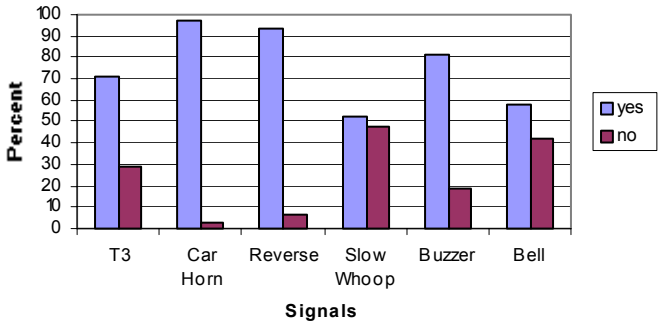

Figure 2. Recall Percentage of each Signal

There was an overall significant difference found between how often participants recalled each of the signals, Q(5, 307)=28.15, p< .001. This statistic was computed using the Cochran Q test which is used when looking for significant differences between three or more matched sets of frequencies or proportions. The Car Horn was recalled the most often, by 297 out of 307 participants (97%), followed by the Reverse alarm, which was recalled by 280 people (91%). The Buzzer was recalled by 249 people (81%), the T-3 by 219 people (71%), the Bell by 177 people (58%). Finally the Slow Whoop was recalled by 159 people (52%). Participants were significantly more likely to say that they had heard the T-3 than the Slow Whoop, Chi-Square test (χ^2) (df 1) = 27.80, p < .001 and significantly more likely to say that they had heard the T-3 than the Bell, χ^2(df 1)= 13.91, p< .001. Participants who said they had heard a signal before, however, could not necessarily identify the signal correctly.

Identification of T-3

The second question that the participants were asked was if they knew what the signal meant. In many cases the subject, although asked, "what does this sound mean", gave responses that would have been expected had they been asked, "what is this sound". For the purpose of analysis the answers were placed into three simple categories, "right", "wrong" and "I don't know" as seen in Figure 3.

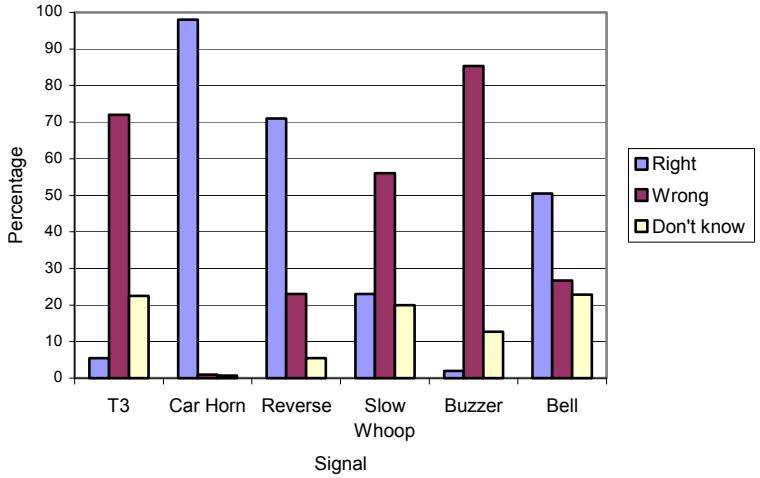

Figure 3. Percentage of Signals Identified

The definition of "right" used for the T-3, Slow Whoop and Bell, all of which were fire alarms, was that the answer had to be related to fire alarms or evacuation to be considered "right". Answers given in response to the industrial Buzzer were defined as "right" if they were related to a factory or mechanical setting, although it is possible that participants could have heard this signal in a different context. The Reverse alarm was operationally defined as correct if the participant identified it as a Reverse alarm. The answers "snow removal" and "garbage truck" were also accepted because in such situations the signal could be heard as the vehicle reversed. The Car Horn was considered correct when participants identified it as a horn. The answers accepted as correct for this signal, included car horn, car alarm, truck horn and boat horn.

Table 2 presents the number of occupants who correctly identified the different signals. The T-3 was identified correctly only 6% of the time. The seventeen people who correctly identified the T-3 as a fire or evacuation alarm were aged 21 through 84 years old (M = 41.20, SD = 16.52), and were equally likely to have been male or female (53% female and 47% male). Among these seventeen participants there was, for example, a mechanic, a student, a janitor, an accountant, a person who was looking for work at the time, and a Ph.D. fellow.

Table 2. Number of Participants who Correctly Identified Each Signal

Signal	Participants (N=307)	Percentage
Car Horn	302	98%
Reverse alarm	218	71%
Bell	155	50%
Slow Whoop	71	23%
T-3	17	6%
Buzzer	6	2%

There is a very significant difference between how often each of the signals was correctly identified, χ^2(df 5)=555.52, $p < 0.001$. The T-3 was identified correctly less often than any other fire alarm signal (Bell and Slow Whoop).

It is also interesting to notice that about the same proportion of participants answered that they "didn't know" the three fire alarm signals (T-3, Slow Whoop and Bell). For the T-3, 69 of 307 or 22% of the participants said they could not identify the sound, for the Slow Whoop, 64 of 307 participants or 21%, and for the Bell, 70 of 307 people or 23% said they didn't know the signal. Eight participants in the sample (3%) could not identify any of the fire alarm signals.

When the T-3 was identified as something other than a fire alarm, most of the time it was because the participants imagined the signal in the context of a domestic environment instead of a public building. This occurred despite a conscious attempt by all experimenters to carefully state that all of the signals heard on the CD were from in and around large buildings. In total, 174 or 57% of the participants answered that they recalled the T-3 signal but then provided wrong identification for the signal. As presented in Table 3, most often the T-3 was identified as a signal related to the telephone with answers that included a busy signal, telephone, a phone that is on hold and an answering machine.

Table 3. Wrong Identification of the Temporal-Three

Identification	Participants (N=174)	Percentage
Busy phone signal	55	32%
Phone beep	20	12%
PA pre-announcement	18	10%
Reverse alarm	17	10%
Time signal	14	8%
Alarm clock	13	7%
TV message coming	10	6%
Hospital alarm	6	3%
Bank machine	4	2%
Other identification	17	11%

Perceived Urgency of T-3

Each participant was asked to rate, on an ordinal scale from 1 to 10, the degree of urgency they felt for each signal: 1 meant "not at all urgent" and 10 meant they felt the signal was "extremely urgent". The differences in perceived urgency between all of the signals, were significant, χ_r^2 (df 5)= 311.87, p< .001.

Table 4. Difference in Perceived Urgency between T-3 and Other Signals

Signal	Mean Perceived Urgency	Standard Deviation	Probability
T-3	3.97	2.42	
Buzzer	4.91	2.74	p< .001
Car Horn	4.93	2.46	p< .001
Reverse	5.60	2.78	p< .001
Slow Whoop	6.01	2.50	p< .001
Bell	7.17	2.74	p< .001

As can be seen in Table 4, the T-3 was considered the least urgent of all the signals. When the T-3 was compared to each of the signals separately, it was significantly less urgent than each of them. The T-3 received an overall rating of 3.97, which could be assessed as a low urgency rating on a scale from 1 to 10. The Buzzer, Car Horn and Reverse signal all

received urgency ratings between 4.91 and 5.60, which could be judged as medium urgency ratings. Finally the Slow Whoop and Bell received ratings of respectively 6.01 and 7.17, which could both be considered high urgency ratings.

On each of the three CDs, one of the fire alarm signals was played first. Although in the initial analysis an order effect was discounted, it was considered prudent to analyze the average perceived urgency of each of these signals when they were played first. The T-3, when no other signal had been heard beforehand, had a mean perceived urgency rating of 3.58, the Slow Whoop had an urgency rating of 6.40 and the Bell had an urgency rating of 7.13. In other words they remained unchanged, which further confirmed the lack of an order effect caused by signal presentation.

It is interesting to consider the urgency rating of each signal while keeping in mind the identity of the signal given by participants. When any of the signals were identified as fire alarms, independent of whether or not they actually were, the urgency generally increased as can be seen in Table 5. Only the Car Horn was never identified as a fire alarm so this signal is not included in Table 5.

Table 5. Identification of any Signal as a Fire Alarm and Perceived Urgency

Signal	Number of subject who did not identify signal as a fire alarm	Mean Urgency when not a fire alarm	Number of subject who identified signal as a fire alarm	Mean Urgency as a fire alarm	Significance Mean urgency when not a fire alarm and when a fire alarm
T-3	290	3.83	17	6.29	$p<0.001$
Slow Whoop	236	6.76	71	7.42	$p<0.05$
Buzzer	265	4.49	42	7.55	$p<0.001$
Bell	152	5.89	155	8.43	$p<0.001$
Reverse	298	5.59	9	5.67	N.S. ($p=.88$)

The mean urgency rating changed from 3.83 to 6.29 when participants identified the T-3 as a fire alarm signal. The same tendency was observed for the Slow Whoop, the Buzzer and the Bell which obtained significantly higher urgency ratings when identified as fire alarms. There was no significant difference for the Reverse alarm although results are in the same direction.

CONCLUSIONS

The objectives of this research project were to evaluate if the T-3 signal was a fire alarm signal that the general public could recall and correctly identify. Another objective of this study was to assess the level of urgency people would attach to the T-3 signal.

Among the signals tested, the Car Horn was recalled the most frequently, followed by the Reverse signal, the Buzzer, the T-3, the Bell, and finally the Slow Whoop. This order of recollection, however, proved inconsequential. Often participants recalled the T-3 as something other than a fire alarm: usually the T-3 was identified as an everyday household signal, such as a busy telephone signal.

It was found that only 6% of the population surveyed was able to identify the T-3 as a fire alarm signal. When compared to the Slow Whoop, which was identified as a fire alarm by 23% of the population, and the Bell, which was identified correctly by 50% of the population, it becomes obvious that the T-3 is not a well known fire alarm.

It is possible that the procedure used led to the problem of incorrect identification. Although people were briefed that the signals they were going to hear through the headphones were from in and around buildings similar to the one they were in, a considerable number of participants identified signals as sounds that could be found in domestic or small scale environments. Since participants were using headphones they may have had difficulty transferring the unfamiliar signals to the actual surroundings. However, this was not the case with more familiar signals such as the Car Horn and the Reverse alarm which obtained correct identification (98% and 71%) when heard through headphones.

Regarding perceived urgency, the T-3 was considered to be the least urgent signal among all six of the signals tested. The T-3 scored a mean of 3.97 on a scale of 1 to 10 with 10 indicating extreme urgency. In contrast, the Bell scored the highest urgency rating with a mean of 7.17, on the same scale.

Generally when a signal was identified as a fire alarm, the perceived urgency was significantly increased. This finding also applies to the T-3. It is suggested, therefore, that to increase the perceived urgency of the T-3, the public should be educated to readily identify the sound pattern of the T-3 as a fire alarm signal.

In light of the temporal characteristics of the T-3 signal, it is not surprising to obtain a weak degree of perceived urgency associated with the signal. In fact, the T-3 ’s rhythm does not seem of sufficient speed to convey an adequate degree of urgency for an evacuation. It is interesting to note that the T-3 pattern sounds very much like many “alert tone” of two-stage alarm systems regularly found in office buildings. Nevertheless, at this point, it is unlikely that

the T-3 will be modified since it is an ISO standard and is now a requirement in building codes in Canada and the USA. It took several decades to agree on a standard evacuation signal; consequently it would be counterproductive to reject it based on the findings of this single study. Re-opening discussions to identify another standard evacuation signal would take enormous time and effort, meanwhile keeping the confusion of multiple fire evacuation signals for years to come. Despite the poor performance of the T-3 signal tested in this study, different steps could be taken to improve the signal. The first step would be to conduct further studies using different sounds with the T-3 pattern. The T-3 signal used in this study was an electronic pulse; it is possible that a bell emitting the T-3 pattern or a slow whoop could convey a higher degree of perceived urgency and be more easily associated by the public to a fire emergency and building evacuation. Another important step to improve recognition of the T-3 is to educate the public. There are a number of approaches that can be considered in educating the public about the recollection, identification and behaviour that they are expected to perform upon hearing the T-3. One of the most promising approaches would be to require immediate alarm signal upgrading in all elementary and high schools. The majority of the population learns fire safety during schooling years. The lessons learned at this time are applied for the rest of their lives. Children would rapidly learn the sound pattern of the T-3 and they would be taught the associated meaning and behaviour, which they should be able to transfer to other buildings that they would be visiting in the future.

The results of this study certainly dispute the suggestion that the temporal content of the T-3 may be sufficiently urgent enough to trigger a general evacuation response. It is our opinion that an alarm signal, without any other cue, cannot convey a sufficient message of urgency to let people know readily that they are expected to evacuate a building. The response to the signal will still need to be learned, and probably will still need to be prompted by voice communication instructions or by the behaviour and directions given by staff. It cannot be expected that occupants will immediately start evacuation or relocation movement upon hearing the T-3 signal; more information will always be required to ensure occupant safe response during a fire incident in a public building.

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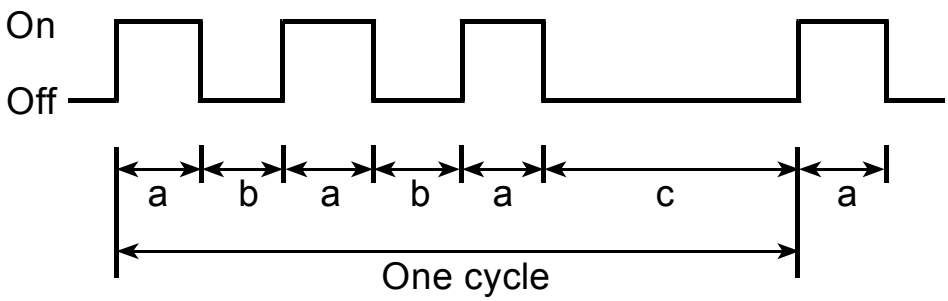

Phase a: signal is on for 0.5±0.05 s
Phase b: signal is off for 0.5±0.05 s
Phase c: signal is off for 1.5±0.15 s
Total cycle to last 4.0±0.40 s

Figure 1. Temporal-Three Evacuation Signal