TITLE: The use of mental metronomes during simulated cardiopulmonary resuscitation training

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The use of mental metronomes during simulated cardiopulmonary resuscitation.

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Running title: The use of mental metronomes in simulated CPR

Abstract

Objective: To evaluate the effect of a mental metronome on chest compression rate at the point of training and 10 weeks later.

Methods: A prospective observational study was performed using veterinary students without training in cardiopulmonary resuscitation (CPR). Students received a lecture and demonstration of CPR. The 'Song group' (SG) listened to "Stayin' Alive" performed by the Bee Gees and were asked to think about the tempo during chest compressions. The 'No Song group' (NSG) were given no guidance on achieving the correct chest compression rate. After the demonstration both groups were instructed to perform chest compressions at a rate of 100 compressions/minute on a canine manikin and the actual rate of compressions administered was calculated (Assessment 1). This task was repeated approximately 10 weeks later (Assessment 2).

Results: 18 students were in the SG and 12 in the NSG. Seventy-eight percent of the SG performed chest compressions between 90 and 110bpm during Assessment 1, compared with 50% during Assessment 2. The NSG had an 8% success rate at both Assessments. Compression rate variance did not change in in either group over time.

Conclusions: Mental metronomes are valuable teaching tools that can help students perform chest compressions at an accurate rate.

Abbreviations

AHA	American Heart Association
BLS	Basic life support
BPM	Beats per minute
CCC	Continuous chest compressions
CPM	Compressions per minute

MWU	Mann-Whitney U
RECOVER	Reassessment Campaign on Veterinary Resuscitation
RVC	Royal Veterinary College

Introduction

Cardiopulmonary resuscitation (CPR) is a complex process, requiring a multi-person team coordinated by a skilled leader and access to medical equipment.[1] Administrators of CPR must operate under a standard protocol and regularly practice their skills in order to be effective.[1] Chest compressions are the cornerstone of CPR and, thus, a vital skill to learn and maintain. Certain chest compression rates have been associated with a higher rate of return of spontaneous circulation in dogs,[2] while suboptimal compression rates in human patients lead to poorer outcomes.

The 2012 Reassessment Campaign on Veterinary Resuscitation (RECOVER) suggested that the research and development of specific educational practices may improve resuscitation outcomes.[1] Human studies assessing CPR instruction and learning retention have shown favorable results, but there are few studies in the veterinary literature. Human studies assessing CPR instruction and learning retention have shown favorable results, but there are few studies in the veterinary literature. Mental metronomes (generally songs with a beat at the desired compression rate) are suggested to augment a CPR provider's ability to perform chest compressions. Previous human medical studies have evaluated the effect of mental metronomes on CPR performance either over time or against a control group, but not both.[4-6] This study aimed to assess whether utilizing a mental metronome would increase compression rate accuracy in students studying at a UK veterinary school and whether any benefits of using the mental metronome would be retained over time.

Methods

The study protocol was approved by the Royal Veterinary College's Ethics and Animal Welfare Committee. Participants for this prospective observational study were solicited via emails requesting volunteers for a study on CPR teaching methods. Emails were distributed to Veterinary Medicine (preclinical years and first clinical year only) and Biomedical Science students at the Royal Veterinary College. This cohort was selected as they had no exposure to CPR at this stage in their education. Students were ineligible for enrollment if they had undertaken any practical training in either human or veterinary CPR. Allocation to the control (No Song Group – NSG) or study group (Song Group – SG) depended on the training session attended and was based on convenience for the student.

During the first session, informed signed consent forms were obtained from all participants. Both groups were given a 20-minute lecture designed by the authors discussing indications for CPR, basic life support, technique for both the cardiac and thoracic pump mechanisms, and appropriate chest compression rate. The lectures and instruction were delivered by the same author. Following the lecture, thoracic pump chest compressions were demonstrated on a canine manikin.[1]

Following demonstration, participants practiced chest compressions on the manikin at a rate of 100 compressions per minute (CPM). Those in the SG listened to the chorus of the Bee Gees' "Stayin' Alive"[2] while practicing chest compressions and were instructed to synchronize their compressions with the beat of the song. The song was chosen as it was being promoted by the British Heart Foundation hands-only CPR campaign and had an easily discernable rhythm of 103/min.[7] Participants in the NSG did not listen to a song during practice and instead were instructed to perform compressions at 100 CPM with no specific

instructions on how to do so. Both groups had their technique and compression rate corrected as needed, with their compression rate being measured in real time with software. The software allowed the author to match the participant's tempo by tapping a screen along with their compressions.[3] Following a short break both groups were asked to perform chest compressions at a rate of 100 CPM without music for 45 seconds. The SG participants were instructed to think about the song during this period. This was Assessment 1 (A1).

The participants were asked to return individually 10 weeks after the first teaching session for Assessment 2 (A2). A uniform return date was not possible due to participant schedules. On this day, they were asked to perform chest compressions on the same manikin at a rate of 100 CPM for 1 minute. No instruction regarding the song was given to either group. Videos of the participants from both sessions were evaluated, and CPM was obtained by counting the number of compressions performed and averaging them over 1 minute.

The CPM and group data for the SG and NSG from A1 and A2 were analyzed using commercially available software.[4] Success rates between groups and group distribution were analyzed using 2-sided Fisher's exact test, success within groups over time using McNemar's test, and effect of time using Spearman's correlation. Medians were compared using a Mann–Whitney *U*-test. A participant was considered successful if they performed chest compressions within the range of 90 to 110 CPM. As this target differed from the current RECOVER guidelines, we performed a post-hoc sensitivity analysis that investigated the effect of changing the target rate to match the guideline recommended compression rate of 100 to 120/min and reanalyzed our data as described above.

Results

Thirty‐nine people responded to solicitation, of which 34 attended A1. Three participants

from the NSG and 1 from the SG did not attend A2. There were 15 participants in the NSG (12 females, 3 males) and 19 in the SG (14 females, 5 males) on A1. There were 12 participants in the NSG (9 females, 3 males) and 18 in the SG (13 females, 5 males) on A2. Participants returned for A2 from 62 to 78 days after A1 (median: 69 days). Time of return did not affect success (rs = 0.16, P = 0.41). Gender of the participant did not affect success (P = 0.69). Course of study (veterinary medicine or veterinary science) did not affect success (P = 1).

Participants in the SG were 79% successful on A1 and 50% on A2. Participants in the NSG were 7% successful on A1 and 8% on A2 (Figures 1 and 2, Table 1). Removal of data for participants who did not attend A2 changed the success of SG to 78% and NSG to 8% on A1. There was a significant difference between the success of participants in the NSG versus the SG during A1 (P = 0.0005) and A2 (P = 0.024). The SG had a lower median CPM on A1 (U = 12.5, Z = −4.06, P < 0.0001) and A2 (U = 59.5, Z = −2.056, P = 0.04).

Post-hoc analysis using 100 to 120 CPM as the target compression rate was performed. Using this target, participants in the SG were 100% successful on A1 and 72% successful during A2. Participants in the NSG were 53% successful on A1 and 50% successful during A2 (Figures **3** and **4**). There was a significant difference between the success of participants in the NSG versus the SG during A1 (*P* = 0.001) but not on A2 (*P* = 0.27).

Table 1: Comparison of teaching methods during A1 and A2

	Successful 90–110 CPM (%)	Successful 100–120 CPM (%)	Median CPM	Interquartile range	95% CI (LL, UL)	Min/Max CPM
SG A1	79	100	108/min	104–110/min	106, 116	102/115/min
SG A2	50	72	111/min	103–117/min	106, 117	92/131/min
NSG A1	7	53	117/min	114–126/min	110, 129	109/148/min
NSG A2	8	50	118/min	113–130/min	110, 129	86/142/min

A1, Assessment 1; A2, Assessment 2; 95% CI, 95% confidence interval (lower limit, upper limit); CPM, compressions per minute; SG, Song Group; NSG, No Song Group.

Discussion

Participants instructed to think about the chorus of the song "Stayin Alive"[2] during chest compressions on a canine manikin (SG) were more likely to achieve a rate of 90 to 110 CPM or 100 to 120 CPM both on the day of training and 10 weeks later. These results suggest that using a mental metronome while performing simulated CPR aided participants in performing CPM at rates within the target range. This would not be possible if there were not a rhythmic structure in the song that people were able to identify and reproduce.

"Stayin′ Alive" was chosen in this study because it is a well‐known song with an easily discernable beat and is currently recommended by the British Heart Foundation as a mental metronome during CPR.[7] We chose a target rate of 90 to 110/min as we predicted that participants would perform at a rate above and below the tempo of the song. Interestingly, no participants in the either group performed compressions at a rate slower than 100/min during A1, but 1 NSG participant and 2 SG participants did so during A2. The current RECOVER guidelines recommend a rate of 100 to 120/min.[1] If participant performance was stratified using this guideline, then the SG would have been 100% and 72% successful during A1 and

A2, respectively, compared with 53% and 50% success during A1 and A2, respectively, in the NSG.

This study looked at the effect of a single song on performance. In practice, any song matching a provider's preference could be chosen provided it has the appropriate tempo. Large searchable databases of music exist and songs can be found by entering a desired beats per minute, allowing providers to select their preference. As CPR guidelines evolve, so can the recommended mental metronome. The implementation of a mental metronome into CPR instruction must be combined with focus on appropriate technique. One study by Rawlins et al found that listening to a song during CPR increased chest compression rate accuracy but decreased compression depth.[8] Rawlins et al speculated that it was the "amusing" nature of the song choice ("Nellie the Elephant") that caused the poor compression depths.

Our findings contrast with a human medical study by Hafner et al that found subjects using a song did not significantly affect chest compression rate accuracy on the day of training.[5] Interestingly, this changed over time and song users were more successful at reaching their target rate after 6 weeks. It is unclear why this happened, but participants in their study had a longer practice period and may have been more tired during their initial assessment period.

This was a prospective evaluation of a specific teaching technique, but there are some limitations worth discussing. This was a manikin trial, which does not recreate the genuine stress of a real cardiopulmonary arrest situation. However, there is little opportunity for practicing and evaluating chest compressions outside of an artificial environment, and simulations have been found useful for training medical skills.[9] True randomization was not performed as groups were determined based on availability. As the same author provided

both the instruction and review of the data, there was no blinding, but as data are quantitative this is unlikely to have a significant effect. The study design is simple and easily reproducible, and despite the small sample size, the effect of the intervention was strong.

Cardiopulmonary resuscitation is a complex and stressful event, and while chest compressions are only a part of the puzzle, they are integral to its success. Using a mental metronome is a universal tool that can be implemented into any practice's CPR protocol without added equipment, and may help improve confidence levels of CPR providers. For veterinary providers, “Stayin’ Alive” may be the song of choice, but many alternatives exist. It would be helpful to evaluate faster songs in future studies, as well as their effect on compression depth, provider confidence, and utility in real CPR situations.

Acknowledgements

Karen Humm, MA VetMB CertVA DipACVECC FHEA MRCVS, Supervisor

The Royal Veterinary College CPD Department

The Royal Veterinary College Clinical Skills Centre Staff

The Royal Veterinary College Clinical Skills Centre Student Students

Footnotes

1. Jerry K‐9 CPR Mannikin, Rescue Critters, Simi Valley, CA.
2. Saturday Night Fever, original movie soundtrack, PolyGram International Music, 1977.
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Figure 1. A comparison of compression rates between groups on Assessment 1 (A1)

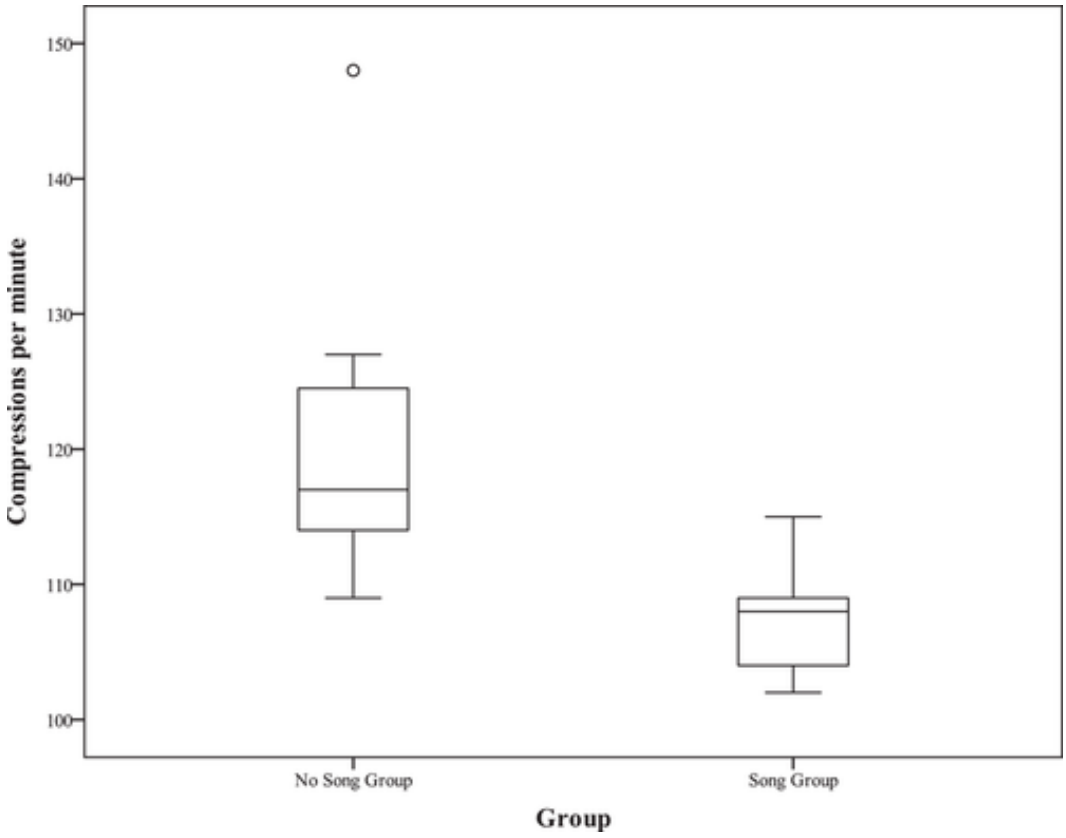

Figure 2. A comparison of compression rates between groups on Assessment 2 (A2)

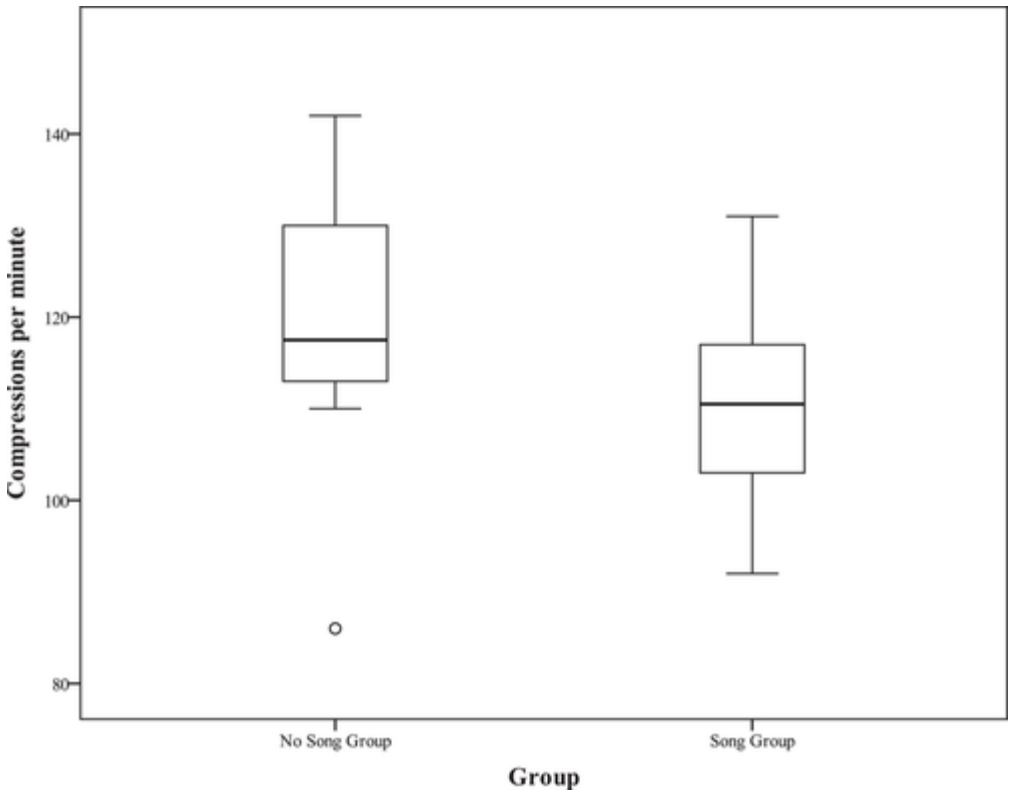

Figure 3. Comparison of success rates using 90 to 110 CPM versus 100 to 120 CPM target on Assessment 1 (A1). CPM, compressions per minute

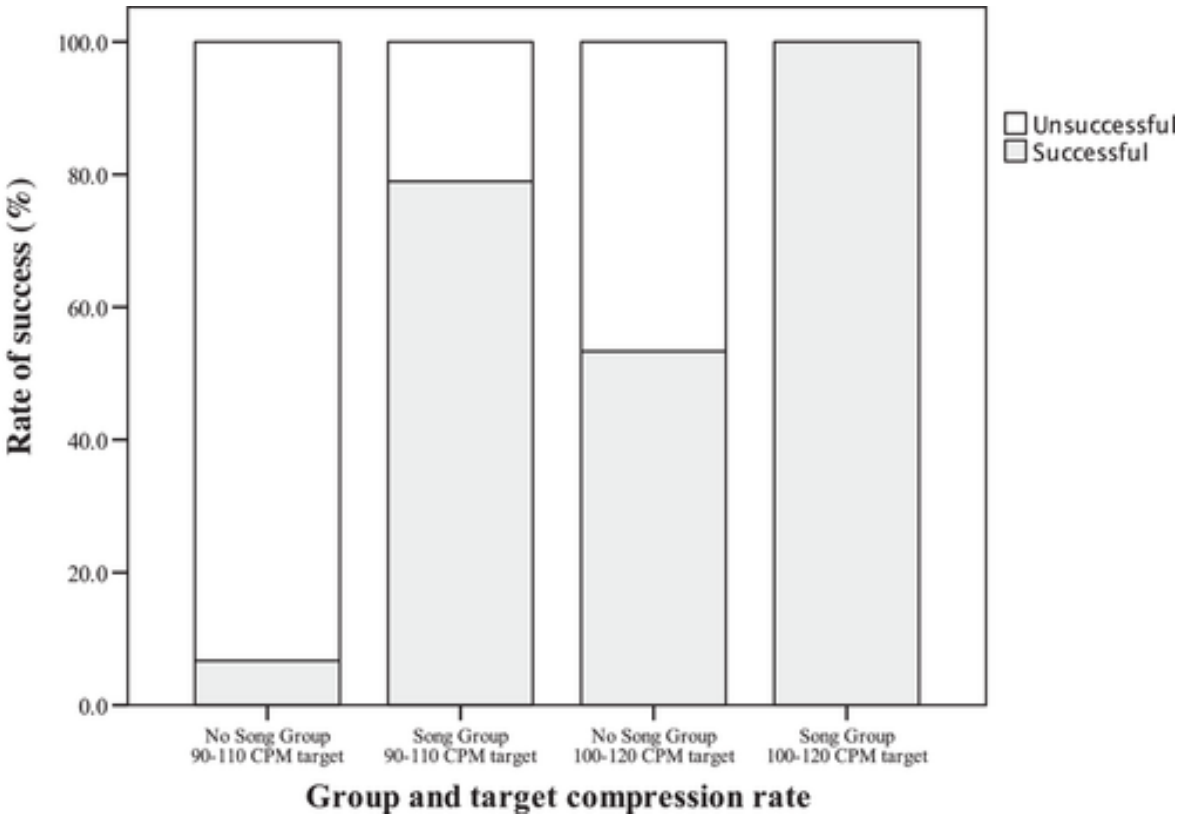

Figure 4. Comparison of success rates using 90 to 110 CPM versus 100 to 120 CPM target on Assessment 2 (A2). CPM, compressions per minute