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See It on a Radio Story: Sound Effects and Shots to Evoked Imagery and Attention on Audio Fiction

Emma Rodero[1]

Abstract

Radio's capacity to stimulate the creation of mental images in the mind of its listeners has long been acknowledged. Nevertheless, research into mental imagery has focused principally on the study of visual stimuli, although studies into radio itself have mostly concerned the field of advertising. In this study, we examine the influence of two stimuli associated with auditory processing on radio: sound effects and sound shots. The chosen context for the study is that of a fictional story, or audio drama, through which to measure the role of these stimuli both in creating mental images in the listener's mind and in maintaining his or her attention. Our findings demonstrate that the inclusion of descriptive sound effects and especially of sound shots in a fictional radio drama increases mental imagery and that a relationship exists between this increase and the degree of listener attention.

Keywords

radio, mental imagery, attention, sound effects, sound shots

Overview

If there is one essential characteristic that can be attributed to radio which is common to practically all radio-related literature, it is its capacity to stimulate the creation of mental images in the listener's mind. This characteristic is a constant in all the relevant literature appertaining to the radio as a medium of communication: "Radio has popularly been referred to as theater of the mind because of its perceived ability to paint pictures in the imagination of listeners" (Bolls, 2002, p. 537), although scarce empirical data are provided to back up this notion. However, despite this ubiquitous reference, compared with other fields, few

[1]Pompeu Fabra University, Barcelona, Spain

Corresponding Author:
Emma Rodero, Pompeu Fabra University (UPF), Faculty of Communication, C/Roc Boronat, 138, 08108, Barcelona, Spain
Email: emma.rodero@upf.edu

studies relating to the capacity of radio to create mental images have been conducted to date. Indeed, while the process of creating mental images has long been the object of study from various perspectives, attention has focused mainly on visual stimuli rather than those which are audio-evoked (Miller & Marks, 1992).

Applied to audio, mental imagery may be defined as a sensorial process generated from a sound stimulus without the true stimulus being present, and which embodies the coding, processing, and evocation of an experience in the memory of the listener (Babin & Burns, 1998; McInnis & Price, 1987; Richardson, 1969). Therefore, auditory processing of any message calls for the listener to use a host of sensory and perceptual skills to extract meaningful information from sound (Kraus & Banai, 2007).

The two most widely referenced theories in literature on mental imagery are Paivio's (1986) dual coding theory (DCT) and Kieras's (1978) propositional-representations theory (PRT), which have differing notions regarding the nature of mental representation triggered by a stimulus and the manner in which it is processed. DCT is most often associated with an analog conception of imagery (inner picture). According to this theory, the messages heard by the listener in auditory processing will be encoded and stored in memory "into two separate mental systems, or codes: one specialized for representing and processing language (the verbal code) and one for processing nonlinguistic objects and events (the non-verbal code)" (Sadoski & Paivio, 2004, p. 1330). Therefore, the listener develops auditory representations in the verbal code for speech and auditory representations in the nonverbal code for nonlinguistic environmental sounds. These two systems are considered to be independent, each activated separately by the stimuli most relevant to it. As they have the benefit of being dually coded in the memory, they should create more mental images and should be remembered in an improved manner.

The PRT conceptualizes mental imagery processing as internally constructed perceptual structures (inner descriptions), separate and different from semantic information but activated and processed in semantic memory (common coding). As related perceptual and semantic knowledge structures are linked in long-term memory (LTM), the stimulus typically evokes both types of cognition. However, in this case, the activation of semantic structures is mediated by the activation of perceptual structures; thus, it should be less intense than a direct activation of perceptual structures during the interpretation of nonverbal stimuli. Furthermore, visually based information has been found to be easier to encode into memory than verbally based information.

Regardless of the nature of the mental representation created and the differences in terms of cognitive processing—which are not addressed in this study—both theories have the same result. In fact, there seems to be no reason to think that it is incoherent to combine a *propositional* view of imagery with a form of dual coding theory, as Kieras (1978) have proposed. The incorporation of nonlinguistic resources into a radio message, inasmuch as it generates auditory representations in the nonverbal code (DCT) or propositional structures created by sound resources (PRT), must increase the rate at which images are generated in the listener's mind. These mental images can vary in vividness, the intensity with which they are activated, and in quantity, which reflects the number of perceptual structures activated in response to a stimulus.

The majority of studies relating to radio and the creation of mental images have focused on the specific field of advertising products. These studies make a distinction between two types of message, those which are more likely to induce such images (high imagery) and those which potentially produce fewer of them (low imagery). With different sound resources, high imagery radio messages contain both verbal and visual information to be processed. By using physiological measures such as cardiac acceleration and based on PRT, Bolls (2002) has demonstrated that high imagery advertisements activate directly propositional structures stored in memory, employing visual cognitive resources. First, the verbal system provides a meaning of the words in the message and, then, the visual system will activate propositional representations of these words. As a result, the imagery generated by verbal information, operated on a sequential frame in temporal order, should be less vivid and in less quantity than the imagery generated by nonverbal information, as the sound effects in a radio message. Miller and Marks (1992, 1997), based on DCT, have demonstrated that sound effects have the ability to generate mental imagery because they have the benefit of being dually coded in the memory. Accordingly, high imagery radio spots are more memorable and effective than low imagery advertisements (Bolls, 2002; Bone & Ellen, 1992; Childers & Houston, 1984; Lutz & Lutz, 1977; Miller & Marks, 1997; Unnava & Burnkrant, 1991). Bolls and Lang (2003) and Potter and Choi (2006), provided additional support for these conclusions in their work which compared high and low structural complexity in radio messages, where complex messages involved multiple changes in voice, sound effects, music, and other sound-based resources. Indeed, the work of these authors established a relationship between these types of messages and their capacity to hold the listener's attention, the other dimension which is the subject of the present study.

Attention may be defined as a capacity which activates the information processing mechanisms when a sensorial stimulus is perceived, regulating and exercising a discriminatory control over cognitive processes. It therefore possesses a modifying and selective element which regulates the structure of psychological processes and thus causes these to take the form of activities oriented toward given objects, so that the individual can discriminate external stimuli at will. Accordingly, attention is directly related to imagery. The creation of mental images needs active, voluntary attention from the listener.

First, during the perception process, the level of intensity or novelty of a stimulus would catch our attention immediately, giving rise to an *orienting response* (OR). Once the attention mechanism (either selective or divided) is initiated, a person is capable of maintaining attention for a short period of time (switched attention). It appears to be clear, then, that the introduction of certain elements—audio elements in the case of radio—for instance sound effects should stimulate the listener's switched attention. Potter, Lang, and Bolls (1997) provided confirmation of these findings in the field of radio by introducing a degree of novelty into a message with the use of sound and production effects and changes of voice and music. They showed that listeners exhibited cardiac ORs following a number of these structural features.

Second, the continued presence of the stimulus and by extension, the stability of the attention (maintained attention), is then achieved when new facets, aspects and relationships are detected in the stimulus (James, 1980; Treisman, 1969; Wright & Ward, 2008). Consequently, the maintenance of attention, which would enable the stimulus to remain in the memory,

depends on the level of variation, the complexity or the intelligibility of the information received by the stimulus, among other factors. These factors may increase the listener's interest levels and encourage him to focus his attention on the stimulus. Therefore, the interest, as a level of motivation, represents a determining factor to attain sustained attention (Rubinstein, 1989). A subject would pay greater attention to something that arouses his interest. Potter and Choi (2006), building on an earlier study conducted by Potter and Callison (2000), gauged attention and interest using a scale of self-reported attention and tonic cardiac activity and found that the most complex messages yielded higher listener attendance levels.

Last, this stability of the attention may vary in degree of intensity and resistance depending on the degree of listener concentration. In the concentration stage, attention is already conscientiously focused on relevant information, leading to discrimination over the remaining information keeping prevalence for relevant information for a prolonged period. As a result, this focused attention may create more mental images in the listener. This means that concentrated attention entails greater effort on account of the heightened extent to which the cognitive resources involved are assigned throughout the processing stage. Indeed, participants in the Bolls and Lang (2003) study reported that they put more effort into processing the high imagery ads.

Along these lines, there is a particular radio format which is especially suitable for producing expressively complex messages that, a priori, might act as a strong stimulus for both imagery and attention: radio dramas or fictional audio stories (Chronis & Hampton, 2004; Farrar-Hartman, 1984; Green, Garst, & Brock, 2004), especially when the field is propitious: "It is sometimes argued that the stimulus to the imagination, especially the visual imagination, belongs to radio alone, and if we are thinking in terms of 'drama' this is unquestionably correct" (Lewis, 1981, p. 9). In fact, some studies have demonstrated that the use of dramatic structures favors listener attention (Lynch & Lo, 1963). Other studies recommend the use of structures common to these radio formats, concluding that the capacity to stimulate the imagination in an advertising message increases when a scene is created and narrated with sound resources, such as sound effects, common to radio drama (Bolls, 2002). In summary, the fictional component in radio dramas converts them into potential stimulators of attention and the imagination because their very substance is of an expressive-imaginative nature, as certain authors have noted: "The fictional aspect of stories also made them suitable for the investigation of imaginal processes" (Greenfield, Farrar, & Beagles-Roos, 1986, p. 205). Accordingly, in this context, it would seem appropriate to apply advances in this area to these radio formats.

Sound Effects and Sound Shots

Just because a message is broadcast via radio does not mean that it will automatically stimulate in the listener the creation of visual images and attention. For this to occur, an audio message, in this case a radio drama, must be designed according to a suitable combination of audio resources or production features, as Bolls (2002) states. Among the wide range of audio resources available in radio fiction, excluding the use of the spoken word, there are two that theoretically have a greater potential for the creation of visual images as they configure the

definition of the different situations of a fictional radio story "using layers of sound to situate listeners in space" (Dunn, 2005, p. 201): the sound effects and sound shots that afford iconic meaning to the narrative (Crisell, 1994, p. 150).

Sound effects are sounds that, in radio production, represent objects or environments, while sound shots, applying the term used in the cinema or in television to determine position, are changes in the sound intensity, established by the distance with respect to the microphone on radio, that are used principally to situate actions and characters in the spatial sense. As a "sound is not only informative about its source and environment, but about its *location* as well" (Gaver, 1993, p. 5), both resources provide the listener with information to identify two fundamental aspects in auditory processing: the content ("what") and the location ("where") of the sounds in the environment (Bregman, 1990). However, while it may be so that sound effects are better able to identify the nature of the sound source ("what") on account of their characteristics, sound shots are elements aimed at identifying the relationships in terms of space between sound objects in the location ("where"), and this information may make it possible to infer what is taking place in the aforementioned space. As a result, the effects have a bearing on the identification of sound objects while sound shots focus on the relationship and movement taking place between these objects.

The main function of sound effects in a fictional story, the descriptive function (Rodero, 2005), is that whose objective is precisely to create an audio reconstruction of reality, imitating reality's actual sounds so as to create in the listener's mind a specific image of the phenomenon that it is intended to represent, that is, describing environments and sound objects. They are explicit sounds, such as a storm with heavy rain and thunder or an alarm clock.

Several studies conducted in the field of advertising have found proof of the power of sound effects to stimulate the creation of visual images and their capacity to affect the listener's attitude, attention and memory even more than other resources (Atwood, 1989; Babin & Burns, 1998; Bolls, 2006; Bone & Ellen, 1992; Miller & Marks, 1997; Potter & Choi, 2006; Potter et al., 1997; Russell & Lane, 1990; Unnava, Agarwal, & Haugtvedt, 1996). However, the drawback of some of these studies is that they do not specify the exact function of sound effects in production, an important factor which could affect results. For example, a sound effect used in a subjective way, intended to stimulate the emotions (like rain used to induce a feeling of sadness), would yield different results in the interpretation made by listeners. In the present study, we believe it is essential to isolate this factor, using only sound effects of a descriptive nature, in other words, those which lend context to the scene (the sound of animals or objects in a household, etc.).

Descriptive sound effects constitute a formal change in the audio message in comparison to the verbal message that should, initially, give rise to an OR, as a biologically hard-wired response to novelty or signals in the environment (Lynn, 1966). From this standpoint, as indeed Potter et al. (1997) have demonstrated, the use of sound effects would lead to an increase in immediate attention. However, as descriptive sound effects provide information on the nature of the sound stimulus, making it easier and encouraging it to be identified, they should in theory also increase the rate at which images are created in the mind. In actual fact, some studies have shown that, as long as the difference in the acoustic properties remains adequate to allow early discrimination, these kinds of sound effects, such as sounds

that are produced by water or sounds produced by animals for instance, can be identified very early by the listeners (Guillaume, Pellieux, Chastres, Blancard, & Drake, 2004). When a listener hears the sound of a cockerel, he automatically builds a specific image in his mind: the image of this cockerel, making it easier to codify the image in the memory and greatly improve the extent to which he remembers it (Sharps & Price, 1991) in comparison to if the stimulus had been verbal. Likewise, this sound is fostering the strength of the main message and giving it a context. This argument is backed by the "context availability" and "elaboration" model (Atwood, 1989) which falls in line with Kieras' (1978) PRT. According to these authors, providing the listener with context during auditory processing means that a phrase can be better understood and remembered more easily because it is more likely to be interconnected with the information that is already stored in the listener's memory. In this manner, the elaboration process is made easier. When contextualizing the sound of the cockerel the listener would relate it to the information that has been recovered from the memory and prepare a representative image, which in this case could possibly be a farm. In this respect, some experiments have demonstrated that the listeners tend to identify the sounds in terms of the objects and events which caused them, describing their sensory qualities only when they could not identify the source events (Gaver, 1993; Vanderveer, 1979).

Motivation and interest both depend on this contextualization and significant association during the coding process, whereby it is also a decisive factor in whether the listener's attention is maintained and he continues to concentrate. As a result, sound effects in an audio drama, by stimulating nonverbal visual codes or propositional structures containing the corresponding auditory information and inasmuch as they are contextual elements that frame and strengthen the content of the message, must heighten the listener's attention and lead to more images being formed in his mind with greater intensity than with a verbal stimulus. These considerations form the basis for the first hypothesis of our research:

> *Hypothesis 1*: A fictional radio story which contains sound effects of a descriptive nature will both create mental images in the mind of the listener and increase his or her degree of attention more than a dramatization without these resources.

Second, in a fictional radio story, sound shots, established by changes in the intensity of sound, are used principally to situate actions and characters in the spatial sense, by adjusting distances. This aspect is essential in the task of radio fiction.

"The writing of every line entails an exact calculation about the distance of the speaker from the microphone and about the way in which the volume of that speech will be controlled from within the studio. It is in these calculations that the real flexibility of radio as a medium emerges" (Raban, 1981, pp. 88-89).

Thanks to changes in the intensity of the stimulus, sound shots identify the relationship and movement in space ("where") of characters, objects and actions, incorporating perspective and dimension into the listener's "zone of audition" (Chion, 1994) or "listening zone" (Beck, 1998). By doing so, they make it easier to organize the stimulus in perceptive terms as they distribute sounds in significant spatial frameworks, by grouping essential sounds together in one same dimension and allowing them to stand out from ancillary sounds, as

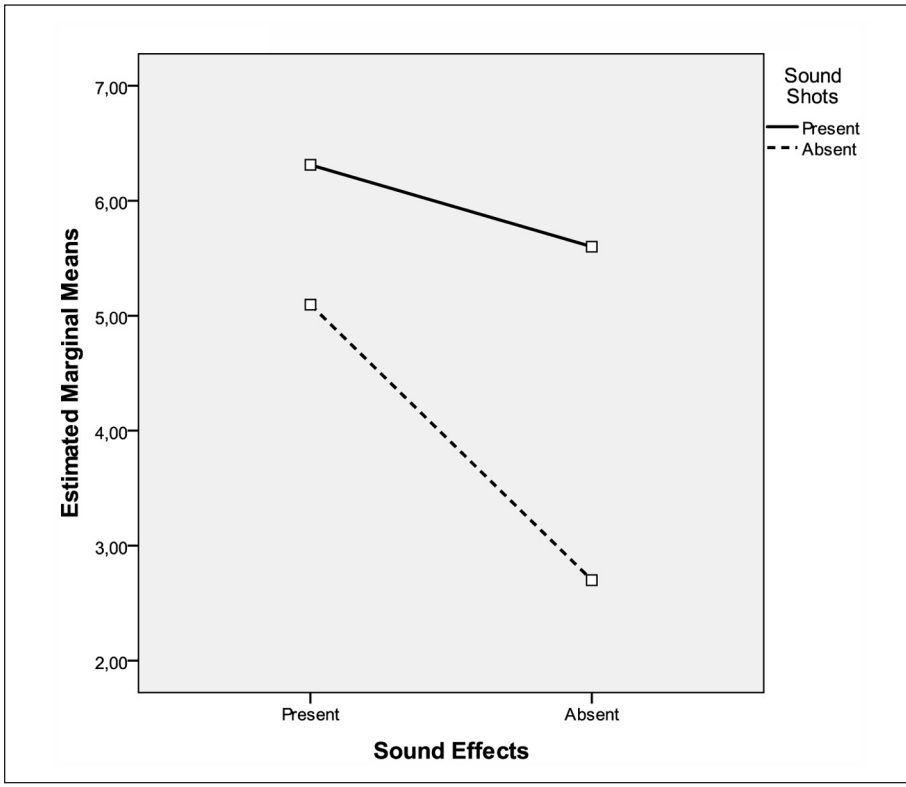

Figure 1. Estimated means of imagery

in the figure-ground phenomenon in Gestalt theory. Accordingly, the scene created is truer and gives the listener a greater sense of reality because it simulates the structure of real space and captures all possible relations between sound objects encoded in a coordinate space, according to the spatial representation theory of imagery processing (Kosslyn, Thompson, & Ganis, 2006). Therefore, this spatial information becomes important in imagery because some experiments have demonstrated that mental images have spatial properties—that is, they have spatial magnitudes or distances (Pylyshyn, 2002, p. 170)—and that both generate visual and spatial representations (Farah, Hammond, Levine, & Calvanio, 1988) depending on the spatial nature of the information processed, regardless of the original input modality, which in this case is auditory (Mellet et al., 1996). Furthermore, electrophysiological and anatomical findings "suggest that different brain structures are specifically activated during the processing of the content and spatial location of sound" (Anurova, 2005, p. 9). In this respect, Shinn-Cunningham and Ihlefeld (2004) have shown that the tasks can be conducted better when the perceived resources stem from various locations. Indeed, Mondor and Zatorre (1995) also coincided with the standpoint that sound attention is focused on the central sound, while attention on distant locations is decreased. As a result, owing to improved

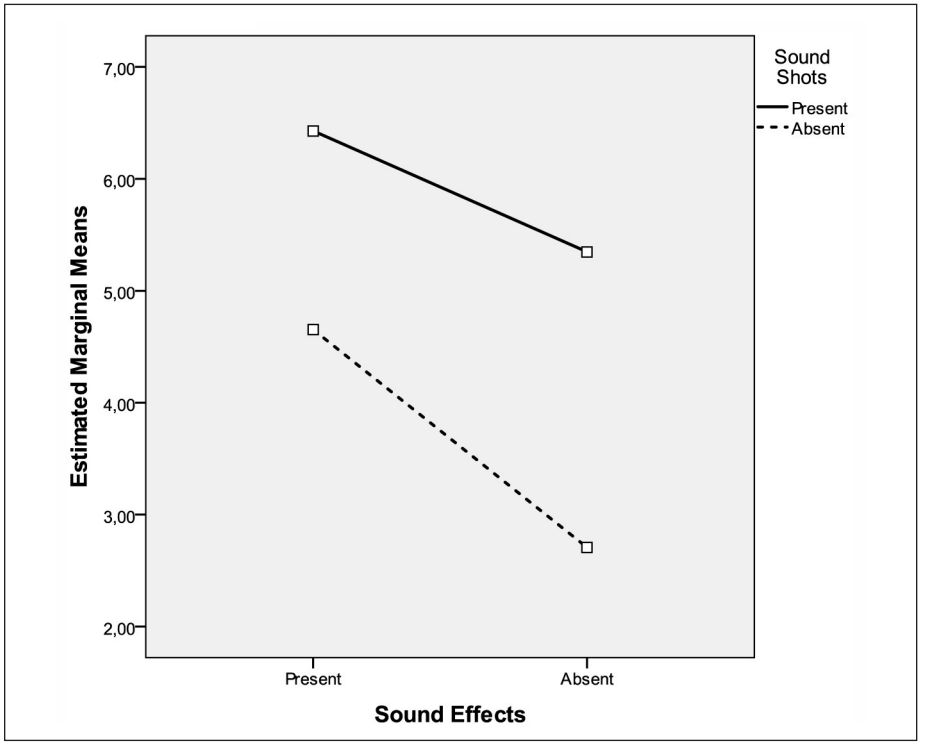

Figure 2. Estimated means of attention

intelligibility (Hawley, Litovsky, & Colburn, 1999), the listener's attention in a story with sound shots focuses on the main actions, which constitute the point of listening or foreground, as opposed to focusing on the secondary actions, which remain in the background. In other words, within the listening zone, the listener focuses his attention on what is taking place in the story and does so by adopting a viewpoint, the point of listening, on the basis of which he organizes his perceptive experience. Accordingly, he establishes a subjective representation (Rodero, 2009, p. 243), which should lead more, highly intense images to be created in the mind, thereby encouraging the listener to keep and focus his attention in relation to a dialogue-based story. "The obvious fact that it is *you* alone who controls your image" (Pylyshyn, 2002, p. 162). As a result, sound shots in an audio drama, by stimulating nonverbal spatial codes or propositional structures and by distributing sounds in significant spatial frameworks, must heighten the listener's attention and lead to more images being formed in his mind with greater intensity than with a verbal stimulus.

Despite the importance of this sound technique for the auditory processing, no studies have yet been conducted into the extent to which the stimulation of the listener's mental images or an increase in his or her attention may be achieved. However, a review of the above-cited studies permits the following hypothesis:

Table 1. Description of the Radio Fiction Stories

Description	Duration
S1: Fictional radio story based solely on dialogues	4 min
S2: Fictional radio story (S1), adding descriptive sound effects	4.30 min
S3: Fictional radio story (S1), adding sound shots	4 min
S4: Fictional radio story (S1), adding sound effects and sound shots	4.30 min

Hypothesis 2: A fictional radio story that employs sound shots to characterize space, action, and characters will create mental images and will increase attention more than a dramatization without these resources.

Finally, this study examines the result of the application of both audio resources in the same story. If it may be deduced that, in isolation, mental images are stimulated and attention increased, then the sum of both factors in one fictional production should reflect this, producing a more complex message from the audio point of view. Therefore, our third hypothesis is as follows:

Hypothesis 3: A radio story that employs descriptive sound effects and sound shots will stimulate to a greater extent the creation of mental images and will increase listener attention compared with a story based solely on dialogues or which only uses one isolated element.

In summary, this study is designed to advance in the impact of auditory structural features on human processing of audio messages, enhancing work in the field of mental imagery and attention, in the belief that "findings that sounds are able to evoke images in listeners as pictures can in viewers would provide a valuable theoretical extension of imagery theories" (Atwood, 1989, p. 587). This is applied to a field little explored from the perspective of fictional radio stories, and by extension audio stories, and we particularly focus on two audio resources which are potentially visual: sound effects and sound shots.

Method

For the purposes of this study, we created a dramatized radio story, initially containing only dialogues, to which two variables were added: sound effects and sound shots. The resulting combinations produced four stories.

Radio Fiction Stimuli

At the outset, rather than employ existing production material, we decided to create a textual, fictional story which, on its own merits, would be capable of stimulating mental images and boosting listener attention. This approach would totally reduce the risk of any member of the

sample population recognizing the plot or other features of the story. The construction of this radio drama was carried out with maximum regard for the structural and textual conventions of a dramatic narrative. First, the plot itself sought to stimulate mental images since it narrates the story of a boy who, wishing to let his imagination run loose, shuts himself up in a wardrobe of his home to live different adventures. Second, the story was completely dramatized, that is, supported exclusively by dialogues so as to avoid stylistic interference from other textual typographies. Third, we strove to adhere to the peculiarities of oral-radio language. Thus, the words employed in the dialogues were mostly concrete in nature as, according to several studies (Bone & Ellen, 1992; Paivio, 1986), concrete language is more effective in stimulating the imagination and facilitating memory than abstract language. Last, the story incorporated instructions to imagine, as this technique is suggested by certain authors in order to stimulate the imagination (Alesandrini & Sheikh, 1983; Lutz & Lutz, 1977; Paivio, 1986) and descriptions to aid the pictorial representation of the actions and characters which occur and appear in the story, a technique suggested by Lutz and Lutz (1977) and Reid and Soley (1982), who determined that descriptive language induces the listener to create mental images.

Under these conditions, the dialogues were recorded in a radio studio affording optimum sound quality and using professional actors so as to guarantee a high level of interpretation. First, we registered the first story (S1), based solely on words. Next, in a postproduction study, a sound technician constructed the second story (S2) to which a different descriptive sound effect was added for each of the story's five scenes. The third version of the story (S3) was also recorded in the radio studio with the corresponding actors, but this time incorporating sound shots, that is, maintaining distances between the actors as indicated by the script. Finally, the fourth version of the story (S4) was constructed in the postproduction studio using the third story as its base, to which descriptive sound effects were added in the same way as with the second story. Consequently, the fourth version contains both sound effects and sound shots. So as to avoid the interference of yet another variable, in no case was music used (see Table 1).

Experimental Procedures

Each one of the fictional stories was played in isolation to a group of 25 people. Thus, the total sample population comprised 100 ($N = 100$) university students studying for a degree in communication, aged from 22 to 25 years old. These students were randomly divided into 4 groups, stratified by gender.

The experiment, employing a focalized attention approach, was conducted simultaneously for all the groups with a view to avoiding any contact among the participants which might compromise the results. Therefore, each group was seated in a different room, all of which were equipped with high-quality sound systems to guarantee optimum listening conditions for each story. The instructions given prior to the experiment were concise: no mention was made of the variables of the study so as to avoid conditioning the participants' attention while they listened to the different narratives (Kisielius & Sternthal, 1986). The groups were only told that they would hear a fictional radio story about which they would later be questioned. Each group listened only once to their respective stories as certain studies on the value of

repetition have not proven that repeating a sound actually favors memory (Valkenburg & Beentjes, 1997). After listening to the story, the participants were given the questionnaire containing the scale of evocation for imagination and attention. The duration of the entire process was 40 minutes.

Imagery and Attention Measures

The dependent variables were established applying the Ellen and Bone (1991) Imagery Scale and the later revision of this scale by Babin and Burns (1998), the validity of which has been confirmed in numerous studies, applied to sound effects by Miller and Marks (1992). Imagery activity was measured using the following variables: vividness, which gauges qualitative aspects, and quantity/ease, which gauges quantitative aspects, with series of 7 points. Both vividness of imagery and the quantity of images and the ease of imagery activation have been highlighted by Ellen and Bone (1991) as identifiable dimensions of imagery processing.

Several studies have signaled the vividness variable as one of the most important for measuring dimension in the process of creating mental images (Cartwright, Marks, & Durrett, 1978; Collins, Taylor, Wood, & Thompson, 1988; Ellen & Bone, 1991; McInnis & Price, 1987). Ellen and Bone (1991) define it as "the clarity with which the individual experiences an image" (p. 96), whereas Morris and Hampson (1983) point to it as an indicator of clarity. In this study, the scale establishes to what extent images were clear, detailed, vivid, well-defined, and lifelike, with a scale of 7 points for each value. The mean for all forms the vividness variable.

The second dependent variable which measures imagery is quantity/ease, and it refers to the number of images stimulated in the mind after each hearing of the sound stimulus (Ellen & Bone, 1991; Kisielius, 1981; McGill & Anand, 1989). Quantity and ease are measured together as certain authors have found that they can both be dealt with empirically under one dimension (Babin & Burns, 1998; Bone & Ellen, 1992; Ellen & Bone, 1991; Miller & Marks, 1992). If it is easier to stimulate mental imagery, more images may be stimulated as well. This variable was measured using a scale of 7 points for 5 values. The participants of the experiment were asked to what extent they generated mental images; how many images were stimulated; what degree of difficulty they experienced in generating the images in their mind; how fast they created these images; and whether they would agree that they had generated images without difficulty. The mean for all forms the quantity/ease variable.

The 10 items of the vividness and quantity/ease scales were subjected to principle components analysis (PCA). Prior to performing PCA, the suitability of data for factor analysis was assessed. The Kaiser-Meyer-Olkin value was .86, exceeding the recommended value of .6 and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

When handling the data from the study as a whole, both variables—vividness and quantity/ease—are codified in a general index that forms the dependant variable imagery, the mean of both variables. These variables maintain a significant and direct correlation, measured using a Pearson's correlation ($r = .939$, p (2-tailed) = .000). Therefore, vividness shares approximately 88% of its variability with quantity/easy.

Moreover, attention was measured using the Potter and Choi (2006) Retrospective Scale as a basis, though lending a varying meaning to each variable that would make it possible to gauge the various forms of conscious attention. Therefore, the participants were required to answer three questions regarding the degree of attention that they had paid to the story: how much attention had they paid throughout the story, in order to gauge the stability of attention or maintained attention; what degree of interest it had held for them, in order to gauge motivation; and how much they had concentrated on it, to gauge effort in terms of concentrated attention. The sample was given instructions to clearly distinguish what was being asked in each question. Each answer was measured on a scale of 7 points with 1 representing the minimum value and 7 the maximum degree of attention, interest, and concentration. The mean for these three dimensions forms the general attention variable.

To test the reliability of this scale, a Cronbach's alpha coefficient was prepared. The alpha coefficient for the two principal variables (imagery and attention) was $\alpha = .974$ and for the 17 items was $\alpha = .987$, suggesting that there was high internal consistency. Also, a factor analysis was conducted for the scale items. All the items were assessed on the appropriate factor (.5 or higher), consistent with the results of Bone and Ellen (1992). Ellen & Bone (1991) and Miller and Marks (1992).

Results

A 2 (sound effects: present vs. absent) by 2 (sound shots: present vs. absent) by 2 (gender: male vs. female) factorial MANOVA was performed on the two dependent variables: imagery and attention. Using an alpha level of .001 to evaluate homogeneity assumptions, Box's M test of homogeneity of covariance was not significant ($p = .038$). Levene's homogeneity of variance test was statistically nonsignificant (imagery: $p < .500$; attention: $p < .048$) making it possible to assume that the variations were the same and fell in line with the principle of homoscedasticity.

Using Wilk's criterion (Λ) as the omnibus test statistic, the combined dependent variables resulted in significant main effects for sound effects, $F(1, 96) = 796.70$, $p = .000$, partial $\eta^2 = .94$, and sound shots, $F(1, 96) = 1497.25$, $p < .000$, partial $\eta^2 = .97$. The gender was statistically nonsignificant $F(1, 96) = 805.48$, $p = .045$, partial $\eta^2 = .01$. The sound effects by sound shots interaction was also statistically significant, $F(1, 96) = 176.71$, $p = .000$, partial $\eta^2 = .79$. The sound effects by sound shots by gender interaction was not statistically significant, $F(1, 96) = 627.56$, $p = .053$, partial $\eta^2 = .01$. In fact, the gender variable was nonsignificant for all analyzed values. The effect sizes of this relationship sound effects and sound shots were important in magnitude as indicated by partial eta-squared. As a result, the conditions surrounding the various stories had a major bearing on imagery and attention, though this was not the case for the gender of the sample subjects.

To test the hypothesis and to probe the statistically significant multivariate effects, univariate 2 (sound effects: present vs. absent) by 2 (sound effects: present vs. absent) ANOVAs were conducted on each individual dependent variable: imagery and attention. The means and standard deviations for each variable and item are shown in Table 2.

Table 2. Means and Standard Deviations for Imagery and Attention

		Sound shots					
		Present		Absent		Total	
	Sound effects	*M*	*SD*	*M*	*SD*	*M*	*SD*
Imagery	Present	6.31	0.22	5.09	0.23	5.70	0.65
	Absent	5.60	0.19	2.70	0.28	4.15	1.48
	Total	5.95	0.41	3.89	1.23	4.92	1.38
Attention	Present	6.42	0.31	4.65	0.37	5.54	0.95
	Absent	5.34	0.39	2.70	0.22	4.02	1.36
	Total	5.88	0.64	3.68	1.03	4.78	1.40

Hypothesis 1

The first hypothesis was that a fictional radio story which applied descriptive sound effects in its production would create mental images and would increase attention levels when compared with a dramatization without these resources. In line with prior research on this resource, our study of the results indicates that it is valid.

For the imagery dependent variable, there was a significant main effect for sound effects, $F(1, 96) = 1062.28$, $p < .000$, partial $\eta^2 = .91$. The stories with sound effects presents, S2 and S4, registered higher incidences of mental imagery than stories with sound effects absents, S1 and S3. The study on the variables that internally make up each scale makes it possible to conclude also that the story with sound effects particularly stood out since it was more vivid, more lifelike, and easier to imagine than the stories without these resources. Therefore, it may be concluded that there is a significant difference, which confirms the first part of the hypothesis.

For the attention-dependent variable, there was a significant main effect for sound effects, $F(1, 96) = 517.44$, $p < .000$, partial $\eta^2 = .84$. The stories with sound effects presents, S2 and S4, registered higher incidences of attention than stories without sound effects, S1 and S3. A more in-depth analysis of the variables in the scale makes it possible to draw the conclusion that the story with sound effects particularly stands out in terms of concentration in the level of attention paid. Therefore, the data indicate that, as well as the creation of visual images, the application of sound effects to a fictional radio story also improves listener attention, and hence Hypothesis 1 is confirmed.

Hypothesis 2

The second of this study's hypotheses stated that a fictional radio story which uses sound shots to characterize space, action, and characters would create mental images and would increase attention compared with a dramatization without these resources.

For imagery, there was also a significant main effect for sound shots, $F(1, 96) = 1863.06$, $p > .000$, partial $\eta^2 = .95$. The stories with sound shots presents, S3 and S4, registered higher incidences of mental imagery than stories with sound shots absents, S1 and S2. These data indicate clearly that stories with sound shots generated more images in listeners' minds than the stories without these resources and stood out particularly due to being more vivid, more lifelike, and easier and quicker to imagine.

For attention, there was also a significant main effect for sound shots, $F(1, 96) = 1100.19$, $p > .000$, partial $\eta^2 = .92$. The stories with sound shots, S3 and S4, registered higher incidences of attention than stories without sound shots, S1 and S2. A more in-depth analysis of the variables in the scale makes it possible to draw the conclusion that the story with sound shots particularly stands out in terms of concentration in the level of attention paid. Therefore, the stories with sound shots commanded a greater degree of attention and, thus, Hypothesis 2 is also confirmed.

Hypothesis 3

The third hypothesis adopted in this study stated that the fictional radio story which employed both descriptive effects and sound shots would provide greater stimulus for the creation of mental images and would increase attention more than any of the other stories. This hypothesis is also confirmed.

First, for imagery dependent variable, there was also a significant interaction between sound effects and sound shots $F(1, 96) = 311.86$, $p < .000$, partial $\eta^2 = .76$. The story S4, with sound effects and sound shots, yielded the best values of mental imagery compared with the stories S1, S2, and S3. In this instance, the story that includes all sound resources was more vivid, more lifelike, and quicker and easier to imagine (see Figure 1).

Second, the hypothesis for the attention variable is also confirmed. There was also a significant interaction between sound effects and sound shots $F(1, 96) = 42.42$, $p < .000$, partial $\eta^2 = .30$. The story S4, with sound effects and sound shots, registered higher incidences of attention than the stories S1, S2, and S3. An in-depth analysis of the variables in the scale points to the fact that the story with the most resources obtains the greatest differences in terms of concentration in the level of attention paid (see Figure 2). Therefore, in consonance with the earlier studies reviewed, regarding complex radio messages that employ different resources, this story achieved the highest levels of mental imagery and attention.

The ANOVA measurement was checked via several post hoc tests (the Tukey's HSD test and Dunnett T3s test), applied assuming equal and unequal variances. All the procedures applied yielded a highly significant difference between groups. Accordingly, the study shows that the four stories present significant differences in the variables analyzed.

Furthermore, the results obtained from the comparison of the four stories reveal a close relationship between the two dependent variables analyzed: imagery and attention. Therefore, although we did not contemplate the possibility in our original hypotheses, the study also reveals that the variables of imagery and attention maintain a significant and direct correlation (measured using a Pearson's correlation), in accordance with the results of each of the stories

($r = .86$, p (2-tailed) = .001). These data indicate that as the degree of visual image creation increases, listener attention also rises.

Discussion

The aim of the study was to ascertain the degree of incidence of two characteristic radio stimuli, sound effects and sound shots, in the creation of visual images and in listener attention when they are applied to a fictional audio story. An analysis of earlier studies conducted in this field led us to anticipate that a radio message which used sound effects and sound shots, or a combination of these, would enhance both the creation of visual images and listener attention. The results of the study, which are statistically significant, support this hypothesis.

First, the study demonstrated that the story based solely on dialogues was the one that least stimulated listeners' imagination and attention levels. This finding lends support to earlier studies in which the use of different resources in radio messages had yielded the same result (Bolls, 2002; Bone & Ellen, 1992; Childers & Houston, 1984; Lutz & Lutz, 1977; Unnava & Burnkrant, 1991), although these studies did not concern the specific genre of radio drama. This phenomenon can be explained due to the dual-code theory (DCT) and the PRT. According to the former, the verbal nature of the stimulus would have triggered a mechanism more linked to semantic processing rather than visual/spatial processing, which would not benefit from double coding. In the case of the latter, the explanation is based on the activation of semantic structures in the working memory. As no perceptual structures (visual [sound effects] and spatial [sound shots]) are activated in response to a stimulus, the coding process in the memory and, by extension, the process for creating images in the mind would be hindered and delayed. Therefore, the listener has created fewer images, encountering greater difficulty and needing more time to do so. Likewise, the images were less intense, less well-defined, less clear, and less lifelike. In addition to this effect, the stability of the verbal stimulus throughout the entire story, due to the lack of variation, has led to a reduction in the stability, interest, and concentration when it comes to the listener paying attention to this story.

As far as sound effects are concerned, our study demonstrates that they are effective in stimulating images and in enhancing listener attention; the stories in which they are used, S2 and S4, have obtained a significant main effect for imagery and attention. This finding is consistent with the literature reviewed regarding applications in radio advertisements (Potter et al., 1997). Indeed, the studies carried out by Miller and Marks (1997) demonstrate that the creation of mental images generated by verbal messages is less intense and numerous than that generated directly by sound effects. However, no such investigation had been carried out into radio drama. Moreover, earlier studies had not involved the prior isolation of the function fulfilled by sound effects in a radio production, a factor which we consider relevant to the results of any investigation into the phenomenon.

The difference in auditory processing stemming from the story with sound effects in comparison to the dialogue-based story can be interpreted in the context of Paivio's DCT and Kieras's PRT, based on the characteristics of these kinds of sounds. The sound effects

have introduced a certain degree of novelty in the stimulus, in contrast to the verbal information, which did initially encourage the listener to pay attention, interest and a greater degree of concentration. In addition, they have provided reference-based information regarding the nature of the sound stimulus ("what"), making it easier to be identified according to the "context availability" and "elaboration" (Atwood, 1989). Due to a greater wealth of reference-based information, the listener almost automatically generated visual images of the story in his mind: more images were created with greater ease and swiftness, clearer, more detailed, better defined, and more vivid and lifelike. As a result, by stimulating auditory representations in the nonverbal visual codes or perceptual structures and as contextual elements that framed and strengthened the content of the message, the sound effects have heightened the listener's attention and lead to more images being formed in his or her mind with greater intensity than with a verbal stimulus.

As for sound shots, our study also demonstrates that their use in a fictional story increases both the creation of visual images and listener attention. The stories in which they are used, S3 and S4, have obtained a significant main effect for imagery and attention. These findings can be also interpreted in the context of Paivio's DCT and Kieras's PRT. The sound shots have activated auditory representations in the nonverbal spatial codes or propositional structures, which have heightened attention and the creation of visual images, though in this case in terms of space. According to the theory of spatial representation (Kosslyn et al., 2006), establishing different distances between the characters has enabled spaces and actions to be more easily situated and, therefore, has provided the listener with a spatial representation ("where"), more lifelike. This increased sense of reality, triggered by the use of sound shots, has arisen because during auditory processing the listener hears events aside from merely acoustic signals: "the sounds of people and things moving, changing, beginning and ending, forever interdependent with the dynamics of the present moment. Auditory experience is always of a flow of sound, constant at times, rising or falling in intensity" (Forrester, 2002, p. 33). Consequently, in addition to characterizing this flow of sound, sound shots have organized the stimulus in perceptive terms by distinguishing between significant sounds (foreground) and secondary sounds (background), as in the figure-ground phenomenon. By simulating the structure of real space and capturing all possible relations between sound objects encoded in a coordinate scene, they gave the listener a greater sense of reality through which to better imagine the event represented in the scene. Indeed, an aspect of mental imagery relevant to McInnis and Price's study (1987) is its effect on the perceived likelihood of events: "the act of visualizing an event can make the event seem more likely" (p. 480). Owing to this distinction, which has improved intelligibility, the listener has better been able to adopt a specific standpoint (point of listening), on the basis of which to create a subjective representation of the story, concentrating on actions performed by sound shots. As Beck (1998) points out, the listener, and thus his or her attention, is always positioned at the centre of the sound which determines the mixing and balancing of sound technically, in other words, his or her attention focuses on and is positioned at the foreground in the space, represented by sound shots. Accordingly, he establishes a subjective representation (Rodero, 2009, p. 243), which should lead more, highly intense images to be created in the mind, thereby encouraging the listener to keep and focus his or her attention in relation to

a dialogue-based story. As a result, sound shots in this study, by stimulating auditory representations in the nonverbal spatial codes or propositional structures, containing and distributing the sounds in significant spatial frameworks, have heightened the listener's attention, interest, and concentration and have created a greater number of clearer, more intense, better defined, and more lifelike images with greater ease and swiftness. Therefore, the findings of this study demonstrate that, in auditory processing also, spatial information becomes important when it comes to increasing the rate at which mental images are created and the listener pays attention.

What was less clear at the outset was whether the use of sound shots would exceed the results obtained in imagery and attention for sound effects, as in fact was the case. On measuring the two dependent variables, the stories with sound shots occupied better place than the stories with sound effects. One likely explanation for this result may be on the differing nature of both stimuli which would give rise to a different kind of auditory processing. Indeed, some studies have shown that the kind of information in the stimulus activates different regions of the brain, as is the case with the visual system. The ventral pathway, including occipito temporal cortex, is thought to be involved in object identification whereas the dorsal pathway, including parietal cortex, processes information regarding the spatial locations of objects, and the spatial relationships among objects (Rämä, 2008). For instance, reference-based information introduced by sound effects ("what") generates a visual image almost automatically, processed by nonverbal codes and perceptual memory structures. The listener is quickly able to identify and visualize the sound object described by the sound clearly and intensely, with virtually no effort, as demonstrated by the Vanderveer (1979) or Gaver (1993) experiments. As a consequence, in this study the story with sound effects obtained better results for the clear and vivid variables and when generating images without difficulty compared with the story based on sound shots. In addition, as the sound effect carries a time-based component, once identified (switched attention) and coded, the listener focuses his or her attention on the content of the story until a second stimulus of this type emerges, whereby any subsequent appearances would raise interest and encourage the listener to keep his or her attention, though always in a general, occasional manner.

Likewise, in addition to generating a visual image, the space-related information established by sound shots establishes the organization in space of this image which supplements the information, delimiting it and adding detail; hence, by activating more auditory representations in the nonverbal codes and perceptual memory structures, the sound shots provide specific information as opposed to the general details provided by sound effects.

Through sound effects, the listener is able to identify and generically imagine the location of a particular scene at the same time as a call of attention is produced on perception of the audio stimulus. However, once the listener has recognized the context, he or she concentrates on the spatial composition of the scene, which is formed and colored by the sound shots. The result is that the story with sound shots creates more detailed, lifelike images, with less difficulty and swiftness, than the one composed using sound effects. In this instance, as the stimulus needs to be arranged into the foreground and background in perceptive terms and to establish relationships between sound objects, it calls for greater attention and, in particular, greater concentration on the part of the listener. In addition, as changes in sound shots also

introduce ongoing variation into the stimulus, due to successive actions in the story rather than the occasional novelty in sound effects, attention is maintained in a more stable manner, in addition to greater concentration, reflecting greater effort, two aspects for which the sound shot-based story differs from the one based on sound effects in accordance with the finding of Bolls and Lang (2003) in processing high-imagery ads. In the case of interest, the two stories obtained the same score.

Nevertheless, the story which achieved the highest level of visual image creation and attention, with a highly significant difference, was that which employed both resources: sound effects and sound shots. As the study had anticipated, the sum of both elements constitutes the most effective composition in achieving both purposes. First, we considered this hypothesis plausible in the light of the findings of earlier studies, according to which a more complex message produces higher degrees of image creation and attention. Our findings therefore concur with the literature reviewed, although these earlier studies had not specifically concerned fictional stories. The feedback from the participants in the experiment, for all the variables higher than the other stories, reveals that this story scores particularly well in realism, in a low degree of difficulty to imagine scenes and in the degree of interest. The conclusion to be drawn from these data is that, in line with the interpretation offered for the other stories, a greater activation of nonverbal—visual and spatial codes—and perceptual structures in response to this complex stimulus, with both audio resources, would have substantially improved the coding process, producing the highest extent of creation of imagery and attention, interest, and concentration levels.

Finally, the study reveals a strong correlation between the two dependent variables, imagery and attention, for the four stories analyzed. This means that as audio resources were introduced into the different stories, the index of visual image creation increased, but to a similar degree as attention, via a linear correlation.

Limitations and Future Research

Although the results of this study are quite conclusive, they may only be interpreted within the context of a laboratory experiment and the consequent inherent limitations thereof. First, this study focused on the use of two specific audio resources: sound effects and sound shots. However, given the diversity and richness of sound in radio, it would be advisable to extend the area of investigation to include other important elements such as music. It may well be that this element, which is not specifically defined as an instrument for the visual interpretation of scenes, would obtain lower scores than the resources that we analyze here. However, it may also be the case that music might induce higher attention levels. This is an area which requires further research.

The study also singled out a specific function of sound effects, the descriptive function, and attempted to isolate this variable. Nonetheless, this audio resource should also be measured in conjunction with other functions, such as its functional role in supporting actions, its subjective role in reinforcing emotions, or its narrative role in marking the structure of narratives. It would be interesting to ascertain whether the other functions of sound effects yield the same indices. The study also shows that sound shots are very effective elements

in achieving our objectives, although we only consider some hypothetical reasons for this effect. Accordingly, further study is required in order to provide an explanation, not only for sound shots' effectiveness in isolation but also in comparison with sound effects.

Finally, although this study provides interesting data on the attention variable, our findings do not indicate how listener attention levels behaved throughout the exposure of the participants to the different stories. It should be remembered that the duration of each story was 4 minutes, and so the degree of attention is likely to have varied. It would, therefore, be of interest to establish at what points any variation occurs and what factors affect this variation throughout the length of the story.

In summary, the results of this study offer support for applying a perception-based conceptualization of audio-evoked imagery processing. Therefore, they may be applied to any audio fiction product using acousmatic sounds, in other words, failing a sound object. Furthermore, the conclusions drawn in this research are of great interest for the audio industry and can be directly applicable to the teaching of sound, especially of radio production.

Aside from the envisaged unfavorable results from the dialogue-based story and the favorable results from the sound-effect and sound-shot based story, the truly revealing aspect of this study is that it shows that spatial, relationship-oriented information introduced by sound shots in a radio drama and by extension in any audio fiction with the same listening conditions, is decisive in stimulating the process whereby mental imagery is created and the listener's attention is maintained. In this case, we can conclude that the information provided by sound shots is highly relevant throughout the auditory processing of a dramatized message.

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Bio

Emma Rodero, MA in journalism by the Faculty of Communication (Pontificial University of Salamanca, Spain) and PhD in communication by the Pompeu Fabra University in Barcelona, Spain, is radio professor and also a visiting professor for numerous universities in Spain and Latin America. She is author of *Producción Radiofónica* [Radio Production] (Cátedra), *Locución Radiofónica* [Voice and Radio Presentation] (IORTV), *La radio que convence* [Advertising on Radio] (Ariel), *Realización de entrevistas y reportajes en la radio* [How to do interviews and reportages on radio] (Cervantes), and around 30 scientific articles or collaborations in books chapters about radio communication.