THE ROLE OF INTONATION PATTERN IN INFLUENCING THE PERCEPTION OF COXSWAIN CALLS

Scarlette Rijkse
BA Linguistics, 2025

Abstract: This dissertation investigated the relationship between language and sport, namely, how certain intonation patterns could influence how a coxswain is perceived by listeners. This study was motivated by findings in communicative contexts such as public speaking, where certain pitch variations and contours have been proven to impact how credible and engaging a speaker is perceived to be by their audience. Having never been examined empirically before, we set out to test whether these patterns also exist in the communication between coxswains and their crews. We measured three pitch variations (many, medium, and few) and two pitch contours (High-Low and Low-High) against four dependent variables of competency, persuasiveness, dynamism, and self-reported arousal (i.e., alertness). Our findings were that monotonous styles, just as in public speaking, have a considerably negative effect on perceptions across all four variables when used by coxswains. High-Low pitch contours were also found to be the optimal pitch contour for competency, persuasiveness, and arousal in comparison to Low-High patterns. This study aims to pave a novel research path, combining both prosodic and sport research, with the hope that our findings could assist coxswains in manipulating their intonation style to be better perceived by their crews.

Keywords: Coxswain, intonation pattern, non-verbal communication cue, pitch variation and contour, attitudinal inference

Supervisor(s): Dr Rory Turnbull

Acknowledgements:

I would like to firstly thank my supervisor, Rory Turnbull, for guiding me through this process and encouraging me with his continued enthusiasm for my project. I would also like to thank the Linguistics Lab manager, Lauren Ackerman, who patiently guided me through the process of building an experiment and analysing my results. I'd like to thank my friends and family for their unwavering support throughout this long process and for spending countless hours with me in the library. I'd like to thank Jack Nicholas from Cambridge University Boat Club who provided the coxswain recording used in the experiment, whose voice will hopefully inspire current and future generations of coxswains to come. Last but certainly not least, I'd like to thank my sister, Caroline Rijkse, who has continued to be my biggest inspiration throughout both my rowing and academic careers, and without whom this dissertation topic would not have been explored.

‘The role of intonation pattern in influencing the perception of coxswain calls’

1. Introduction

1.1 The unique role of coxswains in rowing

Research on human linguistic communication cues has typically focused on speakers in scenarios of, for example, public speaking, radio commercials, or interpersonal conversations (Rodero 2022, Chattopadhyay et al. 2003). However, little attention has been paid to the role of language in sport, specifically in rowing, where communication is essential to athletic performance – through the voice of a coxswain. Coxswains are the smaller, lighter non-rowing members whose primary role is to steer from the back of an eight-person boat or from the front or back of a four-person boat (Rich et al. 2022). Equally as crucial to their role, coxswains communicate continuously with their crew by delivering ‘calls’, which include instructional commands, feedback and encouragement through a speaker system that runs the length of the boat (Rich et al. 2024, Rich et al. 2021). Coxswains communicate with their crew for multiple reasons, such as to issue commands to manoeuvre the boat on and off the water during training and racing, delivering instructional feedback to improve technique, and providing calls of encouragement that influence the attention, confidence, and motivation of their rowers to maximise their physical performance (Rich et al. 2024, Gabana et al. 2015).

When a coxswain is being assessed for selection, coaches often look beyond size and steering capabilities when choosing a coxswain of the highest standard. They look for coxswains who motivate their crew dynamically and neutrally, remain calm and strategic on race day, take control of situations, bring passion and joy to their crews, gain the respect of their rowers, push them to higher standards, and be “fiercely” competitive (Dresser 2020). What remains underexplored, however, is identifying *how* coxswains meet these requirements using only their voice to do so. Indeed, rowers are largely unable to see the coxswain, except the stern pair of an eight-person boat (the two rowers sat directly in front of the cox) (Rich et al. 2024). Therefore, the communication between a coxswain and their crew is entirely dependent on the vocal faculty. A coxswain must effectively use both verbal and non-verbal cues to extract the best physical and technical performance from their rowers, as all other communication strategies, such as facial or gestural cues, are eliminated (Mitchell and Ross, 2013, Rodero 2022).

1.2 . The role of non-verbal communication cues in coxing

While the content of a coxswain speech is important, the way in which they deliver it may hold greater influence over the motivation and performance of their crew (Tracy et al. 2011, Weinstein 2018, Rodero 2011). Verbal communication cues used in coxing function in "guiding the narrative" of a training session or race (Mitchell and Ross 2013, Rich et al. 2024, Gabana et al. 2015). In race scenarios, coxswains control when and where their rowers make pushes by producing certain instructional commands, ("drive the legs harder for ten!") and provide motivating information regarding their boat's position in relation to other boats, the finish line, or a landmark ("I'm on their stern, let's walk through") (Rich et al. 2021, Rich et al. 2024). Furthermore, coxswains dictate the imagery that is provided to their crew which can exercise considerable influence on their athletic performance (Simonsmeier et al. 2021). This can include, for example, motivational commands to "jump off the catch!" or "drive the legs down!", that help the rowers visualize faster more dynamic movements to implement into their stroke (Simonsmeier et al. 2021, Rich et al. 2021).

However, it is notably difficult to investigate the effectiveness of certain verbal cues as this is likely to vary between each individual crew or club. Each crew will have its own identity, whereby it will develop certain calls and imagery that they know work well for them and ones that don't. What resonates with one crew – such as describing the initial leg drive as a "squeeze" while others a "kick" or a "stamp" – may not for another (Dresser 2020, Rich et al. 2024). This variability complicates any attempt to identify universally optimal verbal cues in coxing. Therefore, we propose that it is not what a coxswain says, but the way in which they deliver it (their non-verbal cues) that may distinguish more successfully communicative coxswains. Indeed, several studies have indicated that in communicative interactions (public speaking, radio adverts etc.), the value of the prosodic qualities of an utterance supersede that of the verbal content of the message (Weinstein 2018, Rodero 2011). In other words, *how* a speaker says something is potentially more important than *what* they are saying. This supports the notion that investigating the influence of non-verbal communication cues in coxswain calls on the engagement and motivation rowers will be a productive area of research, and one that has not yet been explored in depth to our knowledge.

1.3. Intonation as a key prosodic cue

Non-verbal communication includes all expressive aspects of speech that extend beyond literal words, and allow a speaker to express emotions, attitudes, intentions, and ideas on a paralinguistic level (Mitchell and Ross 2013). They include kinesics (gestures, movement, and postures), proxemics (space and distance), and paralanguage (relating to voice features) among others (Knapp 1980). In the coxing environment, where coxswains are entirely reliant on their voices, prosody – the paralinguistic elements of speech such as intonation, amplitude, envelope, tempo, rhythm, and voice quality – takes centre stage (Grandjean et al. 2006). These acoustic cues play an important role in communication because they influence the perception of a speaker and the cognitive processing of listeners (Weinstein et al. 2020, Rodero et al. 2017). Prosody is typically studied in two dimensions: emotional prosody (conveying base emotions of happiness or anger, for example) and attitudinal prosody (conveying attitudes such as confidence or enthusiasm) (Mitchell and Ross 2013, Rodero 2011, Weinstein et al. 2018). In the context of coxing, emotional prosody is less relevant, as coxswains rarely express personal emotions, rather, they aim to project attitudes – enthusiasm, confidence, authority among others – with the intention of improving how rowers perceive them and well as increasing their engagement and emotional activation (Rich et al. 2024). Attitudinal prosody, and the way it functions to influence perceptions of speakers, will thus form the basis of our study.

Our study will focus specifically on one prosodic feature: intonation – which refers to the fluctuations of pitch (or f0) across an utterance. Intonation is comprised of two types of pitch variations: pitch level and pitch range. Pitch level refers to the midline at which the melodic contour is delivered, and range is the different between the highest and lowest pitch level. The manipulation of these dimensions allows a speaker to establish pitch variation and contour across an utterance (Gussenhoven 2004). Intonation can be emphatic (with many variations), moderate (medium variations), and monotonous (few variations), and pitch contours across utterances can include High-Low (high initial pitch with descending contour) and Low-High (low initial pitch with raising contour). Intonation has been shown to be especially influential in facilitating the perception of speaker attitudes such as confidence, enthusiasm, and politeness (Mitchell and Ross 2013, Holliday et al., 2023). Further, it has been connected to other social attitudes such as humour, sarcasm, irony, or sincerity (Cheang et al. 2008, Rigoulot et al. 2014, Scharrer et al. 2011).

However, despite its importance, there is still a paucity of research concerning the influence of pitch variations and contour on perceptions of speakers. Even within the studies that have been conducted, findings are mixed. Studies on the influence of intonation on persuasion have indicated strategies with moderate pitch level and significant pitch variations are optimal (Burgoon et al. 1990). Jackob et al., (2011) found that perceptions of credibility and dynamism are improved with greater pitch variety. Rodero et al., (2017) concluded that High-Low pitch contours enhance the autonomic arousal of listeners, while Rodero et al., (2022) found the same response with moderate emphatic intonation. Conversely, some studies have found no effect of intonation on perceptions of persuasion, credibility, or emotional response (Chebat et al,, 2007 Gélinas-Chebat et al. 1996, Elbert and Dijkstra 2014). However, though limited, these findings indicate that the manipulation of pitch in speech is able to exert somewhat of an influence on the way a speaker is perceived and could be applied to the speech of coxswains. Therefore, we propose the following overarching research question:

How does intonation influence a coxswain’s perceived competence, persuasiveness, and dynamism, as well as the autonomic arousal of listeners?

1.4. Research questions and general structure

Though research on the influence of intonation pattern on speaker perceptions in public speaking is limited, research studying its influence on coxing calls is even more scarce. This presents a critical gap at the intersection of prosodic research and communication in sport that we will aim to fill in this study. Previous studies have indicated that, just as in public speaking, intonation might be able to affect how a coxswain is perceived by their crew, which could ultimately lead to improved athletic performance (though this latter point requires more extensive research so will not be directly investigated in this study). Therefore, we propose the following research questions:

RQ1: How does pitch variation influence how a coxswain is perceived and the arousal of listeners?

RQ2: How does pitch contour influence how a coxswain is perceived and the arousal of listeners?

We will endeavour to answer these questions with the following proposed structure: section 2 will review the current literature and state our hypotheses, section 3 will detail the methods of our experiment, section 4 will give the results, followed by the discussion in section 5 and the conclusion in section 6.

2. Literature review and hypotheses

This literature review will discuss how the current literature has investigated the role of intonation in influencing how a speaker is perceived. It will discuss how pitch variations and contour have been shown to convey speaker attitudes and evaluate how this could be applied to a coxing context.

2.1 Intonation in communication

The manipulation of pitch (or f0) is a non-verbal communication cue that is used by speakers across different languages to convey emotions, intentions, attitudes and perceptions (Mitchell and Ross 2013). For example, speakers of English typically raise their average pitch level to come across as more polite and lower it to generate perceptions of authority and competence (Holliday et al. 2023). This harks back to Ohala's (1983) Frequency Code, which states that lower f0 is produced by larger and more dominant animals, thus engendering general perceptions of lower pitch as more assertive, while higher pitch is associated with submissiveness and uncertainty. Further, this explains why many of the world's languages use rising pitch contours for questions – because they indicate uncertainty (Mitchell and Ross 2013). Moreover, both pitch level and range can facilitate the communication of a speaker's base emotions, for example, low pitch levels are associated with sober emotions such as sadness, calmness, or security, while intonation styles with greater pitch inflections denote emotions displaying greater excitement: joy, anxiety, or fear. (Rodero 2011).

This use of pitch variation to express emotions is what is known as ‘emotional prosody’, which has dominated much of the prosodic literature. However, what is more crucial for this study is a consideration of ‘attitudinal prosody’, which has been relatively understudied in comparison (Mitchell and Ross 2013). Attitudinal prosody refers to the attitudes or disposition that a speaker has to the information being delivered which are conveyed in a communicative interaction (Mitchell and Ross 2013). These can include complex constructs such as enthusiasm, boredom, appreciation, or disbelief, among others (Weinstein et al. 2018). Just as with emotions, the manipulation of pitch across an utterance (intonation) is the most important acoustic cue in communicating speaker attitudes. For example, high speaker confidence is typically expressed with a lowering intonation contour at the end of an utterance, for example, while doubt is often associated with rising intonation and elevated pitch (Monetta et al. 2008).

Importantly, Mitchell and Ross (2013) makes the important distinction between the *expression* of an attitude on the part of the speaker, and the *impression* on that of the listener, which results in attitudinal inference. It is this construct that is particularly crucial to our study, as we are examining how coxswains can manipulate their intonation so that their crew might *perceive* in a certain manner. Furthermore, Pell (2006) notes that prosodic attitude cues hold the power to influence the direction or end-result of communicative interactions – a speaker who manipulates their prosody with the intention of persuading a listener of the importance of an activity or idea, for example, is indirectly manipulating the impressions that the receiver forms in response. We might directly apply this to the context of our study, therefore, whereby a coxswain who manipulates their intonation pattern to signal that they are confident in what they are saying means that the rowers listening would be more likely to place greater trust in the changes they are being asked to make. Though it will not be explicitly tested in this study, we imagine that rowers would subsequently respond accordingly with greater commitment – resulting in improved crew performance (Rich et al. 2024).

The idea that the manipulation of a speaker’s prosody can act to fortify an implied communication act has dubbed vocal intonation as the ‘vehicle of persuasion’ (Chebat et al.

2007). Intonation pattern influences persuasion because it allows a speaker to fully communicate the degree of belief, commitment, or strength of their intentions, which allows them to be perceived as more credible (Gelinas-Chebat et al. 1996). This is evidenced in the literature which has found that perceptions of credibility towards public speakers are closely correlated with persuasiveness, which is increased with greater pitch variety (Burgoon et al., 1990). Further, in a study of the prosody of politicians, Rodero (2019) found a positive effect of moderate pitch level on perceptions of credibility, which is supported by the findings of Rodero et al., (2022) in which moderate pitch variations obtained the highest level of credibility for public speakers. Vocal intonation is therefore placed at the heart of our experiment. We will endeavour to show how the perceptions that public speakers are able to engender from listeners, due to their intonation patterns, are also applicable and valuable to coxswains.

2.2 Pitch variation in communication

Empirical studies examining how exactly different pitch styles can influence perceptions are few and far between. One study that does address this research opportunity, however, is Rodero (2022), which found that the number of pitch variations used by public speakers influences how effective and attractive they are perceived to be by listeners. Participants listened to a series of recordings of public speakers where three different intonation styles were used: patterns with few pitch variations, medium variations, and many variations. After each recording, participants rated the speaker on how natural, clear, and understandable they were, with the mean of these responses forming the 'effectiveness' index. Participants were also asked to rate how competent, persuasive, and pleasant they perceived each voice to be, forming the 'attractiveness' index.

Results showed that the pitch condition of medium variations obtained the highest results of both effectiveness and attractiveness, followed by the strategies with many variations, and then few variations. Researchers concluded that the style with many variations was perceived as potentially excessive, with the greater pitch variety sounding overexaggerated and unnatural. This hindered its perception by listeners who preferred a moderate intonation style as a result, leading to greater ratings of effectiveness and attractiveness. The pattern with few variations was the least favourable style because the lack of pitch variety was perceived as monotonous and dull, thus less effective and attractive. These findings supported by Rodero et al., (2022) which found again that intonation styles with moderate pitch variations obtain the highest level of effectiveness and credibility, while monotonous styles are the worst received. Based on these findings and ideas, we postulate the first hypothesis of this research:

H1: The style with medium pitch variations will be perceived as more competent, dynamic, and persuasive than many and few changes in that order.

Rodero (2022) also measured the influence of intonation pattern against autonomic arousal, both in self-report and physiologically, and found it to have a significant effect. Arousal refers to the state of being awake and alert which occurs as a sympathetic nervous system response (Dawson et al. 2000). High arousal levels are indicative of strong emotional activation. In the study, arousal was measured in self-report using the Self-Assessment Manikin (SAM) (Bradley and Lang, 1994). This model presents participants with a series of 5 images depicting a figure ranging from unaroused (sleepy) to extremely aroused (wide awake). Participants selected which image they resonated with the most after listening to each recording. Physiological arousal was measured using electrodermal activity sensors attached to the participants' fingers, where a higher electrical response indicated greater emotional activation.

The findings were that intonation patterns with medium variations elicited the greatest arousal in participants, followed by styles with many variations, for which activation was high but not as intense as for medium variations, followed by few variations. This is supported by Rodero (2015) with the Principle of Distinctive and Contrastive Coherence of Prosody (henceforth referred to as the PDCCP), which posits that the acoustic contrast achieved through pitch variety better captures the attention and arousal of listeners, explaining why both medium and many variations were able to increase participant arousal more so than monotonous styles. Rodero (2022) concluded that the pattern with many variations elicited less arousal than medium variations because it was excessive and therefore counterproductive, leaving medium variations as most preferable. Rodero (2015) also notes that over-emphasis hinders the naturalness of a speaker's speech and reduces how receptive a listener is towards their message, which supports this notion.

However, in physiological arousal, Rodero (2022) found that medium variations was not sufficient to increase the arousal of participants and had to be complemented with other non-verbal communication cues (gestures) to do so. This was also found in Rodero et al., (2022), where the most emphatic styles (many variations) achieved a greater physiological emotional response over moderate styles for public speakers. Instead of being counterproductive, a more active and dynamic intonation pattern with constant pitch variations was better able to increase the physiological arousal of listeners. Notably, however, these results were gathered from physiological measures of arousal, for which we did not have the necessary equipment to test in our study. When participants are asked to self-report their arousal, we expect that they might find the styles with many variations as excessive regardless of their true body activation (that we will be unable to measure), leaving the medium variations style as the most preferable for arousal, in accordance with Rodero (2022 and 2015).

The least favourable style in Rodero (2022) was one with few pitch variations, whereby a repetitive and constant sound with little change failed to increase the arousal of participants. This notion aligns with the theory of "sensory adaptation", which posits that arousal is reduced in response to monotonous styles with little pitch variation due to the perception of a constant and repetitive sound, which causes the brain to become fatigued as there is no acoustic contrast (Wark et al. 2007). Due to the lack of pitch variety, in accordance with the PDCCP, monotonous styles failed to capture the attention and arousal of participants (Rodero 2015). The same finding was true of Rodero et al., (2022), whereby monotonous styles elicited the least arousal from listeners of public speakers, in comparison to styles with both medium and many pitch variations. Based on these findings, we formulate our second hypothesis:

H2: The style with medium pitch variations will elicit greater self-reported arousal than many variations, and few variations will be the worst perceived overall.

2.4 Pitch contour in communication

As well as the strength of pitch variations, this study will also examine the influence of pitch contour on listener perception. In our study we will manipulate the pitch level and range across different utterances to produce two pitch contours: High-Low (HL) and Low-High (LH). HL patterns have a high initial pitch followed by a descending contour across the utterance. This is the inverse in LH patterns, which start in a lower pitch and have a rising contour throughout the utterance. The perceived productivity of examining the influence of pitch contour is principally derived from Rodero et al., (2017), which found a significant effect against listener perception. HL patterns were better perceived than LH ones across dependent variables of effectiveness (how clear, natural, pleasant, dynamic and persuasive the voice was perceived to be) and adequacy (correctness, appropriateness, comprehensibility, and credibility).

Across many languages, HL patterns are commonly used in declarative sentences, which are neutral or factual statements. This means that HL patterns generally sound more assertive and confident than LH patterns, which are used interrogatively or in instances of uncertainty. HL intonation patterns therefore naturally lend themselves to persuasion, given that it aligns with the way speakers often convey clear, factual, or conclusive information (Mitchell and Ross 2013). Therefore, we predict that listeners of coxswains will respond the same way as those of public speaking in Rodero et al., (2017), given that coxing calls are almost entirely declarative in nature: they are typically commands, encouragement, or statements of information delivered to a crew, (Rich et al. 2024). As a result, HL patterns would sound more natural than LH when used in coxing calls, thereby improving perceptions. Further, due to their declarative nature, we expect them to be perceived as more assertive in comparison to the typically more doubtful LH patterns. We therefore propose our third hypothesis:

H3: The HL intonation pattern will be perceived as more competent, persuasive, and dynamic than the LH pattern.

As well as improving listener perceptions, we also predict that HL pitch contours will increase the self-reported arousal of participants in our study. This prediction is primarily derived from Rodero et al., (2017) which also measured the physiological arousal of participants using electrodermal activity sensors. They found that HL obtained the best results, indicative of greater emotional activation in comparison to LH intonation patterns. This was due to the theory of 'dual function', as part of the PDCCP (Rodero, 2015). This posits that pitch changes have two distinct functions: to distinguish different parts of a sentence into prosodically distinct units (distinctive function) and establish acoustic contrasts between high and low pitch (contrastive function) (Rodero, 2015). As a result, they can differentiate the relevance of the content of an utterance. For example, in declarative sentences, accessory information is often delivered in an initial higher pitch to capture the attention of the listener, before the important information is delivered in a lower pitch to conclude the message (Rodero et al. 2017). The contrastive function of the pitch changes (PDCCP) attracts attention thereby increasing arousal. Higher pitch has indeed been proven to attract attention in voice perception, demonstrated by the High Voice Superiority Effect which shows the perceptual dominance of sounds with higher f0 (Marie and Trainer, 2013).

Therefore, we predict that, as was found in Rodero et al., (2017), intonation styles with LH patterns will fail to capture the attention and arousal of participants due to their initially low pitch. This will be furthered by the fact that declarative sentences are typically HL in pitch contour, and as we have established, coxing calls are largely declarative in nature. This means we expect participants to perceive the HL intonation patterns as more natural for the speech they are hearing, meaning they will be more attentive and thus more aroused as a result. As such, we propose our fourth and final hypothesis:

H4: The HL intonation pattern will elicit greater self-reported arousal than the LH pattern.

1. Method

This study measured 3 voice pitch variations (medium, many, and few) and 2 voice pitch contours (High-Low (HL) and Low-High (LH)) against measures of self-reported perceptions of competency, dynamism, persuasiveness, and arousal. Each pitch condition was tested with three different utterances, giving a total of 15 recordings. The order of the recordings was randomized. Statistical analysis was subsequently performed using paired t-tests – three between each of the pitch variations, and one between the two pitch contours measures.

3.1. Participants

At total of 40 participants aged 18-30 years old completed the study, recruited from university and club boat clubs. All participants were currently or had previously been part of a competitive university or club rowing program and had been coxed regularly before. Consent was obtained from all participants before beginning the experiment. All participants were over 18 years old and could withdraw at any time. The 40 participants were exposed to all the experimental conditions.

3.2. Stimuli

3.2.1. Stimuli design

A total of fifteen recordings were used for this experiment, 3 for each of the 5 intonation patterns: three pitch variations (medium, many, few) and two pitch contours (HL and LH). The pattern with medium variations had a moderate amount of pitch variety across an utterance, the pattern with many variations had a considerable amount of pitch variety, and the pattern with few variations was monotonous. The pattern with a HL pitch contour had a high initial pitch and a descending pitch contour across each utterance, and the pattern with a LH contour had a lower initial pitch with a rising contour.

The recordings were of a male coxswain of an 8-person boat, who recorded his calls during a race. He consented to his voice being used in the experiment. From this original recording, we extracted five utterances to be used as the experimental stimuli. Each recording lasted 5-10 seconds. The participants of our study were not familiar with his voice prior to completing the experiment, to eliminate any possibility of preconceived perceptions that could have affected the experiment results.

The five sample sentences were calls that were familiar in style to all participants, who had been coxed at a high-performance level before. They ranged from longer instructional commands: *"I want you to start dropping the blades in, loose on the drop in"*, to calls of encouragement: *"yeah that's good, that's good! Lengthen in 2, lengthen in 1, go!"*, and shorter dynamic phrases: *"legs, long, legs, long"*.

3.2.2. Pitch manipulation details

The pitch of each recording was manipulated using *Praat's* acoustic analysis software by measuring pitch level and range. The pitch tracks were stylized to show individual pitch points, which were then altered to produce each of the intonation patterns described in the experimental design. The pitch values were calculated in Hz.

To create the stimuli with many variations, the pitch points were drawn further apart to ensure greater range between them (see Figure 1). The higher points were raised by roughly 30Hz from their original positions, while the lower ones were further lowered by the same amount. The average pitch level for the recordings with this pattern was 220 Hz, and the average pitch range was 240.5 Hz.

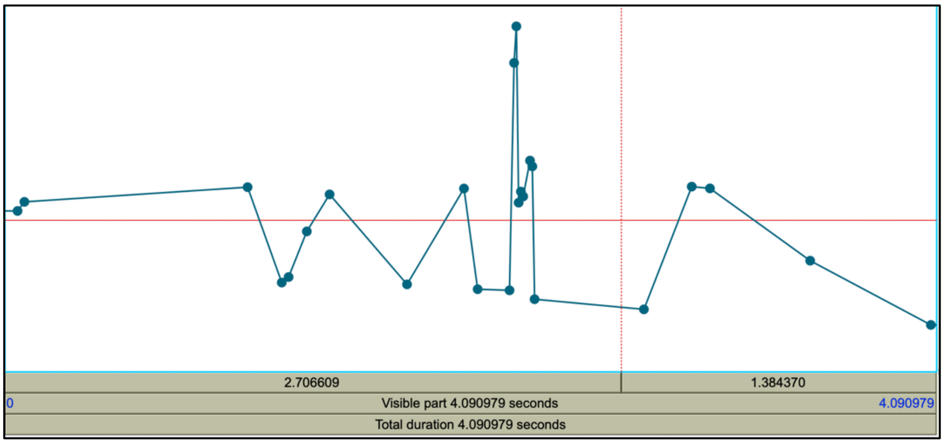

Figure 1: example of a manipulated pitch track of a stimulus with many pitch variations.

For the 'few' condition, the pitch points were drawn closer together by roughly 30Hz than their original positions, thereby reducing the range between them and resulting in a monotonous voice with little pitch variation. (see figure 2). The average pitch level was 198.9 Hz, and the average pitch range was 135.2 Hz.

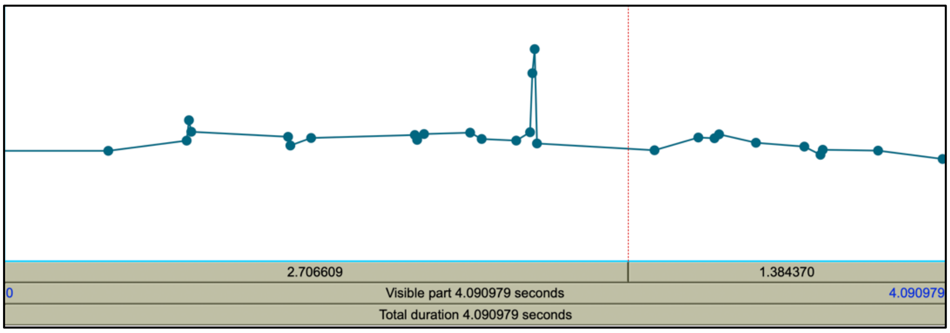

Figure 2: example of the same pitch track as Figure 1, but manipulated to have an intonation pattern with few pitch variations.

To create the medium variations stimuli, the pitch points were drawn closer together by roughly 10Hz. In the original recordings, there was already a good level of pitch variation. We could have used these as the 'medium' stimuli, but since the pitch 'many' and 'few' stimuli had been noticeably manipulated, we needed to make the 'medium' stimuli also sounded manipulated. This was to ensure listeners were not biased towards the patterns with medium variations due to the more 'normal' sounding voice, as this would have impacted the accuracy of the results examining the effect of intonation pattern. The average pitch level of the medium pattern was 209.7 Hz, and the average pitch range was 225.1 Hz.

To create the intonation patterns with High-Low (HL) pitch contours, all pitch points at the beginning of each phrase were raised, while the points at the end of the phrase were lowered to give a falling effect. The opposite was conducted for the Low-High (LH) pattern. The average pitch level for the HL patterns was 211.5 Hz and for the LH patterns it was 217 Hz. The average pitch range between High and Low portions of the HL patterns was 71.2 Hz and for the LH patterns in was it was 60 Hz.

3.3. Procedure

Participants accessed the study via an online experiment platform on a mobile device (phone/laptop). They gave their consent and confirmed that they were 18 years of age or older. They answered some demographic questions concerning their age, whether they had been previously or were currently part of a high-performance university or club rowing program, and if they had been coxed regularly before. The task instructions were presented with an example audio of the kind of recordings they were about to listen to – the example sentence was not one of the experimental stimuli. Participants listened to 15 recordings in total, 3 for each of the 5 intonation patterns. The order was random. After listening to each recording, participants rated how competent, persuasive and dynamic they perceived the voice to be, as well as their self-reported arousal. This was completed using sliding scales ranging from 0-100, where 0 = not at all, and 100 = very. For the arousal scale, the images used in the Self-Assessment Manikin (SAM) model were provided for guidance underneath (Bradley and Lang 1994). This procedure was repeated with all the recordings. Participants could play the recordings as many times as they wanted to. When participants had finished, they were thanked for their contribution and could close the experiment.

3.4. Dependent Variables

We measured participants self-reported perceptions of how competent, persuasive and dynamic they perceived the voice in each recording to be. These three dimensions were measured on sliding scales ranging from 1-100, where 1 represented the minimum value and 100 the maximum. We deemed these three variables to be the most valuable for our study, as they are particularly essential qualities for a successful coxswain to have to control and motivate their crew (Gabana et al. 2015, Dresser 2020).

We also measured the emotional response of participants through their self-reported arousal. As stated previously, high arousal levels are indicative of strong emotional activation. Higher levels of alertness in rowers allow them to be more receptive and responsive to coxswain calls, so arousal is a valuable dependent variable to test against different intonation patterns (Gabana et al. 2015). To measure arousal in self-report, we used another sliding scale from 1-100. However, we also wanted to use an element of the Self-Assessment Manikin (SAM) scale, which has been used to measure self-reported arousal in the literature (Bradley and Lang, 1994). It is a series of 5 images depicting a figure ranging from unaroused (sleepy) to extremely aroused (wide awake). We included this in our study by inserting the images used in the SAM model underneath the arousal sliding scale. Participants used the sliding scale to select which image of arousal they most resonated with (or somewhere in between them).

4. Results

The data was submitted for statistical analysis using a series of paired t-tests. Three paired t-tests were used to analyse the relationship between the 3 intonation patterns (medium, few, many), and a further t-test for the High-Low (HL) and Low-High (LH) intonation contours. For each t-test, results were gathered regarding each of the 4 dependent variables: competency, dynamism, persuasion, and self-report arousal. Results are provided in Table 1.

4.1. Medium vs Few condition

Paired t-tests indicated an extremely significant effect for intonation pattern between medium and few variations, $p < 0.0001$ (see Figure 3). Participants rated few variations much lower than medium variations across all three attitudes. For competency, medium variations (M = 62.6, SD = 14.5) was rated higher than few variations (M = 47, SD = 20.4). For dynamism, medium variations (M = 56.4, SD = 16.7) was rated higher than few variations (M = 38.9, SD = 19.7). For persuasiveness, medium variations (M = 57.9, SD = 16) was rated higher than few variations (M = 40.8, SD = 19.5).

For self-reported arousal, there was also an extremely significant effect for intonation pattern, $p < 0.0001$ where medium variations (M = 54.9, SD = 17.8) was rated higher than few variations (M = 32.7, SD = 22).

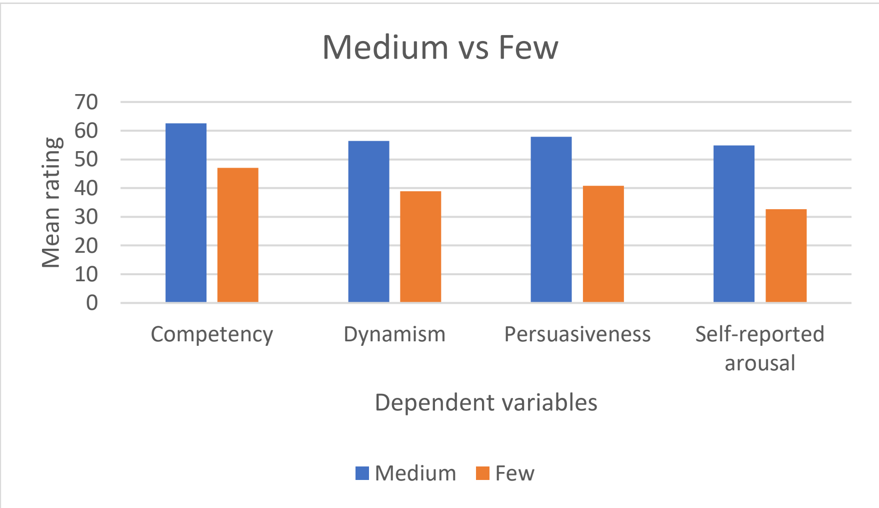

Figure 3: Bar chart comparing mean ratings of competency, dynamism, persuasiveness and arousal for intonation patterns with medium and few pitch variations.

4.2. Many vs Few condition

An extremely significant difference was also found between the few and many variations conditions, $p < 0.0001$ (see Figure 4). Ratings were again higher for styles with many variations than few variations across all three attitudes. For competency, many variations (M = 60.6, SD = 17.5) was rated higher than few variations (M = 47, SD = 20.4). For dynamism, many variations (M = 61, SD = 15.7) was rated higher than few variations (M = 38.9, SD = 19.7). For persuasiveness, many variations (M = 60, SD = 16.5) was rated higher than few variations (M = 40.8, SD = 19.5).

For self-reported arousal, there was also an extremely significant effect for intonation pattern, $p < 0.0001$ where many variations (M = 56.6, SD = 20.9) was rated higher than few variations (M = 32.7, SD = 22).

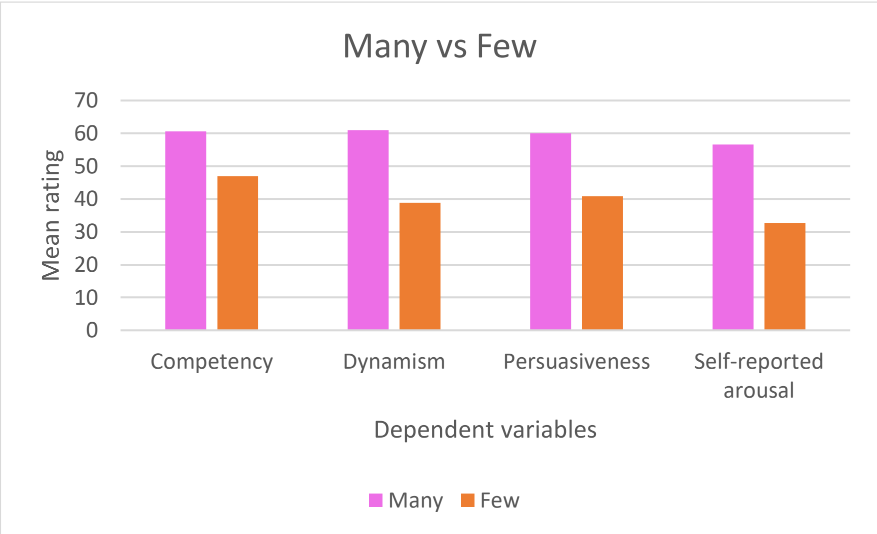

Figure 4: Bar chart comparing mean ratings of competency, dynamism, persuasiveness and arousal for intonation patterns with many and few pitch variations.

4.3. Medium vs Many condition

There was no significant difference in the ratings for styles with medium and many variations for competency and persuasiveness (see Figure 5). For competency, $p = 0.3891$, and medium variations (M = 62.6, SD = 14.5) was rated higher than many variations (M = 60.6, SD = 17.5). For persuasiveness, $p = 0.2767$, and many variations (M = 60, SD = 16.5) was rated higher than medium variations (M = 57.9, SD = 16), but neither of these differences reached statistical significance. For dynamism, there was a statistical difference between medium and many variations, p = 0.0097. Many variations (M = 61, SD = 15.7) was rated higher than medium variations (M = 56.4, SD = 16.7).

For self-reported arousal, many variations (M = 56.6, SD = 20.9) was rated higher than medium variations (M = 54.9, SD = 17.8), but this result did not reach statistical significance (see Figure 5).

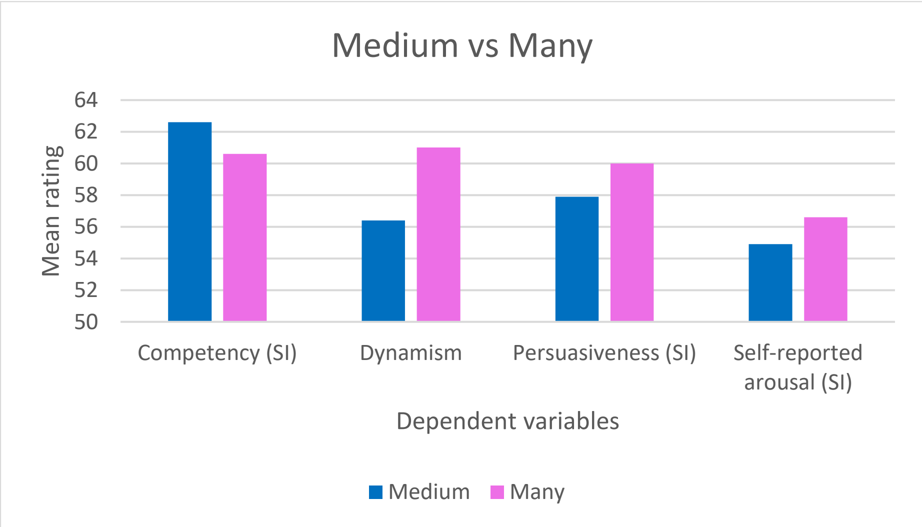

Figure 5: Bar chart comparing mean ratings of competency, dynamism, persuasiveness and arousal for intonation patterns with medium and many pitch variations. SI = statistically insignificant.

4.4. HL vs LH condition

We also conducted a separate t-test between the High-Low and Low-High condition. For competency and persuasiveness, there was significant difference between pitch contours, where styles with HL intonation patterns were rated higher than styles with LH intonation patterns (see Figure 6). For competency, p = 0.0041 and HL (M = 65.6, SD = 16) was rated higher than LH (M = 60, SD = 18.9). For persuasiveness, p = 0.0116 and HL (M = 60.7, SD = 17.2) was rated higher than LH (M = 55.2, SD = 18.6). For dynamism, p = 0.0339 and HL (M = 59.8, SD = 16.5) was rated higher than LH (M = 55.3, SD = 19), but this result did not reach statistical significance.

For self-reported arousal, there was a significant effect for intonation contour, p = 0.0058. The HL intonation pattern (M = 57.8, SD = 19.2) was rated higher than the LH intonation pattern (M = 51.7, SD = 21).

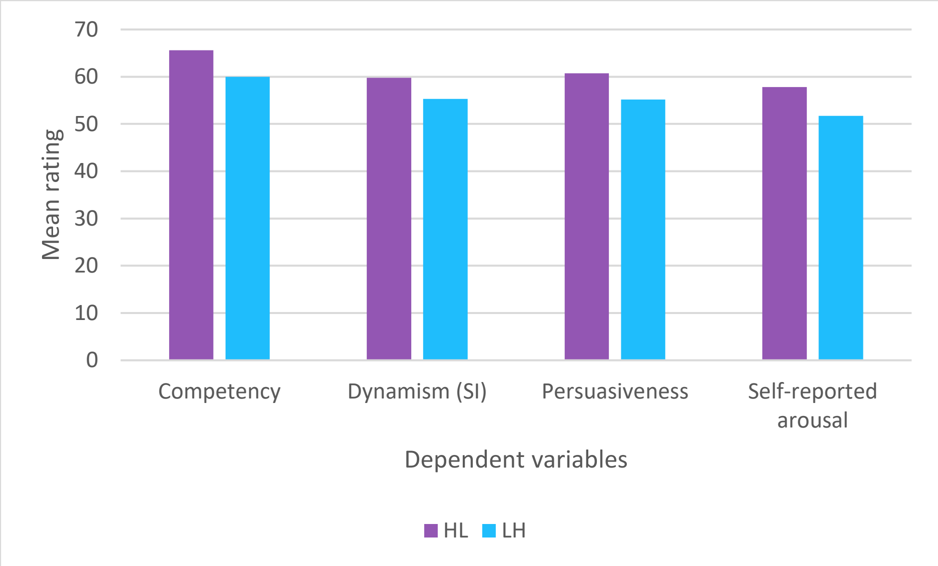

Figure 6: Bar chart comparing mean ratings of competency, dynamism, persuasiveness and arousal for intonation patterns with HL and LH pitch contours.

Intonation style	Dependent measure							
	Competency		Persuasiveness		Dynamism		Arousal	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Many	60.6	17.5	60	16.5	61	15.7	56.6	20.9
Medium	62.6	14.5	57.9	16	56.4	16.7	54.9	17.8
Few	47	20.4	40.8	19.5	38.9	19.7	32.7	22
HL	65.6	16	60.7	17.2	59.8	16.5	57.8	19.2
LH	60	18.9	55.2	18.6	55.3	19	51.7	21

Table 1: Means and SD for dependent variables by intonation style.

5. Discussion

5.1. Summary of research questions and key findings

Our study investigated the relationship between speaker intonation pattern and listener perception in the context of coxing. We had two primary research questions: RQ1: How does pitch variation influence how a coxswain is perceived and the arousal of listeners? RQ2: How does pitch contour influence how a coxswain is perceived and the arousal of listeners? To answer these questions, we held four hypotheses: H1: intonation styles with medium pitch variations will be perceived as more competent, dynamic, and persuasive than many and few variations in that order. H2: medium pitch variations will elicit greater self-reported arousal than many and few variations in that order. H3: the HL intonation pattern will be perceived as more competent, dynamic, and persuasive than the LH pattern. H4: the HL intonation pattern will elicit greater self-reported arousal than the LH pattern.

Our results indicated that the worse intonation style for coxswain calls was few pitch variations, as rowers perceived it as significantly less competent, dynamic, and persuasive than intonation styles with medium and many pitch changes. Participants were also significantly less aroused in response to coxswains with few pitch variations. The optimal intonational style was inconclusive, as the results for the medium vs many conditions did not reach statistical significance for arousal, competency, and persuasiveness. Between the HL and LH pitch contours, HL was found to be the optimal style, as it was perceived as more competent, persuasive, dynamic, and arousing – though the results for dynamism did not reach statistical significance.

5.2. Interpretation of results

5.2.1. Hypothesis 1

Our first hypothesis proposed that strategies with few variations would be the least favoured across all perception measures. This was supported by our findings, which were that, as we predicted, participants rated the intonation strategy with few pitch variations as significantly less competent, dynamic, and persuasive than both the medium and many variations styles. This finding is therefore aligned with Rodero’s (2015) Principle of Distinctive and Contrastive Coherence of Prosody, which states that intonation patterns with greater pitch variation are more engaging for listeners, because the acoustic contrast between the rises and falls makes a sequence sound more dynamic (Addington, 1968). This explains why participants found the strategy with few pitch changes to be clearly the least dynamic in comparison to the styles with medium and many variations, due to the lack of acoustic contrast between the rises and falls. Furthermore, our results support previous literature which has found that monotonous styles negatively impact listener perceptions of both competency and persuasiveness, as these behaviours are closely associated with greater pitch variety (Burgoon et al. 1990, Jackob et al. 2011). This explains why the style with few pitch variations was rated as the least favourable intonation style for both competency and persuasiveness against both medium and many pitch variation styles (Gelinas-Chebat et al. 1996).

However, our first hypothesis is not fully supported by the results, as it also predicted that participants would confidently rate the intonation pattern with medium variations as the optimal style. This was not the case, as our results comparing medium and many variations were largely inconclusive: the results for competency and persuasiveness did not reach statistical significance. Further, the only perception measure than did reach significance was dynamism, but it was many variations, not medium, which was rated as more dynamic. These results contradict the findings of previous studies, in which intonation styles with medium variations are perceived more favourably than styles with many variations (Rodero 2022, Burgoon et al. 1990). These studies contend that strategies with many pitch variations are counterproductive, as they come across as excessive and sound exaggerated or unnatural to listeners, rendering moderate styles most optimal (Rodero et al. 2022).

A possible explanation for this could be that the current literature is focused on contexts of public speaking and radio adverts, where speakers are using regular speech with a communicative intention towards a particular audience. Their aim is often to appear natural and engaging, which would explain why intonation patterns with many pitch variations are unpreferable, as speakers do not want their speech to seem overexaggerated or unnatural (Jackob et al. 2011). However, in the context of our study, coxing is arguably an already ‘unnatural’ form of spoken communication as it does not sound like regular speech. Coxswains regularly deliver singular or pairs of words, repeated for emphasis, in time with the movement of the rowers (“legs, long, legs, long”) or short dynamic commands (“catches in sharper, ready, go!”) (Rich et al. 2021). As such, the possible unnaturalness of strategies with many variations could have been neutralised in our experiment, as this factor was not relevant for the participants who were all rowers and were therefore accustomed to the more robotic-like nature of coxswain calls. This could explain why the results for the perceptions of competency and persuasiveness did not reach statistical significance between the patterns with medium and many pitch variations, and why many variations was perceived as more dynamic. Given the unnaturalness factor had been neutralised, the greater acoustic contrast in the many variations style would have served to only increase the perception of dynamism, rather than hinder it due to its unnatural sound.

Overall, in response to the first part of the first research question of whether the number of pitch variations influences how a coxswain is perceived, we can make the following assertions: monotonous styles negatively impact how competent, persuasive, and dynamic a coxswain is perceived to be. Styles with many variations are perceived as the most dynamic of all the intonation patterns. It was inconclusive as to whether medium or many variations is the preferred for competency and persuasion, meaning it is difficult to identify an overall optimal intonation pattern across all three measures.

5.2.2. Hypothesis 2

Our second hypothesis posited that intonation patterns with few pitch variations would elicit the least arousal the three pitch conditions. This was supported by our findings, in which, as we expected, participants rated the monotonous style as significantly less arousing than both the medium and many variations styles. This result is aligned with previous studies, in which monotonous intonation patterns have been found to negatively impact both self-reported and physiological arousal of listeners in contexts of public speaking and radio adverts (Rodero 2022, Rodero et al. 2017). It is also supportive of the Principle of Distinctive and Contrastive Coherence of Prosody, which asserts that as well as improving perceptions of dynamism, greater pitch variety is particularly conducive to increased arousal, because the auditory difference between the greater number of rises and falls better attracts the listeners' attention (Rodero 2022, Rodero 2015). Furthermore, our finding aligns with the theory of "sensory adaptation", which posits that arousal is reduced in response to monotonous styles with little pitch variation due to the perception of a constant and repetitive sound, which causes the brain to become fatigued as there is no acoustic contrast (Wark et al. 2007). Both theories proposed in the current literature serve to explain why the lack of acoustic variety in the intonation style with few pitch variations in our study failed to increase the arousal of the participants in comparison to the strategies with greater variety (medium and many variations).

Our second hypothesis was partially contradicted by the results, however, in that we had predicted patterns with medium variations to clearly elicit the greatest arousal, but the difference between medium and many variations did not reach statistical significance. This finding contradicts the findings in the current literature which identify intonation patterns with medium variations as the best style for eliciting arousal in listeners (Rodero 2022, Rodero et al. 2017). Again, these studies explain these findings with the notion that too many pitch variations are perceived as unnatural and thus counterproductive in communicative contexts, decreasing arousal as a result (Rodero 2022). Taking our previous argument once more, we might explain our contradictory finding with the idea that coxswains already sound unnatural in comparison to public speaking contexts, for example, and thus the counter productiveness of many pitch variations could have had a reduced effect. This could have led to the lack of significance between medium and many variations for arousal.

Overall, in response to the second part of our first research question of whether the number of pitch variations influences the arousal a coxswain elicits in listeners, we can make the following assertions: intonation styles with few variations have a significantly negative effect on the arousal of listeners. Whether styles with medium or many variations is preferable for eliciting arousal is inconclusive in our study, as this result did not reach statistical significance.

5.2.3. Hypothesis 3

Our third hypothesis posited that a High-Low (HL) pitch contour would be perceived as more favourable than a Low-High (LH) one across all three perception measures. Our results were largely corroborative, in that as we predicted, the HL pattern was rated as more competent, persuasive, and dynamic than the LH pattern, although the result for dynamism did not reach statistical significance. Our findings are thus supportive of Rodero et al., (2017) which found HL pitch contours are perceived as more attractive than LH ones. This study highlights that HL patterns are typically used in declarative sentences across languages, while LH ones are used interrogatively or in instances of uncertainty (Rodero et al. 2017). As a result, listeners perceive HL patterns as more engaging because speakers sound more confident and assertive. Notably, coxswain calls are almost entirely declarative, as they are typically commands, encouragement, or information delivered to a crew (Rich et al. 024). This would further explain why HL patterns were better perceived in our study, because being typically used for declarative sentences, they sounded more natural as coxing calls, as well as more competent and persuasive than the more doubtful LH pattern.

Our result for dynamism, which did not reach statistical significance (though HL still obtained a higher mean score than LH), was unexpected as it contradicted Rodero et al., (2017) in which HL patterns were perceived as more dynamic than LH ones. A possible explanation for this could be that the intonation style of the coxswain in the recordings prior to manipulation was already dynamic in nature with a considerable amount of pitch variety. For the HL and LH conditions, the original pitch variety remained the same despite the initial and final pitch levels being manipulated for each utterance to fit a HL or LH pattern. As we have established, greater pitch variety is conducive to greater perceptions of dynamism, therefore, both HL and LH patterns could have still sounded considerably dynamic due to the base pitch variety of the coxswain in the recordings (Rodero 2022, Rodero 2015). This could potentially explain the lack of statistical significance between the dynamism ratings for the two pitch contours.

Overall, in response to the first part of the second research question of whether pitch contour affects how a coxswain is perceived, we can make the following assertions: HL intonation patterns are preferable over LH patterns, because they are perceived as more competent and persuasive. Whilst our results for dynamism did not reach significance, HL patterns still obtained a higher mean score than LH ones, which suggests that more research with speakers of different pitch variety could reveal whether pitch contour truly influences perceptions of dynamism or whether this measure is only affected by pitch variety.

5.2.4. Hypothesis 4

Our fourth hypothesis posited that HL patterns would elicit greater self-reported arousal than LH ones. This was supported by our findings, in that as we predicted, participants rated HL as significantly more arousing than LH. This directly aligns our results with Rodero et al., (2017) which obtained the same finding. In this way, our results are also supportive of the theory of 'dual function' as part of the Principle of Distinctive and Contrastive Coherence of Prosody (Rodero 2015). This posits that pitch changes distinguish different parts of a sentence into prosodically distinct units (distinctive function) and establish acoustic contrasts between high and low pitch (contrastive function) (Rodero 2015). As a result, they can differentiate the relevance of a content of an utterance, for example, a higher initial pitch captures the attention of the listener before the remainder of the message is delivered in a lower pitch or descending contour (Rodero et al. 2017). This theory has been shown to increase both self-reported and physiological arousal in participants of the Rodero et al., (2017) study, and explains why participants in our study were significantly more aroused by the HL pattern than the LH one. Furthermore, as is proposed in the literature, the fact that HL patterns are most typically used in declarative sentences would have sounded more natural to listeners of coxing (which is declarative in nature as we have established), resulting in increased receptiveness towards the message being delivered, thereby increasing arousal (Rodero et al. 2017).

Overall, in response to the second part of the second research question of whether pitch contour influences the self-reported arousal a coxswain elicits in listeners, we can make the following assertions: HL intonation patterns are significantly more successful at increasing the arousal of listeners of coxing than LH patterns.

5.3. Practical implications

This section will discussion the implications of our findings for how coxswains should manipulate their speech. Persuasiveness was the first of our dependent measures and was found to be negatively affected by monotonous styles and LH pitch contours. As we have established, a coxswain with a more persuasive intonational pattern will better convince their athletes that the change or push that they are asking them to make is worthwhile. We expect that, if tested, this increased persuasiveness would likely result in a more committed physical or technical response from the crew (Gabana et al. 2015). Therefore, coxswains should avoid intonation styles with few pitch variations and aim for a HL pitch contour.

Competency was our next measure, which was also found to be negatively affected by monotonous styles where there was no significant difference between medium and many variation styes and was also reduced by LH pitch contours. Crews rely heavily on their coxswain to manoeuvre them safely and effectively, as well as deliver a structured race plan to the highest standard (Rich et al. 2024). Thus, it is vital for a crew to perceive their coxswain as competent in order to trust that they are in control of the boat, allowing the rowers to do their job properly. Further, competence has been found to be the greatest predictor of persuasion and therefore closely linked to credibility, meaning that if a coxswain is perceived as more competent, this will likely also increase how persuasive they are (Burgoon et al. 1990).

Therefore, coxswains should aim to include greater pitch variety in their voices, as well as use HL pitch contours, in order to increase perceptions of competence and therefore persuasiveness in order to encourage athletes to perform changes when asked.

Our third perception variable was dynamism, which refers to how vivid, powerful, self-assured, and lively a speaker is perceived to be, and can also exert an influence on a speaker's credibility and persuasiveness (Burgoon et al. 1990). Our study found that speakers with more emphatic intonation styles (many variations) are perceived as more dynamic, in comparison to moderate and monotonous styles. A coxswain who is particularly dynamic in their vocal style will bring a sense of energy into their crew, which will encourage the same liveliness and passion in their athletes that is conducive to improved athletic performance (Rich et al. 2021, Dresser 2020, Gabana et al. 2015). Thus, coxswains should include greater pitch variation in their speech to enhance perceptions of dynamism, with the hope that this would positively impact the performance of a crew. We found no significant difference between pitch contours for dynamism, suggesting that pitch variation is a more productive cue for this variable than pitch contour. HL contours still obtained a higher mean that LH contours, indicating that further research should be done to explore this further.

Our fourth and final variable was autonomic arousal, whereby higher arousal levels are indicative of strong emotional activation and greater alertness (Bradley and Lang 1994). We perceived this to be a valuable measure because high arousal levels are crucial to the success of a coxswain in maximising the performance of their crew during a race. Indeed, rowers are thinking about a great number of things during a race (technique, power, their position in relation to other boats etc.) as well as becoming gradually fatigued (Rich et al. 2024, Rich et al. 2021). Thus, having a coxswain who can manipulate their prosody to effectively capture and increase their crew's arousal is essential, as their voice is more likely to cut through the noise and fatigue in the rowers' heads and allow them to better respond to the commands being made (Gabana et al. 2015). As our results have shown, monotonous styles have a considerably negative effect on arousal levels, meaning coxswains should use greater pitch variety to keep their crews actively engaged. Further, HL pitch contours were found to be significantly preferable for arousal, indicating that coxswains should employ them to capture the attention and increase the arousal of their crews.

5.4. Limitations

Though this study provides a valuable insight into how pitch variation and contour influence of perceptions of a coxswain's voice, several limitations should be acknowledged. Firstly, all the experimental stimuli was taken from a singular recording from a male coxswain. While this was done deliberately to control for voice variability – allowing the full effect of pitch variation and contour to be examined – this also introduces a potential confound; the observed results could be specific to this speaker's vocal characteristics. In other words, the gender or mean f0 of the speaker could have impacted the perception ratings for some participants regardless of the changing intonation patterns. Thus, if we had included stimuli from a range of different coxswains varying in age, mean f0, and style, this would have increased the generalizability of the pitch effects that we found and thus strengthened the validity of our findings.

Another important limitation to recognise is the artificial manipulation of the pitch in the experimental stimuli using *Praat* software. This was done to allow for precise control over the pitch variations and contour of the recordings, rather than spending time coaching a coxswain on how to produce the exact intonation pattern we required for each stimulus. However, this often resulted in some words in the stimuli sounding somewhat 'robotic' due to the pitch manipulation, which could have affected how participants responded to them. We tried to control for this, by warning participants in the task instructions that the production of some words may sound unnatural, and to focus their attention on their perception of the intonation styles presented. Nevertheless, it is worth considering that listeners might respond differently to naturally produced intonation patterns as opposed to manipulated ones, which is information that is limited by our methodology.

Despite this, our decision to manipulate a pre-existing coxing recording arguably preserved the naturalness of the stimuli more so than hindered it. The original recording was taken by a coxswain during a race, meaning that even in the manipulated stimuli, participants could hear the clunking of the oars that were present in the original race recording. Therefore, the atmosphere of the stimuli closely mimicked that of rowing while listening to a coxswain, as the calls were produced rhythmically in time with the movement of the rowers. This would have been difficult to replicate if we had created our stimuli by asking a coxswain to record scripted calls in an artificial environment. The recordings might have sounded unnatural and lacking the intent of a coxswain in an actual race scenario, which could have affected the perceptions and arousal of participants. Therefore, we can say that although our methodology limits our understanding of how participants would respond to naturally different intonation patterns versus manually manipulated ones, it crucially allows our experiment to come as close as possible to a real coxing environment to get a more accurate idea of how a coxswain would realistically be perceived.

It must be noted, however, that this experiment would have retained a certain limitation regardless of whether we had produced the stimuli using a pre-recorded and manipulated voice, or one with a coxswain coached to speak in a certain way. Indeed, our experiment lacks ecological validity, in that it does not establish an explicit link between our results and physical performance. Further research is needed to examine whether the perceptions of different intonation patterns from our participants would be the same if they were heard in real-life race scenarios, and whether this would translate into improved or decreased athletic performance as a result. The logistics of examining our results in a real-life scenario presents a host of complications which prevented it from being conducted in the current study, meaning that further research is necessary in order to confirm this link.

Further methodological limitations include the repetition of sample sentences in our experimental stimuli. There were three sentences repeated in each pitch variation (medium, many, few) and a further three repeated for each contour (HL and LH). We did this to control for semantic content, meaning that the differences in the participants' ratings of each pitch condition were more likely due to their perception of the intonation pattern rather than any differences in sentence meaning or complexity if we had used many different sentence types. The repetition of sample sentence was designed to improve the internal validity and reliability of our results. Where it could have limited our study, however, is in leading to potential familiarity or fatigue effects. Though each recording was no longer than 7 seconds, the fact that there were 15 to listen to could have reduced participant engagement towards the end of the experiment and thus impacted the results. Further, because the sentences were repeated, participants might have begun to anticipate or recognise each sentence type and respond differently because it was no longer novel. We attempted to combat any familiarity effects through randomizing the order with which each participant heard the recordings, though we must recognise that this could have still slightly affected the accuracy of our results.

5.5. Suggestions for future research

Our study is the first to have ever empirically examined the effect of intonation pattern on perception of coxing, meaning that a plethora of ideas for future research in this area has undoubtedly been opened, which would continue to further our understanding of how prosody and communication in sport interact. The first of these could be to examine the effect of multiple speakers, whereby participants rate the recordings from coxswains of different genders, pitch levels, accents, or vocal styles to examine whether the effects of pitch variation and contour that we found in our study are consistent across different voices. This would increase the generalizability of the initial findings of this study if they were indeed consistent, as in our study we only used the voice of a singular male coxswain.

Secondly, future research could extend beyond the self-report structure of this experiment. We did not have access to the equipment needed to measure physiological arousal and attention, so this could be implemented in future studies to investigate whether certain pitch variations and contours can be as influential as to affect the physiological emotional response of listeners. This could be done using electrodermal activity sensors for arousal and ECGs for attention, for example, as was conducted in the studies we discussed in our literature review (Rodero 2022, Rodero et al. 2017). These studies found significant effect of intonation pattern on physiological emotional response, so it would be valuable to investigate whether these findings would occur in the perception of coxing calls. Investigating physiological response alongside self-reported measures would therefore combine subjective and objective data to produce stronger conclusions about the effect of a coxswain's intonation style.

Furthermore, future studies could improve the ecological validity of our results by investigating them in a real-life coxing context. For each trial, researchers could instruct coxswains to use a certain intonation pattern over given distance, and record both the self-reported perceptions of the rowers afterwards, and potentially their physiological arousal and attention using the techniques mentioned above. This would of course introduce other challenges, such as having less control over the intonation patterns produced by the coxswains, or successfully using the technology used to measure emotional response while the athletes are rowing. Nonetheless, such a study would increase the ecological validity of our results because they would be tested in an environment that realistically matched how participants would encounter coxing outside of the experiment (as opposed to the online, controlled setting of our experiment). It would provide valuable information regarding whether intonation pattern influences rowers' perception of a coxswain in a real-life scenario as much as, or more than, in self-report, and whether the patterns that we found to be significant also remain the same or not.

Lastly, future studies could measure whether improved perceptions of coxswains due to intonation pattern leads to improved athletic performance. Our study investigated whether certain intonation patterns could improve how a coxswain is perceived by their crew, with the overarching assumption that this would in turn increase the performance of the boat as a result. We were not able to measure this however, due to the self-report structure, and thus this is something that future studies could investigate in real-life rowing scenarios. This could be achieved using telemetry (systems of wires and screens attached to a boat), which is a tool used widely in rowing that measures the power output and technical effectiveness of each athlete while rowing. For example, in a trial in which a coxswain has been instructed to use a certain intonation pattern, researchers could examine firstly the self-reported and physiological responses of participants, and importantly, measure whether improved perceptions influenced the overall power output and effectiveness of the boat. Ascertaining whether the link between intonation pattern and perception could lead to improved athletic performance would doubtlessly enhance the value of our findings. This would provide coxswains with somewhat of a tested 'guide' on how best to manipulate their prosody to improve both how they are perceived by their crew as well as the physical performance of their boat.

6. Conclusion

This study set out to investigate how certain intonation patterns could influence how competent, persuasive, and dynamic coxswain was perceived to be, as well as the effect on the self-reported arousal of listeners. Intonation styles with few variations were the worst perceived, and while there was not a clearly optimal style between medium and many variations, the latter was more dynamic. This supported our hypothesis that monotonous styles would be the least favourable intonation pattern and indicates that coxswains should avoid such styles with little pitch variety. Our hypotheses were not supported by the fact that medium variation styles were not optimal. Coxswains could still employ more emphatic intonation patterns to increase perceptions of dynamism, however. HL pitch contours were found to be more favourably perceived than LH ones, which corroborated our hypotheses and aligned with the literature where is has also been found (Rodero et al. 2017).

Our study was limited primarily by the small speaker sample, which meant we could not test whether the effect of intonation pattern was tied to voice style or not. Further, the online self-report structure of our experiment inhibited our ability to measure physiological arousal, as well as test our methodology in a real-life rowing environment. Future studies should aim to expand the range of speakers to improve the generalizability of our results, explore physiological arousal to combine subjective and objective data, and potentially test our methodology in real-life rowing contexts to enhance the ecological validity of our findings.

Overall, our study has taken the first step into discovering the relationship between intonation and voice perception in the context of the rowing world, which has never been studied empirically before. It has expanded the current prosodic literature to demonstrate that intonation pattern can exert an influence on listener perception in a communicative context that differs significantly from that of public speaking or radio adverts. Being the first study to investigate intonation and coxing in combination, our findings demand further research to be conducted to improve their validity, generalizability and reproducibility. This will allow for a deeper exploration of the ways that a coxswain's intonation patterns can influence both how they are perceived and the emotional response of their crew. Nonetheless, our findings provide both current and future coxswains with valuable, empirically tested information of how to best manipulate their prosody to best motivate and control their crews, in the hope that this will lead to improved crew performance.

List of References

Bradley, M.M. and P.J. Lang. 1994. 'Measuring emotion: the self-assessment manikin and the semantic differential'. *Journal of Behavior Therapy and Experimental Psychiatry* 25: 49-59.

Burgoon, J. K., T. Birk, M. Pfau. 1990. 'Nonverbal behaviors, persuasion, and credibility'. *Human Communication Research* 17: 140–169.

Chebat, J.C., K.E. Hedhli, C. Gélinas-Chebat and R. Boivin. 2007. 'Voice and persuasion in a banking telemarketing context'. *Perceptual and Motor Skills* 104: 419-437.

Chattopadhyay, A., D.W. Dahl, R.J. Ritchie and K.N. Shahin. 2003. 'Hearing voices: the impact of announcer speech characteristics on consumer response to broadcast advertising'. *Journal of Consumer Psychology* 13: 198-204.

Cheang, H. S., and M.D. Pell. 2008. 'The sound of sarcasm'. *Speech Communication* 50: 366-381.

Dawson, M. E., A.M. Schell and D.L. Filion. 2000. 'The electrodermal system'. *Handbook of Psychophysiology* 2: 200–223.

Dresser, E. 2020. 'Crew selection part 3 – coxswain selection. row2k'. Last accessed 11 May 2025, from https://www.row2k.com/features/5099/Crew-Selection-Part-3--Coxswain-Selection/.

Elbert, S.P. and A. Dijkstra. 2014. 'An experimental test of the relationship between voice intonation and persuasion in the domain of health'. *Psycholinguistic Health* 29: 1014-1031.

Gabana, N. T., J.L. Van Raalte, J.C. Hutchinson, B.W. Brewer and A.J. Petitpas. 2015. 'The effects of music and a coxswain on attentional focus, perceived exertion, motivation, and performance during a 1,000 m ergometer rowing sprint'. *Journal of Applied Sport Psychology* 27: 288–300.

Gélinas-Chebat, C., J.C. Chebat and A. Vaninsky. 1996. 'Voice and advertising: effects of intonation and intensity of voice on source credibility attitudes toward the advertised service and the intent to buy'. *Perceptual and Motor Skills* 85: 243–262.

Grandjean, D., T. Bänziger and K.R. Scherer. 2006. 'Intonation as an interface between language and affect'. *Progress in Brain Research* 156: 235-247.

Gussenhoven, C. 2004. 'The phonology of tone and intonation'.

Holliday, J.J., A. Walker, A., M. Jung and E. Cho. 2023. 'Bringing indexical orders to non-arbitrary meaning: the case of pitch and politeness in English and Korean'.

Jackob, N., T. Roessing and T. Petersen. 2011. 'The effects of verbal and nonverbal elements in persuasive communication: findings from two multi-method experiments'. 245-271

Marie, C. and L.J. Trainor. 2013. 'Development of simultaneous pitch encoding: infants show a high voice superiority effect'. *Cerebral Cortex* 23: 660-669.

Martín-Santana, J.D., C. Muela-Molina, E. Reinares-Lara and M. Rodríguez-Guerra. 2015. 'Effectiveness of radio spokesperson's gender, vocal pitch and accent and the use of music in radio advertising'. *BRQ Business Research Quarterly* 18: 143-160.

Mitchell, R. L. and E.D. Ross. 2013. 'Attitudinal prosody: what we know and directions for future study'. *Neuroscience & Biobehavioral Reviews* 37: 471-479.

Noveck, I.A. and A. Reboul. 2008. 'Experimental pragmatics: a Gricean turn in the study of language'. *Trends in Cognitive Sciences* 12: 425-431.

Ohala, J.J.1995. 'The frequency code underlies the sound-symbolic use of voice pitch'. *Sound symbolism* 325-347.

Pell, M.D. 2006. 'Judging emotion and attitudes from prosody following brain damage'. *Progress in brain research* 156: 303-317.

Rich, J., K.V. Sparks, S.T. Pottratz and B. Leaf. 2024. 'Coxswains are performers too: considerations for coxswain mental skills training'. *Journal of Sport Psychology in Action* 15: 1-14.

Rich, J., S.T. Pottratz and B. Leaf. 2021. 'Understanding the unique psychological demands of competitive collegiate rowing: a guide for practitioners'. *Journal of Sport Psychology in Action* 12: 42–53.

Rigoulot, S., K. Fish and M.D. Pell. 2014. 'Neural correlates of inferring speaker sincerity from white lies: an event-related potential source localization study'. *Brain Research* 1565: 48-62.

Rodero, E. 2011. 'Intonation and emotion: influence of pitch levels and contour type on creating emotions'. *Journal of Voice* 25: 25-e34.

Rodero, E. 2015. 'The principle of distinctive and contrastive coherence of prosody in radio news: an analysis of perception and recognition'. *Journal of Nonverbal Behaviour* 39: 79-92.

Rodero, E. 2022. 'Effectiveness, attractiveness, and emotional response to voice pitch and hand gestures in public speaking'. *Frontiers in Communication* 7: 869084.

Rodero, E., L. Mas and M. Blanco. 2019. 'The influence of prosody on politician's credibility'. *Journal of Applied Linguistics and Professional Practice* 11: 89–111.

Rodero, E., O. Larrea, I. Rodríguez-de-Dios and I. Lucas. 2022. 'The expressive balance effect: perception and physiological responses of prosody and gestures'. *Journal of Language and Social Psychology* 41: 659-684.

Rodero, E., R. F.Potter and P. Prieto. 2017. 'Pitch range variations improve cognitive processing of audio messages'. *Human Communication Research* 43: 397-413.

Scharrer, L., U. Christmann, U. and M. Knoll. 2011. 'Voice modulations in German ironic speech'. *Language and Speech* 54: 435-465.

Simonsmeier, B. A., M. Andronie, S. Buecker and C. Frank. 2021. 'The effects of imagery interventions in sports: a meta-analysis'. *International Review of Sport and Exercise Psychology* 14: 186–207.

Wark, B., B.N. Lundstrom and A. Fairhall. 2007. 'Sensory adaptation'. *Current opinion in neurobiology* 17: 423-429.

Weinstein, N., K. Zougkou and S. Paulmann. 2018. 'You 'have' to hear this: using tone of voice to motivate others'. *Journal of Experimental Psychology: Human Perception and Performance* 44: 898.