INVESTIGATION AND COMPARISON OF THE SOUND QUALITY OF THE LURES USED FOR GREYHOUND RACING

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This study investigates and compares the acoustic signatures of a traditional wire-cable pulled lure system and two novel alternative battery-operated lure systems which were developed to eliminate the hazardous steel-wire cable and make the sport of greyhound racing safer for greyhounds, participants, and spectators. The acoustical measurements of these three lure systems were conducted at the Murray Bridge greyhound racing track in South Australia with high-frequency B&K Type 4191 microphones. The microphones were positioned within the starting box and on the track adjacent to the starting boxes, at both the straight track and bending track. The measurements captured the sounds that the greyhounds hear before and after the opening of the starting box gate. The sound quality analysis was conducted to compare the lure sounds. It was found when the battery-lure was installed with all nylon rollers, it presented less sound energy than the traditional wire-cable pulled lure. When two of the nylon rollers were replaced with steel rollers, the battery-operated lure emitted a louder sound than the traditional wire-cable-pulled lure. The different acoustic characteristics of these lure systems suggest future research is warranted on the reaction of greyhounds to different lure sounds, particularly their excitement level within the starting box as the lure approaches. This initial research also suggests some greyhounds may not clearly hear the battery-operated lure with all nylon rollers approaching the starting boxes and the timing of these greyhounds to jump may be delayed, particularly during high wind conditions.

Keywords: Greyhound racing; wire-cable pulled lure; battery-operated lure; sound quality.

1. Introduction

Greyhound racing is a popular recreational pastime that is enjoyed by people of all ages and is legal in many counties including Australia, the United States, the United Kingdom, Sweden, Denmark, Germany, Netherlands, New Zealand, Mexico and Vietnam. In Australia, races are conducted at purpose-

built tracks and the races are run counter-clockwise generally on oval-shaped tracks with a mechanical lure system [1, 2]. Racing greyhounds are stimulated to chase the lure by both sight and sound [3]. The most common lure used in Australia is the wire-cable-pulled lure system where a continuous wire-cable pulls the lure carriage along a guide rail on the inside of the track. The wire-cable-pulled lure emits a sound that greyhound trainers link to chasing behaviour when the greyhounds are pups so that when they hear this sound it is paired with excitement and racing. The sound of the lure is used to stir the greyhounds prior to racing. The wire cable runs along guide rollers and can travel at a speed more than 30 m/s [4].

The wire-cable-pulled lure system is considered a Work Health and Safety issue for track-side staff and a potential hazard for the greyhounds. When the lure is operating, its many parts are moving at high speeds, which could cause hazards to the greyhounds and nearby people if it catastrophically failed. The battery-operated lure developed by Covey Associates and manufactured by Steriline Racing is now used at the Murray Bridge, Richmond and Grafton greyhound racing tracks. The self-propelled lure is powered by a rechargeable lithium-ion battery and importantly eliminates the high-speed steel-wire cable, therefore reducing the operational risk to both racing greyhounds, race officials and the general public. Meanwhile, there is a risk that the implementation of such an alternative lure system might result in a non-desirable greyhound response. The greyhounds have been visually and aurally conditioned to follow the wire-cable-pulled lure during racing and training. So, it is advised that the battery-operated lure should generate the same visual and audible stimulation to which the greyhounds have been conditioned.

Currently, it is not known exactly how a greyhound's hearing system responds to lure sound. The fact is that the wire-cable-pulled lure has been used for decades in greyhound racing. When the battery-operated lure was invented to replace the wire-cable-pulled lure to increase safety and reduce cost, there was concern that this much quieter, battery-operated lure might affect greyhound racing performance as its sound was significantly different from the wire-cable-pulled lure. Therefore, it is worthwhile studying the acoustic difference between the innovative battery-operated lure and the traditional wire-cable-pulled lure, as well as how alternative lure sounds might affect greyhound racing performance.

This paper focuses on the measurement and objective analysis of the existing cable and proposed cable-less lure sounds. To this end, this research undertook sample measurements of the acoustic signatures of a traditional wire-cable-pulled lure system and two alternative battery-operated lure systems developed by Covey Associates and Steriline Racing. The sound of different lure systems was compared through sound quality analysis.

2. Murray Bridge Greyhound Racing Track and Different Lure Systems

The acoustic measurements were conducted at the Murray Bridge greyhound racing track located in South Australia. The track plan is shown in Fig. 1(a) with four different starting positions including the two used in this study. The starting box at the 455 m is shown in Fig. 1(b, c). The arrangement being common at all starting positions. In the racing event, the greyhounds are initially locked in the starting box. The lure commences its progression around the rail from a location behind the starting box. When the lure approaches, the starting box gate is triggered to open with the greyhounds released to rush out of the starting box and chase the lure along the track towards the finish.

(a) (b) (c)

Figure 1: (a) Murray Bridge greyhound track plan. (b) 455 m starting boxes from side looking. (c) 455 m starting boxes from behind looking.

Three different lure systems are investigated and compared in terms of their acoustic performance; these are shown in Fig. 2. The Murray Bridge track wire-cable-pulled lure configuration is shown in Fig. 2(a). The two different configurations of the battery-operated lure system developed by Covey Associates and Steriline Racing is shown in Fig. 2(b, c). In Fig. 2(b), there are twelve nylon rollers installed to guide the lure. The two larger diameter rollers orientated in a vertical plane carry most of the vertical load while the two rollers directly beneath these carry the lateral load of the lure. An alternative battery-operated lure configuration where the upper pair of nylon rollers were swapped with mild-steel rollers is shown in Fig. 2(c).

(a) (b) (c)

Figure 2: (a) Wire-cable-pulled lure. (b) Battery-operated lure with twelve nylon rollers. (c) Battery-operated lure with ten nylon and two steel rollers (highlighted by the red circles).

3. Lure Acoustic Performance Measurement

It is known that greyhounds are able to hear sounds at a higher frequency than humans (45 kHz vs. 20 kHz) [5, 6]. For this reason, a multi-channel noise and vibration data acquisition system and a pair of high frequency microphones were selected over a traditional sound level meter for the collection of the lure sounds. High frequency Brüel & Kjær (B&K) Type 4191 40 kHz measurement grade microphones were used for the acoustic signals collection.

For each experiment, two simultaneous acoustic recordings were taken at the following two locations: within starting Box 1 and approximately 2 m from the inside track measured perpendicular from the box opening trigger. The microphone layout which was approximately common at each of the start locations with the microphone positions highlighted by the red circles is shown in Fig. 3. The acoustic signals within the box offer insights as to what the greyhounds experience before and shortly after the box gate is opened. The signals on the track, meanwhile, represent the true acoustics of the lure system and offer insights as to what the greyhounds experience while chasing the lure.

Figure 3: Microphone and data acquisition system position.

Nominally identical acoustical measurement campaigns were undertaken at the 395 m and 455 m starts. As shown in Fig. 1(a), the 395 m start allowed acoustical data to be measured while the lures approached and pulled away from the microphones along straight sections of track before and after the measurement location. The 455 m start allowed acoustical data to be measured while the lures approached on a bend and pulled away along a straight section of track [7]. The sound signals measured at the 395 m start and 455 m start are shown in Fig. 4 and Fig. 5 respectively. Around 10 s acquisition results are presented, 5 s from each starting distance before and after the box gate was triggered and opened.

The large peaks at around 5 s in the box sound signals indicate the box gate opening. Looking at the lure sound signals measured in the box, when the lures are approaching, the lure sounds in the box are obviously increased which could excite the greyhounds and ready them to jump. After the box gate is opened, the lures keep moving closer to the box and the sound pressure in the box continues to increase. This assists the greyhounds to recognise the lure position from previously learned auditory clues and readies them to jump out of the box when the gate is opened.

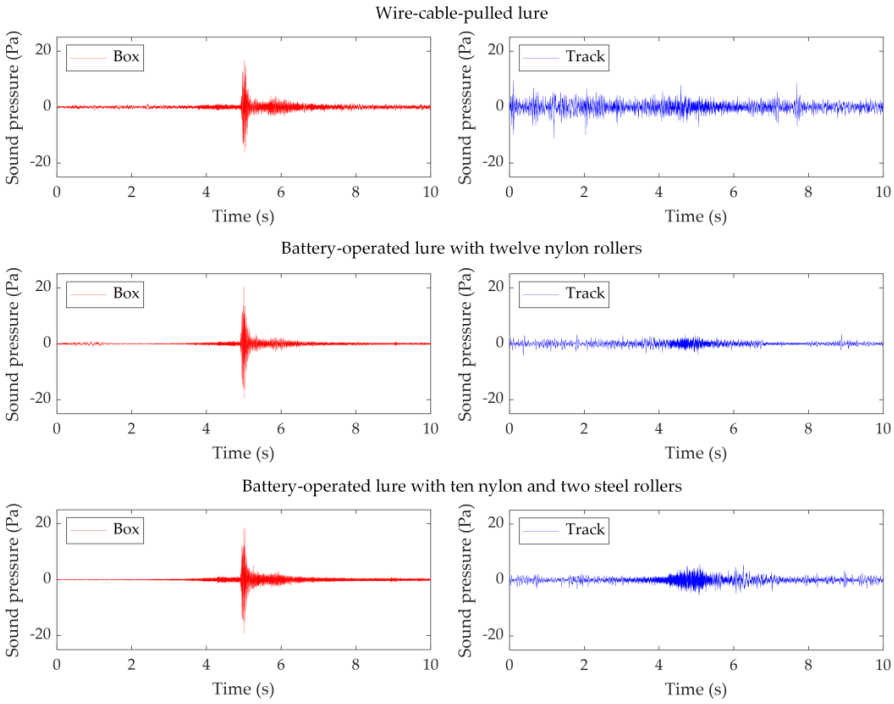

Figure 4: Example lure acoustic signals measured at the 395 m start.

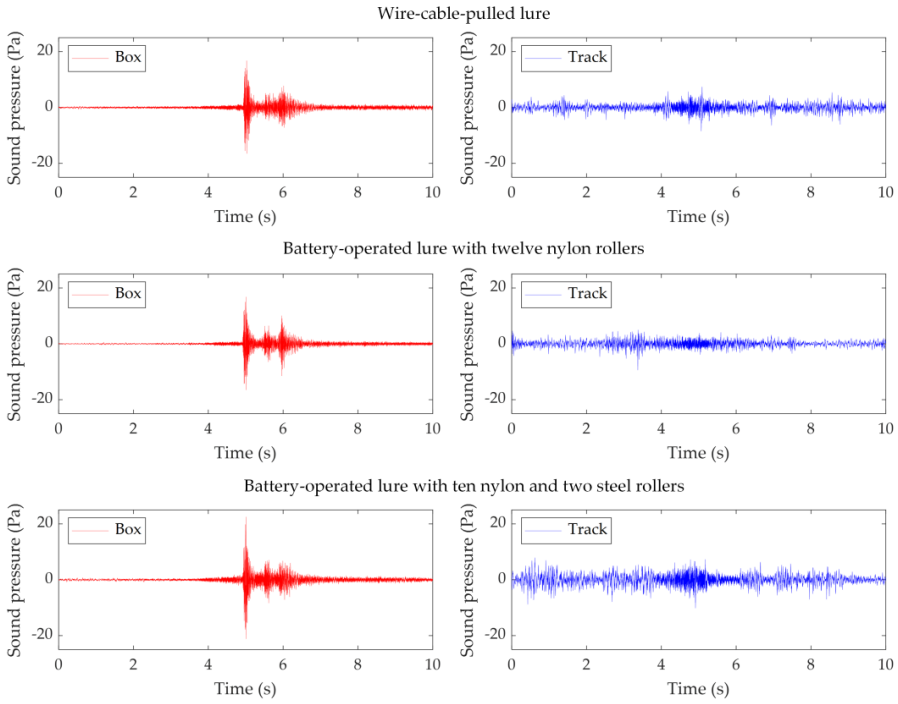

Figure 5: Example lure acoustic signals measured at the 395 m start.

After the greyhounds are released from the starting box, they chase the lure as a result of visible and audible stimuli. The acoustic signals measured on the track also show increments when the lure passes. However, in addition to the lure sounds, the microphone also records significant environmental noise which sometimes even has higher sound pressure than the lure sounds. In the following sections, sound quality analyses of the measured signals were therefore conducted to extract the potentially critical characteristics from the lure acoustic performances and to compare them from different perspectives.

4. Sound Quality Analysis

Human psycho-acoustic research shows that the perceived sound loudness varies when the sounds have different frequencies even when they have same sound pressure [8, 9]. Additionally, the human emotional response to sounds is greatly affected by the sound frequency component, typically described as sharpness [10, 11]. Assuming this theory is also correct for greyhounds, sound quality analysis was conducted for the measured lure sounds in this section from the loudness and sharpness perspectives. This hypothesis is made based on the following conditions and observations: Canines have been living together with humans for a long time. In real life, canines live in same sound environment as humans and have evolved to present very similar sound behaviours to humans. For example, humans can “talk” to their pet dogs just in the same way (loudness, stress, tone. . .) as they talk to other humans; canines respond to human voices well, especially for trained canines.

In the sound quality analysis, the loudness was calculated according to the ISO 532-1(2017) [12] with the following parameters: spectrum resolution of specific loudness: 1/8 bark; time interval: 10 ms. The sharpness was analysed using the Zwicker method [13]. The loudness of different lure sounds measured at the 395 m and 455 m starts are shown in Fig.6 and Fig.7 respectively.

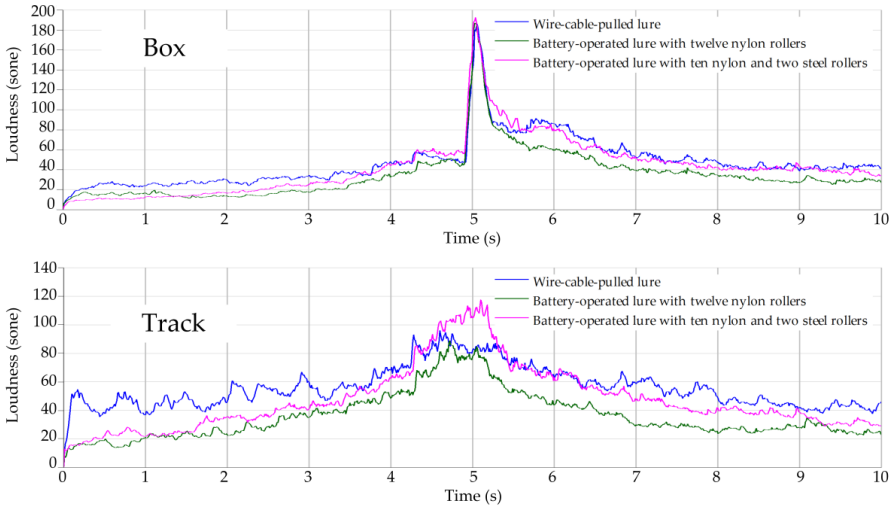

Figure 6: Loudness of the lure sounds measured at the 395 m start.

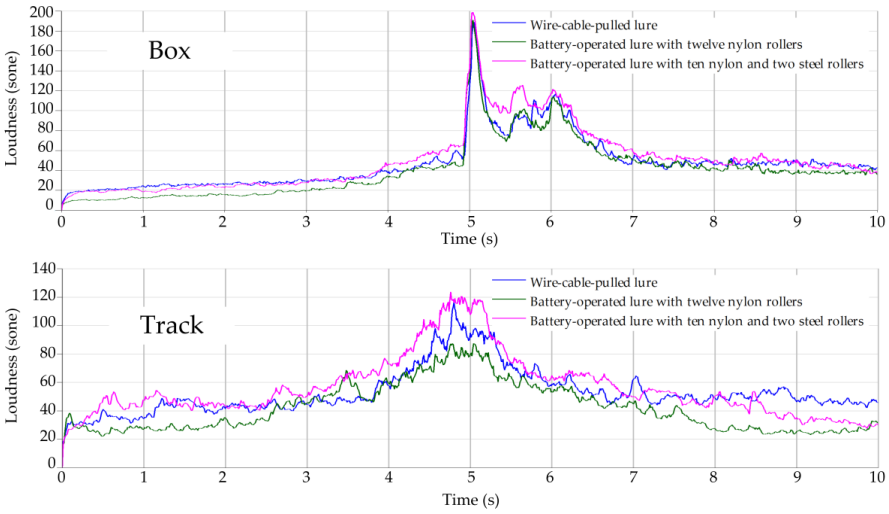

Figure 7:Loudness of the lure sounds measured at the 455 m start.

Comparing the lure sounds measured in the box, the battery-operated lure with twelve nylon rollers had a lower loudness than the wire-cable-pulled lure both before and after the box gate was opened. Using the battery-operated lure may present a problem when the starting box is closed, in so much as the greyhounds may not hear the sound of the approaching lure clearly and may not be sufficiently excited by the sound.

The lure sounds measured on track shows a significant increase in loudness when the lures are close to the microphone. This demonstrates that the lure sounds have clearly higher loudness than the environmental noise due to relatively higher frequency. It is therefore possible for the near greyhounds to hear and distinguish the lure sounds from the environmental noise during racing.

Nevertheless, the battery-operated lure with twelve nylon rollers shows a reduction in loudness when compared to the wire-cable-pulled lure, so it may not provide a similar level of sound excitation as the wire-cable-pulled lure during racing and the greyhounds chasing performance may also be affected by this relatively quieter lure. In contrast, when the battery-operated lure is installed with ten nylon and two steel rollers, it shows higher loudness peaks than the wire-cable-pulled lure which implies better hearing excitation during racing.

The sharpness of different lure sounds measured at the 395 m start and the 455 m start are shown in Fig. 8 and Fig. 9 respectively. It can be seen that the battery-operated lure shows lower sharpness than

the wire-cable-pulled lure when installed with twelve nylon rollers but shows higher sharpness than the wire-cable-pulled lure when installed with ten nylon and two steel rollers.

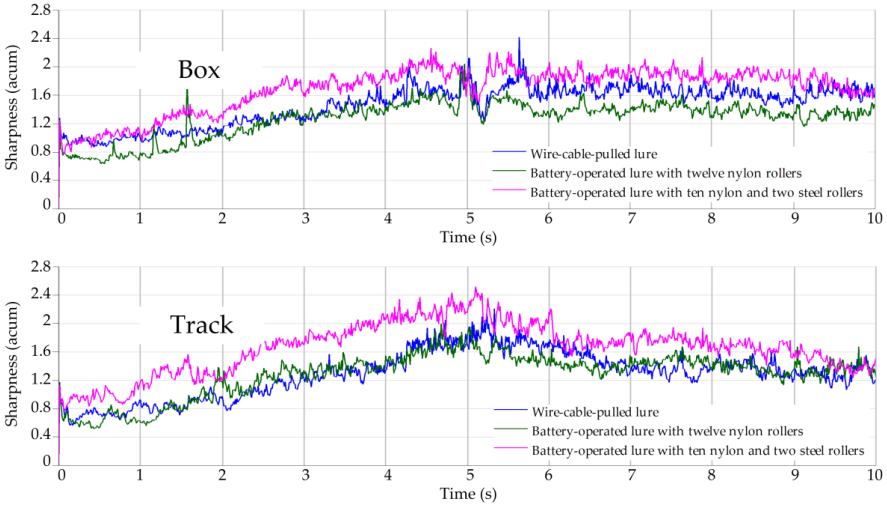

Figure 8: Sharpness of lure sounds measured at the 395 m start.

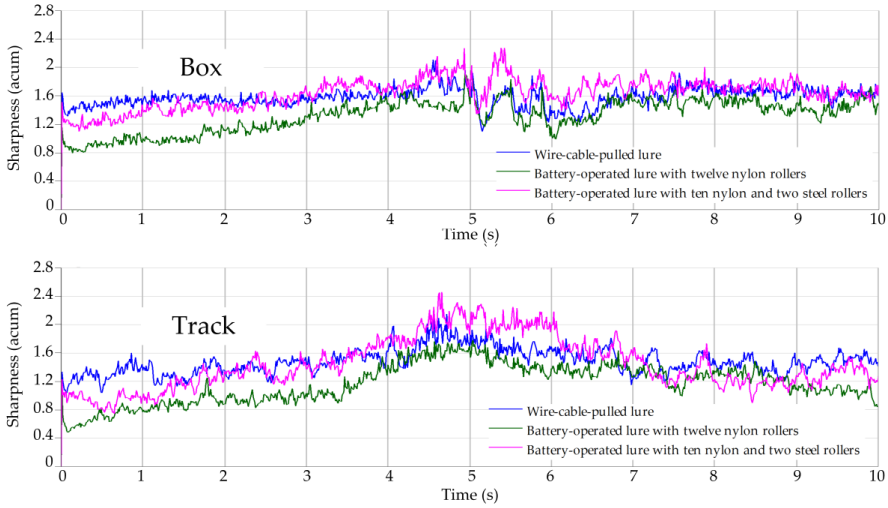

Figure 9: Sharpness of lure sounds measured at the 455 m start.

5. Conclusions and Recommendations

This paper researched the acoustic difference between the traditional wire-cable-pulled lure and the novel battery-operated lure. From the sound quality analysis results, it was found that when the battery-operated lure is installed with twelve nylon rollers, it emits a less powerful sound than the traditional wire-cable-pulled lure. This might affect the greyhounds excitation immediately prior to the starting box gate opening. A fair racing start may be compromised if all the greyhounds are not sufficiently excited by the approaching twelve nylon roller lure. The alternative battery-operated lure which has ten nylon rollers and two steel rollers demonstrated an increase in the sound energy at magnitude that was higher than the wire-cable-pulled lure.

A more detailed and conclusive study into the greyhound's behaviour within the starting boxes as the battery-operated lure approaches is strongly recommended. This study would enable a greater understanding of what a statistically significant number of greyhound's experience within their respective starting box as the lure approaches and the boxes open. It is recommended that a number of different

battery-operated lure configurations be trialed to ascertain the optimum pre-box opening and racing lure acoustical configuration for greyhound excitation. Besides, the greyhounds behaviour of chasing lures with different sound characteristics such as the introduced sound of one or more squawkers also deserves further research.

REFERENCES

1 Hayati, H., Eager, D., Peham, C. and Qi, Y. Dynamic behaviour of high performance of sand surfaces used in the sports industry, *Vibration*, **3**(4), 410-424, (2020).

2 Hayati, H., Eager, D. and Walker, P. The effects of surface compliance on greyhound galloping dynamics, *Proceedings of the Institution of Mechanical Engineers, Part K: Journal of Multi-body Dynamics*, **233**(4), 1033-1043 (2019).

3 Starling, M., Wilson, B. and McGreevy, P. Effects of lure type on chase-related behaviour in racing greyhounds, *Animals*, **10**(12), 2262, (2020).

4 Eager, D., Hossain, I., Ishac, K. and Robins, S. Analysis of Racing Greyhound Path Following Dynamics Using a Tracking System, *Animals*, **11**(9), 2687, (2021).

5 Heffner, H.E. Hearing in large and small dogs: Absolute thresholds and size of the tympanic membrane, *Behavioral Neuroscience*, **97**(2), 310, (1983).

6 Poese, M. E., *Performance Measurements on a Thermoacoustic Refrigerator Driven at High Amplitudes*, Master of Science Thesis, Graduate Program in acoustics, Pensylvania State University, (1998). Kanders, K., Lorimer, T., Gomez, F. and Stoop, R. Frequency sensitivity in mammalian hearing from a fundamental nonlinear physics model of the inner ear. *Scientific reports*, **7**(1), 1-8, 2017.

7 Eager, D., Hossain, I., Ishac, K. and Robins, S. Analysis of Racing Greyhound Path Following Dynamics Using a Tracking System, Animals, **11**(9), 2687, (2021).

8 Suzuki, Y. and Takeshima, H. Equal-loudness-level contours for pure tones, *The Journal of the Acoustical Society of America*, **116**(2), 918-933, (2004).

9 Fasti, H., Jaroszewski, A., Schorer, E. and Zwicker, E. Equal loudness contours between 100 and 1000 Hz for 30, 50, and 70 phon, *Acta Acustica united with Acustica*, **70**(3), 197-201, (1990).

10 Swift, S.H. and Gee, K.L. Implementing Zwicker sharpness using specific loudness calculated from the "Procedure for the computation of loudness of steady sounds.". *The Journal of the Acoustical Society of America*, **141**(5), pp.4022-4022, (2017).

11 Berglund, B., Preis, A. and Rankin, K. Relationship between loudness and annoyance for ten community sounds. *Environment International*, **16**(4-6), 523-531, (1990).

12 ISO 532-1:2017. Acoustics—Methods for Calculating Loudness—Part 1: Zwicker Method, *International Standards Organisation: Geneva, Switzerland,* (2017).

13 Zwicker, E.; Fastl, H. Psychoacoustics: Facts and Models, *Springer Science & Business Media: Berlin/Heidelberg, Germany*, 22, (2013).