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When the 8-count is not enough: An analysis of the interaction modalities enacted by artistic swimmers in a collective choreography

VINCENT GESBERT, *and* DENIS HAUW

Research Center in Psychology of Health, Aging and Sport, University of Lausanne, Lausanne, Switzerland Institute of Sport Sciences, University of Lausanne, Switzerland

This study explored interpersonal coordination on artistic swimming teams by focusing on how swimmers interact with their environment when they adjust their movements to each other. This competitive context has never been investigated and we expected that the swimmers' interpersonal coordination would provide new insights into the coordination of their activities during team performances. Ten swimmers volunteered to participate in the analysis of national or international competitions. The method was based on individual enactive interviews designed to grasp swimmers' activity as they adjusted to each other. Through an inductive content analysis, five meaningful interactions were identified, with: (a) the 8-counts, (b) the activity of other swimmers, (c) key moments in the music, (d) their own sensations, and (e) the material environment. The results revealed how the swimmers' activity was developed from different types of information that enabled them to make sense of the movements underway to achieve team performance.

KEY WORDS: Artistic swimming, Elite performance, Interpersonal coordination, Meaningful interactions, Situated activity.

Surprised by a no-look pass in a basketball game or intrigued by the synchronization of two jumpers on a trampoline—we are often delighted by how members on a sports team coordinate so quickly and accurately. Team performance requires the coordinated contributions from two or more members acting interdependently to achieve a common goal (Eccles & Tenenbaum, 2004), and understanding exactly how this is accomplished has become a key challenge for sports psychologists (Araújo & Bourbousson, 2016; Gesbert & Hauw, 2019; Santos, Duarte, Davids, & Teoldo, 2018). Many studies have

Correspondence to: Vincent Gesbert, Lausanne Sports Science Institute, Lausanne University, Quartier UNIL-Centre – Bâtiment Synathlon, 1015 Lausanne, Switzerland (e-mail: Vincent.gesbert@unil.ch).

explored this topic but, to our knowledge, none has investigated interpersonal coordination on artistic swimming teams. Yet, this sport, which requires both technical skill and artistic quality, provides an example of achieving interpersonal coordination in an environment that is inauspicious for exchanging and sharing information (i.e., aquatic). These two factors together suggest that the interpersonal coordination required for team performance might be somewhat different from what has usually been reported. We therefore studied the interpersonal coordination of artistic swimmers to gain deeper insight into the processes at stake in aesthetic team sports.

In artistic swimming, a synchronized choreography is accompanied by music. The choreography is accomplished by two, eight or ten[1] swimmers and is respectively called a duet, a team or a combined. Choreography in a free program[2] is defined as the chaining of figures, highlights and moves[3] for three minutes and thirty seconds for a duet and four minutes for a team. Team choreography, however, also includes formations and formation changes. Formations are created by the eight swimmers positioning their bodies in the water and maintaining specific distances and alignments among them. The swimmers must move in the formation while maintaining its structure and change the formations very quickly. A choreographed performance has about 50 formations and formation changes, and accuracy and speed are elements of difficulty that the judges recognize and appreciate. These factors suggest that team performance is built on swimmers' interdependent contributions, thus emphasizing the pivotal role of coordination on artistic swimming teams. Researchers have investigated team performances via interpersonal coordination from within a variety of theoretical and methodological frameworks (see Araújo & Bourbousson, 2016, for a review).

One group of studies has worked within a social-cognitive framework (see Eccles & Tenenbaum, 2004) to understand how teammates' knowledge or mental model sharing impacts the quality of team coordination. These studies have shown that team members build knowledge on how their teammates tend to respond in a given task situation and that sharing this knowledge predicts the degree to which they achieve implicit coordination, defined as the team's ability to achieve coordinated actions without extensive verbal

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[1] In this study, we were interested only in duets and teams.

[2] There are two types of program. A technical program requires the performance of certain technical elements during the choreography. A free program does not.

[3] A synchronized swimmer travels a path in the pool. Although there are many possible directions, the team must cover the surface of the pool in length and width. More than 80% of a choreography involves performing moves while moving.

communication during competition (e.g., Blickensderfer, Reynolds, Salas, & Cannon-Bowers, 2010). A second group of studies has been based on an ecological framework (see Vilar, Araújo, Davis, & Button, 2012) and assumes that sharing affordances between team members explains interpersonal coordination. The studies have shown that by detecting and using affordances *for* another person (i.e., the set of actions a teammate or opponent can perform) and affordances *of* another person (i.e., the set of actions another player affords the perceiver), team members can adjust their collective behaviors online (e.g., Fajen, Riley & Turvey, 2009; Silva, Garganta, Araújo, Davids, & Aguiar, 2013). The third group of studies is based on the enactive framework (see Bourbousson & Fortes-Bourbousson, 2016), with a focus on team members' activity and its dynamics during competition. Activity here refers to the meaningful level of coupling between athletes and the environment (e.g., Hauw, 2018; Hauw & Durand, 2008). These studies have shown how individual activity contributes to or perturbs the activity of other team members (e.g., Gesbert, Durny, & Hauw, 2017).

This last framework, with its focus on meaning, appears well-suited for studying team performance in artistic swimming because a strong emphasis in this sport is placed on aesthetic components, which concern execution (30% of the score) and music interpretation (40% of the score). Execution here refers to height (i.e., being as high out of the water as possible for most actions), the accuracy of all lines and positions within the formation, the rate at which the formations shift, and the maintenance of formation shape while moving and performing figures or moves. Music interpretation is the expression of the music's mood. Movements should thus be synchronized between the swimmers and with the music, using rhythm, melody or accents to emphasize aesthetic effects. Many changes in context (in, out and under the water) and grouping also occur during a choreography, and the interactions must be adjusted to these unfolding situations during the choreography-performance. Although many sports performances (e.g., acrobatic gymnastics, figure skating, dance, artistic swimming) are judged on a mix of execution, synchronization and music interpretation, little is known about the types of interpersonal coordination established during performance and how they evolve. This study was designed because we expected that interpersonal coordination in this sport would be different from what has usually been reported in other sports.

The study thus explored how members of an artistic swimming team efficiently adjust to each other while managing aesthetic constraints in an inauspicious environment (i.e., water). We used the enactive framework and set two research questions. RQ1: What are the meaningful interactions that

enable swimmers to efficiently adjust to each other during a choreography-performance? And RQ2: How do these interactions fluctuate to achieve high performance? This last question especially refers to the situated characteristics of these meaningful interactions—that is, how these interactions are enacted in the fluctuating course of situations during a choreography-performance.

Method

Participants

Ten Swiss artistic swimmers between 16 and 22 years old volunteered to participate in this study. All competed at a national or international level (e.g., Junior World Championship, European Cup). We obtained agreement for this study from the players, their parents, and the coaches. The protocol followed the guidelines of the Declaration of Helsinki. All data and their analyses were rendered anonymous. This study was approved by the *Commission cantonale d'éthique de la recherche sur l'être humain* (i.e., Cantonal Ethics Commission for Human Research).

Data Collection

We collected data for each swimmer based on descriptions of lived experience during an international or national competition. These data were collected during enactive interviews, which are designed to provide rich descriptions of lived experience (e.g., O'Halloran, Littlewood, Richardson, Tod, & Nesti, 2018; Rochat, Hauw, Antonini-Philippe, Crettaz von Roten, & Seifert, 2017). In this case, we focused on the experience corresponding to how the swimmers made sense of the situation in which they had acted. The swimmers were informed that the study objective was to collect their experience as they adjusted to each other. First, each swimmer selected a performance from the ongoing year. The only instruction was that this performance had to have occurred during an official national or international competition. They were then invited to segment their activity into meaningful sequences (Zacks & Swallow, 2007) from the video of that performance. The aim was to document the dynamics of the events occurring along the performance in relation to the choreography. Second, the swimmers reenacted the dynamics of these events and completed them in relation to their lived experience (Gesbert & Durny, 2017; Hauw & Durand, 2008; Rochat, Gesbert, Seifert, & Hauw, 2018). The interviewer (i.e., first researcher) and interviewee (i.e., swimmers) viewed the video recording together and the swimmer was prompted to re-experience and describe the stream of past experience in relation to the dynamics of the performance events identified on the recording. Each swimmer was thus prompted to describe, explain and comment on what she had done in order to be synchronized with her teammates during the choreography, while simultaneously adopting a stance such that, as she relived her own past experience, she deliberately ignored the outcome. The researcher used prompts inspired by course-of-action theory (Theureau, 2003), which is now used in many sport psychology studies (e.g., Gesbert

et al., 2017; Hauw, Berthelot, & Durand, 2003; Rochat et al., 2017). Essentially, these prompts are designed to elicit three types of information as the action unfolds: the units of meaningful action (What were you doing at this instant? What were you thinking about?), intention (What were you looking for by carrying out this action?), and perception (What was drawing your attention at this moment? What were you sensitive to?). The interviews were conducted in French, since the swimmers were French-speaking, at Lausanne University. They lasted between 60 and 100 minutes.

Data Analysis

All the interviews were transcribed verbatim. The researchers re-read the transcripts to identify and characterize the environmental information that the swimmers had used to adjust their activity to the needs of the team. By grouping the information that organized their sense-making (i.e., salient statements), we were able to identify the meaningful interactions that enabled them to efficiently adjust to the needs of the team during a choreography-performance (i.e., RQ1). The data coding followed the three steps of inductive content analysis (Biddle, Markland, Gilbourne, Chatzisarantis, & Sparkes, 2001): (a) identify each swimmer's salient statements and sort them into raw data themes (common environmental information that the swimmer was interacting with), (b) group raw data themes into first-order themes, and (c) group first-order themes into general dimensions. First, the two researchers independently identified and grouped the salient statements of each verbatim into a single database system. They examined the data list and identified the content and meaning related to the swimmers' experience of adjusting their activity (i.e., raw data themes). Second, the two researchers compared and contrasted their own raw data themes in order to come to agreement. The same process was used for the other stages of the analysis. In order to describe how these interactions fluctuated during choreography-performance (i.e., RQ2), the choreography-performance was broken down into phases (see FINA for more precision): (a) preparation outside the pool, (b) diving into the water, (c) preparation and execution of figures, (d) preparation and execution of highlights, (e) maintaining and/or shifting the formation shape, and (f) movements in the pool. For each phase, the meaningful interactions preferentially used by the swimmers when they adjusted to each other were identified and noted on a double entry table (See Table 2). From this table, different fluctuations along choreography-performance have been characterized from quantitative (i.e., number of modalities of interaction used by the swimmers) and qualitative perspectives (i.e., type of modalities of interaction used by the swimmers). Then, we scrutinized the meaningful interaction preferentially used by the swimmers during the choreography-performance (i.e., the most important degree of occurrence during performance) and how it was combined with other interactions during the choreography-performance.

Trustworthiness Of The Data And Analysis

Several measures were taken to ensure the trustworthiness of the data and analysis (Tracy, 2010). First, the interviewer (i.e., first author) was experienced at conducting enactive interviews. Second, when an area of research is not well-known (i.e., the meaningful interactions enacted by artistic swimmers to adjust to the needs of collective behavior), inductive

analysis is advised to describe the *phenomenon* (Côté, Salmela, Baria, & Russell, 1993). Third, the two experienced researchers, each having conducted previous qualitative research independently, coded the data transcripts on the swimmers' experience as they adjusted their activity to the needs of the team. The initial agreement rate was 83% for describing the raw data themes. Disagreements were resolved by discussion until a consensus was reached. Then, the same process was used to identify the first-order themes and general dimensions. The agreement between the two researchers was 95%. The disagreements were resolved by discussion until a consensus was reached. Fourth, data saturation occurred at the tenth interview. During this last interview, no additional raw data themes and general dimensions were produced. According to Guest, Blince, and Johnson (2006), this number was sufficient, as saturation generally occurs between six and 12 interviews.

Results

Results revealed five general dimensions that distinguished the meaningful types of interaction as the swimmers adjusted to each other in competition (i.e., RQ1). These meaningful interactions were in relation to (a) the activity of one or more swimmers, (b) the environmental information coming from inside or outside the pool, (c) the 8-counts, (d) key moments in the music, and (e) their own feelings (see Table I[4]). First, we present and describe the raw data themes characterizing each of these meaningful interactions. Then, we characterize the situatedness of these meaningful interactions during the choreography-performance (i. e., RQ2, see Table II).

RQ1. The Meaningful Interactions During Choreography-Performance

1. Interacting with the activity of one or more swimmers

This kind of interaction was characterized by 11 raw data themes.

The swimmer's voice. Before diving, the swimmers were sensitive to the counts out loud made by the swimmer considered to be the leader: "*Here the leader said 'eehhh' before she started counting. This got us ready. Then she immediately began the count*." Underwater, they were also attuned to the sounds produced by a specific swimmer when the quality of the music underwater was poor: "*We could not listen everything….So, I'm counting underwater, and I'm making a sound with my mouth; the others are tuned in to it and it helps us be more synchronized; since I know the figure and the movements I put the accents at the right moment so it's even prettier."*

[4] For each general dimension, raw data themes are presented independently of first-order themes.

TABLE I
Meaningful Interactions Between Swimmers And The Environment As They Adjusted To Each Other To Achieve Interpersonal Coordination

Raw Data Themes	**First-Order Themes**	**General Dimensions**
Interaction with …	**Interaction With …**	**Interaction With …**
A swimmer's voice	The activity of one or more swimmers	**THE ACTIVITY OF ONE OR MORE SWIMMERS**
The position occupied by one or more swimmers		
The distance with one or more swimmers		
Parts of a swimmer's body		
Effects of her teammates' activity		
The compression co-built with another swimmer		
The compression built by other swimmers		
The effects of the partial movements of one or more swimmers		
Alignment with two or more swimmers		
Eye contact with other swimmers		
The balance constructed with other swimmers		
	Environmental information coming from outside of the pool	**ENVIRONMENTAL INFORMATION COMING FROM THE POOL OR OUTSIDE THE POOL**
The starting whistle		
The judges		
The lines on the pool ceiling		
The LED displays around the pool		
The pool walls	Environmental information coming from the pool	
The underwater lights		
The pool ladders		
The pool corners		
The middle of the pool		
The 8-counts of the choreography	The 8-counts of the choreography	**THE 8-COUNTS**
The music's key moments	The music's key moments	**THE MUSIC'S KEY MOMENTS**
The water contact on her body	Her own feelings	**HER OWN FEELINGS**
Her own bodily sensations		
The amount of movement		

The position occupied by one or more swimmers. When the swimmers were preparing a movement or figure in the pool, they were sensitive to the position occupied by one or more of their teammates and adjusted their activity accordingly: "*P is the base of the formation and so she's the one I get up on. I'm very attentive to her movements and when she's in the middle, I climb up.*"

The distance with one or more swimmers. When the swimmers were in formation, they were sensitive to the distance between them. By monitoring

TABLE II
Situatedness Of The Meaningful Interactions Enacted By Swimmers During Choreography-Performance.

To…	**Prepara-tion Out Of Water**	**Dive Into The Water**	**Performance Of Figures**			**Performance Of Lifts (Highlights)**		**Maintaing And Changing Formations**		**Moving Across The Pool**			
Interacting With….	**Get prepared out of the water**	**Dive into the pool and move through the water**	**Perform a figure with the legs**	**Prepare and perform a figure with the upper body**	**Perform spins**	**Prepare and perform a platform lift**	**Prepare and perform a throw**	**Maintain a formation**	**Change formations**	**Move laterally with the formation**	**Move diagonally with the formation**	**Change direction with the formation**	**Move diagonally and on the back with the la formation**
A swimmer's voice	X					X / .	X / .						
The starting whistle	X												
The judges	X												
The 8-counts		X	X	X	X	X / .	X / .	X	X	X	X	X	X
The underwater lights		X											
The key moments in the music			X	X	X		X						
The effects of the partial movements of one or more swimmers			X										
Water contacts with the body			X										

(continued)

(continued) TABLE II

To…	Preparation Out Of Water	Dive Into The Water	Performance Of Figures			Performance Of Lifts (Highlights)		Maintaing And Changing Formations		Moving Across The Pool			
Interacting With….	**Get prepared out of the water**	**Dive into the pool and move through the water**	**Perform a figure with the legs**	**Prepare and perform a figure with the upper body**	**Perform spins**	**Prepare and perform a platform lift**	**Prepare and perform a throw**	**Maintain a formation**	**Change formations**	**Move laterally with the formation**	**Move diagonally with the formation**	**Change direction with the formation**	**Move diagonally and on the back with the la formation**
One's own bodily sensations			X										
The position occupied by one or more swimmers				X		X	X	X	X	X	X	X	
Parts of a swimmer's body				X		X	X						
The pool walls					X								
The balance constructed with other swimmers						X	X						
The compression co-built with another swimmer							X						

(continued)

(continued) TABLE II

To…	Prepara-tion Out Of Water	Dive Into The Water	Performance Of Figures			Performance Of Lifts (Highlights)		Maintaing And Changing Formations		Moving Across The Pool			
Interacting With….	**Get prepared out of the water**	**Dive into the pool and move through the water**	**Perform a figure with the legs**	**Prepare and perform a figure with the upper body**	**Perform spins**	**Prepare and perform a platform lift**	**Prepare and perform a throw**	**Maintain a formation**	**Change formations**	**Move laterally with the formation**	**Move diagonally with the formation**	**Change direction with the formation**	**Move diagonally and on the back with the la formation**
Eye contact with other swimmers							X						
The alignment with two or more swimmers								X	X	X			
The amount of movement										X	X	X	X
The effects of teammates' activity										X	X		X
The middle of the pool										X	X	X	
The scoreboard/LED displays											X	X	

(continued)

(continued) TABLE II

To…	Prepara-tion Out Of Water	Dive Into The Water	Performance Of Figures			Performance Of Lifts (Highlights)		Maintaing And Changing Formations		Moving Across The Pool			
Interacting With….	**Get prepared out of the water**	**Dive into the pool and move through the water**	**Perform a figure with the legs**	**Prepare and perform a figure with the upper body**	**Perform spins**	**Prepare and perform a platform lift**	**Prepare and perform a throw**	**Maintain a formation**	**Change formations**	**Move laterally with the formation**	**Move diagonally with the formation**	**Change direction with the formation**	**Move diagonally and on the back with the la formation**
The pool ladders											X	X	
The pool corners											X	X	
The lines of the pool ceiling													X
Number of interac-tion modalities used by the swim-mers for…	3	2	5	4	3	4	7	3	3	6	8	7	4

Captions.

and making sure that this distance was optimal, they ensured that the formation was viable at a given instant and for the upcoming next movements or figures: "*When we're in these positions with the arms and legs, we have to be about half an arm's length apart. Sometimes I can even feel the arms and this helps me to know that our formation is really nice. I do this with M, I check the distance with her, and after I do my move.*"

Parts of a swimmer's body. When bodily contact was established between the swimmers, such as during a lift,[5] they became sensitive to a teammate's body part (e.g., shoulder, buttocks, feet, back), depending on their position and their role, and adjusted their activity accordingly: "*There I'm really tuned in to the center swimmer. I get her on my shoulders and push her up […].*"

The effects of a teammate's activity. During some movements, the swimmers sometimes had no opportunity to monitor a teammate's behavior (e.g., during a duet, a swimmer often has her back to her partner). They were thus sensitive to the effects of her activity and more particularly to her movements in the water: "*I can feel there's movement in the water, she's there and if I no longer feel anything I think to myself that there's a problem and I need to move up so that we stay together.*" In team swimming, a swimmer may be in the lead in the formation and thus unable to visually monitor her partners' activity. To adjust the amount of movement to that of her teammates, the leader was also attuned to the effects of their activities, such as the movement of water: "*I'm up front and I can feel in fact this sort of pressure from the others. I can feel them coming up behind me, I feel the water coming toward me a little and I have to manage how it's happening.*"

The compression co-built with another swimmer. During the lifts[5], the swimmers became attuned to the compression being built, while remaining attuned to the quality of bodily contact established with their teammate: "*It's a matter of gaining momentum underwater, except that now we're two compressing together and no longer each on her own. It's really both our bodies that have to be as compact as possible underwater so we have enough momentum.*"

The compression built by other swimmers. During the lifts, the base was also sensitive to the compression produced by the lifters, as this helped her to know intuitively whether or not she should rise up to push the flyer off the lift: "*The lifters have to rise up at the same time, and I have to have the right tempo with them... I can't lift up if they're not pushing me, I have to feel the compression.*"

The effects of partial movements of one or more swimmers. During the execution of leg figures (i.e., with their heads underwater), the swimmers were

[5] The lift is an acrobatic movement, with a pyramid of athletes who unite their maximal power to propel one of them, the flyer, completely out of the water.

sensitive to the leg movements of one or more swimmers in order to ensure that their own movements were synchronized and to adjust the speed of their movements if necessary: "*Here we go for another big figure. Even though it's the execution that's especially important, I'm still tuned in to her legs. When I hear them snap together in the water, I know where we are from this information.*"

Alignment with two or more swimmers. While preparing or changing formations, the swimmers would align with one or more of their partners to facilitate or maintain the formation structure: "*There, it's a formation change. At that moment, I look to see whether I'm lined up on the side and then I look to the front to make sure I'm lined up with her. I move over a bit to be better lined up with my partners*."

The gaze of other swimmers. During the lifts, the swimmers who supported the base could be sensitive to a part of the base's body and to the other swimmers involved in this support activity, as their synchronization was important to ensure sufficient force for an explosive lift: "*This lift is also the moment when I have to look at the teammate across from me who has the other foot. I have to be sure of being at the same height as her, you could say eye to eye, to increase the pressure so that after it explodes*."

Building balance with other swimmers. For some lifts, the swimmers were sensitive to the balance they needed to achieve with other swimmers to support the base. Their support activities had to somehow be compensated in order to stabilize the flyer: "*There, I'm paying attention to the two swimmers on the sides ... supporting the most weight ... and we're already really trying not to make her move on the sides, we're steadying her ... and for example I can feel if ... S who's on the left, is a little off, if I feel that it's falling a bit and I go up a little ... in fact we say that we're keeping things in balance. There, when she can stay stable like this, it's good!*"

Interacting With Environmental Information Coming From Inside Or Outside The Pool. This kind of interaction was characterized by nine raw data themes.

The starting whistle. In the preparation period outside the pool, the swimmers waited for the judge's whistle to signal the start of the music and choreography: "*Right from the start, you have to be really concentrated to hear the start of the music because a whistle signals it, but we still have 3 seconds before the music actually starts*."

The judges. During this same period, the swimmers were sensitive to the position of one the judges, decided on before the competition began, to ensure that the direction of their movements and gazes stayed synchronized: "*So there we have our eyes on the first judge and there again, with those in the front, we're watching that first judge … it's more graceful*."

The underwater lights. When the swimmers dived into the pool, they

were sensitive to underwater lights to adjust the amount of their movement: "*We dive into the water and we have to be careful about how much we move forward … For example, there're underwater lights and we might say OK, let's stop a little before the first light or just at that first light.*"

The lines on the pool ceiling. When the swimmers moved on their backs and were unable to see their teammates, they could tune in to the lines on the pool's ceiling to make sure that they were staying on course and keeping an optimal distance between them: "*Some pools have lines on the ceiling and this helps you monitor your movements, to know how you're moving on the diagonal….*"

The scoreboards/displays. While moving on the diagonal on the stomach, the swimmers were sensitive to the scoreboards and LED displays around the pool to help them maintain their pattern with their teammates: "*On the diagonal, we know exactly the angle we're moving toward … and above the judges there are advertising displays that we focus on … We stay on the right course like that.*"

The pool walls. During spins, the swimmers used the pool walls to ensure they had completed a 180° rotation/revolution and were synchronized with their teammates: "*During spins, I always say wall-wall and there I have a reference point in the pool because I count my rotations with the walls: I say 1 wall, 2 walls, 3 walls … it's important to make sure I'm rotating in synch with the other swimmers.*"

The pool ladders. When the swimmers changed formation and direction, the pool ladder provided relevant information about the viability of their pattern: "*Here we focus on the ladder, there're four of them in a pool and there she said to me: focus on the ladder and in fact that's a marker for me in the pool (coming out of a body boost and changing the formation, moving on the diagonal).*"

The pool corners. When the swimmers changed formation and direction, they could tune in to the pool corners to ensure the viability of their pattern: "*We were moving to the right and then we turned like this to move there on the diagonal … I'm going to see the pool corner. So I'm going to target it. It's become a habit.*"

The middle of the pool. When the swimmers changed direction, a focus on the middle of the pool helped them ensure the viability of their pattern: "*My coach told me I needed to aim for the middle of the pool because I have a tendency to go like this. So I tried turning a bit to be a little more toward the center of the pool when my head came out of the water.*"

Interacting With 8-Counts. *This kind of interaction was characterized by one raw data theme. The swimmers were sensitive to the counts for the choreography*

that had been co-constructed with the coach. Several swimmers were sensitive to the counts throughout the choreography to stay synchronized: "Always the counts, I count all the time, 1,2,3,4,5,6,7,8 all the time to stay really synchronized, to be sure we all have the same rhythm" or at specific moments like the lift: "There I'm really counting because this lift was never really in sync and so I was really counting … and 5 and 6 … to get really compressed at 7 and do all the movements up to the push so it would be even better. It has to be elegant!" Counting was also emphasized when the quality of the music underwater was not good enough: "*I realized after we dived that the sound quality wasn't very good … so I focused on counting even though at first I had a hard time.*"

4. Interacting with key moments in the music

This kind of interaction was characterized by one raw data theme. The swimmers were also sensitive to the key moments embedded in the music to time their activity: "*After the boost,*[6] *there's a high point in the music, so I immediately curled up into a ball and waited for her to push me, she pushes me at the high point and that's when I do my movement. It's really important that at high points like this, it looks like the explosion of a Champagne cork.*" By interacting with the key moments in the music, they could be also sensitive to other environmental information such as the feeling of compression or the balance enacted with another swimmer: "*There I know from the rhythm of the music, they're going to push me at the high point so I try more than anything to really stay in balance before they propel me upward and I try to go as high as possible.*" Sometimes they stopped interacting with the music because of its poor quality underwater and relied on the counts: "*The quality of the music underwater wasn't too good … so I had to concentrate on the counts for the choreography. The music helps to be sure that we're on the right count but when we can't hear it well we stay concentrated on the counting and wait till we're out of the water to catch up if we need to.*"

5. Interacting with one's own feelings

This kind of interaction was characterized by three raw data themes.

The water in contact with one's body. For certain figures when the swimmers had their heads underwater, they were sensitive to the feeling of

[6] The boost is a rapid, headfirst rise, with a maximum amount of the body above the surface of the water (FINA).

the water on their body to stay synchronized with their teammates: "*So that we're coordinated, the two of us, so that we get our legs out of the water at about the same height … I know that I have to be at a certain depth. I feel how high the water is on my thighs and that's a cue, and with that I know I'll be fine because I'll have less distance to cover since she's faster*."

One's own bodily sensations. For certain figures when the swimmers had their heads underwater, they had to perform leg movements at precise leg angles. To do this, they tuned in to specific bodily sensations that they had already experienced and associated with well-performed figures: "*There the angles are super important, I can't let my leg be too low or too high ... all the swimmers have to have the same height, have the leg at the same height, once I feel that I have it, I keep it there, it's really different for each of us, for example, someone might feel she's straight when she's in the right position ... for me, I know that I start to feel my abs when I have to be at 45°.*"

The amount of movement. During the set-up or a formation change, the swimmers sometimes moved blind and were not able to see their partners. To keep moving while staying synchronized, they were thus sensitive to their momentum: "*During a blind change in formation, the one that's moving can't see but you still have to know exactly how much you need to move forward, so it's really the feeling of movement. I feel like I'm moving a certain amount ... for example, I know I have to do a breaststroke of a certain intensity so that they can follow me. If I'm too fast, we won't be in formation anymore. We work on this a lot in training.*" It should be recalled that the distance separating the swimmers for both duets and teams is a criterion of unity for the judges.

RQ2. Situatedness Of The Meaningful Interactions During Choreography-Performance

The results presented in Table II indicate the connection between situations and the meaningful interactions during choreography-performance. All the meaningful interactions are indicated in the first column (e.g., interacting with…). Then, the following columns correspond to phases of the choreography-performance: (a) preparing out of the water, (b) diving into the water, (c) performing figures, (d) performing lifts (highlights), (e) maintaining and/or changing formation, and (f) moving across the pool. Table 2 thus depicts the fluctuations of these meaningful interactions (i.e., displayed by an X) as the swimmers sought to adjust to each other during the phases of choreography-performance. Results indicate that the meaningful interaction

predominantly used by the swimmers during the choreography-performance was the 8-counts. Then, for each phase in which this modality was used, the results show how swimmers interacted with other meaningful interactions to efficiently adjust each other. For instance, during the phase "Dive into the water", swimmers interacted with the 8-counts and the underwater lights whereas during the phase "Maintaining and changing formations", swimmers interacted with the 8-count and the activity of the others such as the distance and alignment. Results also depict two phases in which the use of 8-counts was either not possible (i.e., during the preparation out of water) or proscribed due to the poor quality of the music underwater (i.e., during the performance of lifts displayed by /X). In these two phases, swimmers systematically interacted with the swimmer's voice.

Discussion

The aim of this study was twofold: (a) to identify the meaningful interactions that enabled artistic swimmers to perform together efficiently (i.e., RQ1) and (b) to determine how these meaningful interactions fluctuated during choreography-performance (i.e., RQ2).

RQ1. The Meaningful Interactions that Artistic Swimmers Enacted To Perform Together

The results suggest that the adjustment activity between swimmers was distributed over several properties.

First, the 8-counts appeared to be the foundation for their adjustment activity in every situation. These counts enabled the swimmers to have similar rhythms and thus synchronized movements (Brown & Meulenbroek, 2016). This shows that, by counting, swimmers can interact efficiently and maintain rhythm during performance.

Second, they also interacted with the activity of other swimmers in three complementary ways: sight, hearing and touch. Their activity took into account the positions of the other swimmers, the distances and alignments with them, the gaze of another swimmer, and the effects of some swimmers' movements to adjust to each other. Although visual information was required to assess how well aligned they were to maintain the formation shape or how quickly they were performing the rise to foster compression between them (Karin, 2016), this information also gave them a sense of being tuned in

together or not, which encompassed not only topographic interaction, but also emotions and intention (see Himberg, Laroche, Bigé, Buchkowski, & Bachrach, 2018; Legrand & Ravn, 2009; Montero, 2006). In addition to supporting other studies in the sports sciences that have highlighted the importance of visual information in how team members adjust each other (e.g., Correia, Araújo, Craig, & Passos, 2011), these results emphasized how the swimmers made sense of the movements being performed and how they adjusted their own movements from this information.

The swimmers also took into account voices. This auditory information was especially needed during the preparation phase outside the pool when there was no music. One swimmer counted aloud to give her teammates the rhythm to follow, suggesting its importance in their activity. Moreover, the quality of the music underwater was sometimes judged as insufficient. One of them thus reproduced the rhythm of the music with her mouth so that the others could keep or reenact the same rhythm. This type of information helped them assess how well they had synchronized and prepare for the next figure or highlight. Although the role of auditory information has already been highlighted in the sports sciences for recognizing an opponent's movement or adjusting one's own movement (see Camponogara, Rodger, Craig, & Cesari, 2017), our results further suggest how this information can also help team members adjust to each other.

Moreover, the swimmers exploited touch when they bodily interacted to prepare and perform a highlight. In these situations, they became attuned to the feelings of compression or stability enacted with the other swimmers to adjust their movement for the figure. This information, emerging directly from their mutual intertwined movements, helped them make sense of how much compression or stability had been achieved to perform the figure or highlight (e.g., *our bodies were not as compact as usual*). These results echo the findings of Lund, Ravn, and Christensen (2012), who showed how rowers were attuned to the feelings of movements that worked against each other, offering them a constant opportunity to mutually re-establish their own good rhythm. In the present study, the activity centered around whether the compression between the lifters and base was sufficient to forcefully propel the acrobat and achieve aesthetic effects.

Third, key moments in the music offered the swimmers the opportunity to adjust to each other. This additional auditory information was important because it helped them structure and achieve the synchronized movements and manage the aesthetic markers. With fatigue and/or task constraints (e.g., performing an underwater movement), swimmers can lose the choreography's rhythm. Key moments like voice intonation or the introduction of lyrics

offer auditory affordances (Steenson & Rodger, 2015) for adjusting their movements and/or reenacting the choreography counts. By interacting with this auditory information, artistic swimmers make sense about where they are in the choreography (Legrand & Ravn, 2009), when they should perform the next push or how many counts remain before performing the next figure, and how they can emphasize certain aspects of movement to generate aesthetics effects.

Fourth, by interacting with their own bodily sensations, the swimmers made sense about the achievement of synchronized movements and figures. This coupling informed their actions in an efficient, orienting and continuous manner so that they could adjust their own movements online to environmental contingencies (He & Ravn, 2017; Sutton & Williamson, 2014). Similarly, when they performed underwater figures, their activity was meaningful as they used cues from the water contact on their bodies to be as high as possible with their teammates. Again, the level of energy displayed by this body involvement also contributed to the aesthetic effect (see Merritt, 2013; Montero, 2006).

Fifth, the swimmers interacted with environmental information inside or outside the pool to adjust to each other. Choreography-performance involves movements like changes in formation and/or direction that are potential sources of disruption. As these movements sometimes had to be accomplished without visual information coming from teammates' activity, it was particularly interesting to note how they adapted to these potential disruptions to stay together. When they moved on their backs, they interacted with the ceiling lines, and the information emerging from this coupling helped them adjust their movements to maintain the shape of the formation. Likewise, when they moved diagonally on the stomach, they interacted with scoreboards and other LED displays around the pool. Although this form of coupling has already been described in individual sports (e.g., Hauw, Renault, & Durand, 2008), our results emphasize how the material environment can be exploited to make sense of unfolding interactions and efficiently adjust.

RQ2. The Situatedness Of The Meaningful Interactions During Choreography-Performance

The results suggested two modes of organization corresponding to two distinct ways of sensemaking: (a) complementary and (b) compensatory.

First, the results described how the swimmers preferentially interacted

with the 8-counts to adjust to each other. Except for the preparation phase outside the pool and sometimes for the performance of lifts, these counts seemed to be the basis for their activity, fostering a sense of togetherness and potential adjustments. They offered the swimmers a constant opportunity to adapt, maintain and reenact the required rhythmicity between their movements and the music structure (see Schiavio, Gesbert, Reybouck, Hauw, & Parncutt, 2019). The music was also crucial because it gave them the opportunity to make sense of where they were in achieving synchronized movements. In complement to the counts and depending on the task constraints (i.e., highlights, figures, movements, maintaining or shifting the formation), the swimmers interacted with other information such as the activity of other swimmers, key moments in the music, their own sensations and/or their material environment. This information was complementary to the swimmers' activity as they sought to efficiently adjust their movements to each other (Hauw & Durand, 2008).

As they interacted with the 8-counts, the swimmers also interacted with the activity of the others to gain a sense of the online accuracy of all lines and positions. Their activity was thus situated (Mohammed, Favrod, Antonini-Philippe, & Hauw, 2015). Additional visual information allowed them to mutually adjust their movements to promote or maintain the formation shape, which had to be immediately recognizable to the judges. This aesthetic dimension probably explains the emergence of this specific organization of the swimmers' artistic activity in comparison with the results already described in other team sports like soccer (e.g., Gesbert et al., 2017). Besides synchronization, these artistic swimmers need to reach a high level of aesthetic performance and, to cope with this concern, their activity is based on exploring and interacting with ecological information coming from teammates' movements, key moments in the music or their own sensations.

The results also revealed a second organization to make sense of the unfolding situation. During the preparation phase without music outside the pool, the swimmers compensated by interacting with the voice of a swimmer who was counting out loud. This auditory information thus became meaningful to them as they sought to achieve and maintain synchronous movements and an overall aesthetic effect. In an inauspicious environment like water, some of the interactions during the choreography-performance were also likely to be hindered, depending on the task constraints. The swimmers' activity was then based on new functional interactions with their environment to build the information they needed and efficiently adjust their movements to each other. This property of their activity has been described as the concept of degeneracy (see Seifert, Button, & Davids, 2013).

Similarly, when the poor quality of the music underwater made it hard for the swimmers to enact the same rhythmicity, they chose to interact with the voice of the swimmer who seemed the most skilled at reproducing the music's rhythm. This gave the pushers a sense about when to push up the pillar. The swimmers thus explored and adapted to their environment, which offered useful resources/information for their adjustment activity (Hauw et al., 2008). This exploration no doubt accounted for their ability to vary their interactions with the environment to achieve the collective choreography-performance (i.e., being synchronized with each other and the music). Understanding performance in these terms implies that artistic swimmers' expertise can be conceived as an activity that allows them to master the dynamics of their interaction with their environment (see Barab & Plucker, 2002; Hauw, 2018) in order to constantly enact the information needed to perform together.

Limitations, Implications and Conclusion

This study had limitations. The sample was made up of ten junior swimmers, making it difficult to generalize the findings to all artistic teams, especially senior teams. Moreover, although these swimmers performed at a high level, it is possible that elite artistic swimmers competing at the highest level (i.e., greater expertise) would enact other types of meaningful interactions.

Methodologically, the objective of the enactive interviews was to elicit descriptions and explanations of the athletes' activity that was meaningful for them, which precluded the collection of data on other levels of activity (e.g., sensorimotor level). Moreover, the enactive interviews were new for the swimmers, which increased the risk that they would build new meanings regarding their past experience. Three main precautions were taken to avoid this and help the swimmers reenact their past experience: (a) careful explanation that the aim of the interview was to access and understand what they did, perceived, thought, and sought in order to efficiently adjust to each other during a choreography-performance and instructions to put aside their post-experience judgments and reflections during the interview; (b) the use of choreography-performance videotapes to enhance their capacity to remember how they experienced their past performance and situate each component of their experience in relation to observable events (e.g., diving into the water, preparing a figure, preparing a platform lift, performing a platform lift, changing formations, moving laterally, etc.); and (c) keeping the swimmers focused on the stream of their past experience and deliberately ignoring outcomes by avoiding the use of time connec-

tives (now, at this moment, next, etc.). These precautions have been used in previous studies in sports psychology (see Gesbert et al., 2017; Rochat et al., 2018), and the reenactment situation was quite similar to the lived experience during the choreography-performance.

Notwithstanding these limitations, the results provided interesting insight into how artistic swimmers adjust to each other during choreography-performance. This has implications for coaches and practitioners working with artistic swimmers across the world. First, even though enactive interviews encourage the reenactment of athletes' past experience, they also raise athletes' awareness about their meaningful interactions with the environment. This awareness may prompt thinking about new possible interactions to experiment with in upcoming training or competition sessions (see Hauw, 2018). Thus, for sports psychologists, the enactive interview may stimulate exploration and extend the range of interaction modalities enacted by artistic swimmers (see Schiavio et al., 2019). Second, coaches might use a constraint-led approach (e.g., Davids, Button, & Bennett, 2008) to afford swimmers the opportunity to explore, experiment, develop and master new meaningful interactions to efficiently adjust to each other. This pedagogical approach is based on exploiting and manipulating task, individual and environmental constraints in order to disrupt and/or proscribe familiar meaningful interactions and thereby encourage the emergence of new interactions. For instance, coaches have given colored glasses to their swimmers to promote instabilities in the interactions enacted by the swimmers during performance (i.e., proscription of the visual modality), affording them the opportunity to develop new ways of sensemaking to efficiently adjust to each other.

In conclusion, in response to our research questions, our study identified five meaningful interactions enacted by high-level artistic swimmers to make sense of their unfolding situation and efficiently adjust to each other (RQ1). It described how these different interactions fluctuate during choreography-performance and shed light on two ways of sensemaking about the unfolding situation: complementary, with the 8-count as the basis for their activity, and compensatory, when the 8-count is disrupted or not possible (RQ2). Future studies focused on either duets or teams should be conducted to exploit and test this model.

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