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Original Article

Impact of sport on social cognition: an analysis based on structural equational models

CATALINA QUINTERO LÓPEZ[1].,VÍCTOR DANIEL GIL VERA[2].,CAROLINA VÁSQUEZ LÓPEZ[3]., JENNIFER CRISTINA ÁLZATE JARAMILLO[4].
[1,2,3,4,]Research Group"Basic and Applied Neurosciences"–Line "Neurocognitive Profiles and Psychology" Universidad Católica Luis Amigo, Medellín-COLOMBIA

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Abstract
Social factors are positively associated with social cognitions related to physical activity. Participation in physical activity is associated with positive health outcomes, and the intentional exercise required in sport improves mental health. This research presents a structural equation model (SEM) to evaluate the variables that most influence social cognition; empathy and compassion. Was used a representative sample of 50 soccer players from a sports club of Medellin, Colombia. The sample was selected taking into account a 5% margin of error and a 90% confidence level, the population size was 57 soccer players. The results of the Kaiser-Meyer-Olkin (KMO) sphericity test and the Bartlett's test indicated that the factor analysis is adequate, all constructions are statistically significant. Goodness-of-fit tests indicate that the model fits well with the data. This paper concludes that, of all the constructs considered: interaction with authority figures, interaction with the opposite sex, being in evidence, affirmative expression of discontent, interaction with strangers and acting in public, the construct that most influences the latent variable "empathy" is the interaction with the opposite sex. The construct that most influences the latent variable "sympathy" is the affirmative expression of discomfort.
Keywords: social cognition, SEM, sport, brain, executive functions

Introduction

Social cognition is defined as the processes by which we draw inferences about other people's belief and intentions and how we weigh social situational factors in making these inferences(Alvarez-Astorga et al., 2019). Social cognition is impaired in a large number of neurological afflictions, including neurodegenerative diseases, neuropsychiatric disorders and neurodevelopmental syndromes, and has become a significant element in differential diagnoses (Duclos, Desgranges, Eustache, & Laisney, 2018). This paper presents the development of a structural equation model (SEM), which seeks to examine the variables that influence the social cognition (empathy and sympathy) in soccer players belonging to sports clubin Medellin, Colombia. Five constructs were considered: interaction with authority figures (AA), interaction with the opposite sex (AB), be in evidence (AC), assertive expression of discomfort (AD), interaction with strangers (AE) and act in public (AF) and two latent variables were used,empathy and sympathy. Social cognition plays a role in team sports in aspects such as the players themselves because they have to assess what is going on, what they have to do to succeed, and they have to react and adjust their plays based off their teammates and the opposing teams (Koples, 2019). In the rest of the paper presents a general contextualization on social cognition, the methodology used and the results analysis. Finally, the study concludes.

Social cognition and sports

Social cognition can be defined as a process in which an individual makes sense of, interprets, analyzes, and reacts to a social situation using cognitive processes (Landau, Meier & Keefer, 2010). Social cognitionis a concept introduced by neurosciences, to refer to a neuropsychological process that has been studied over the last few years in various clinical conditions such as: schizophrenia, autism, attention deficit hyperactivity and antisocial personality disorder. It is defined as a subject's ability to perform emotional processing, interpreting other people's intentions and beliefs in the midst of social situations(Christidi, Migliaccio, Santamaría-García, Santangelo, & Trojsi, 2018). Social cognition neuroanatomy is explained by multiple neural connections of cortical and subcortical structures, with predominance of the specifically prefrontal frontal lobe. This concept studies the neurobiology of responses of empathy, sympathy, moral reasoning, recognition of the gaze and internalization of social rules (Fede et al., 2016).
Many sports, whether it be a team sportor an individual sport, include social cognition in multiple aspects. Soccer can be used as an example because there are two teams playing against each other, each team has at least one coach, and there are referees judging the plays(Koples, 2019). Social cognition can be analyzed from the

Corresponding Author: CATALINA QUINTERO LÓPEZ, E-mail: Catalina.quinterolo@amigo.edu.co

individual player because they have to know what to do, where to run and who to pass the ball(Koples, 2019). They analyze the social situation of where their teammates are and which ones are able to receive the ball, while also knowing the game and what to do to not receive a penalty by the referee, as well as pleasing the coach by playing well and aiding in scoring a goal(Koples, 2019).

The role of social cognition is present in individual sports competitions such as figure skating because the skater needs to pay attention to the program they are performing while also being sure not to fall on a jump and if they do, they need to adjust their performance to score higher on interpretation of music as well as knowing what the other competitors performed so they can try and score higher(Koples, 2019). For figure skating, the components to analyze are the skater themselves, the program, what the coach has taught them previously to succeed, the other competitors and their programs and abilities, and the sport itself and what to do to not get score deductions. The judgement of a sport can be biased and can impact the way the individual performs (Plessner & Haar, 2006). If a team loses, the attitudes of players is most likely to have feelings of unfair judgements (Plessner & Haar, 2006). On the other hand, the winning team would be more likely to feel they were judged fairly (Plessner & Haar, 2006).

This puts an emphasis on the social aspect involving the referee or judge and how they determine what is right or wrong. Another aspect to consider while playing sports is the audience. If i were performing a figure skating program, i would want to consider how interested the audience is in my performance and i would have to adjust my performance to capture everyone's attention. It is also proven that physical activity leads to feelings of high self-confidence which can positively impact the individuals involved (Ivaskiene, Skyriene & Cepelioniene, 2013). If an individual is confident in what they are doing, they are more likely to perform well, opposed to having doubts in their abilities leading to a more negative outcome (Ivaskiene et al., 2013). Studies have also shown that physical activity can increase and improve cognition in adults, which is one of the many benefits that playing sports can have (Langlois, Chassé, Dupuis, Kergoat & Bherer, 2013).

Empathy and sympathy

Empathy, the sharing and understanding of feelings of others, is a fundamental aspect of social competence, and a lack of empathy has been associated with aggressive behavior (Jolliffe & Farrington, 2004; Noten, Van der Heijden, Huijbregts, Van Goozen, & Swaab, 2019). Sympathy is usually evoked by heightened awareness of and concern for others' suffering by perceiving or reacting to their distress or need. Sympathetic contexts appear to spur creative solutions, because those who react sympathetically to others' suffering tend to seek novel, desirable, and prosocial solutions that alleviate suffering and promote well-being (Yang & Yang, 2016).

Empathy is the ability to put oneself in another's shoes and actually imagine how another must be feeling. Sympathy is the ability to recognize and feel sorrow or pity for the suffering of another (Chapman, 2012). These abilities are even expressed in discrete parts of the brain—sympathy is thought to use recognition functions in the frontal lobes of the brain's third layer, while empathy is thought to include functions in the lower right lobes of the cerebrum (Chapman, 2012). Figure 1, presents the ubication of each lobe:

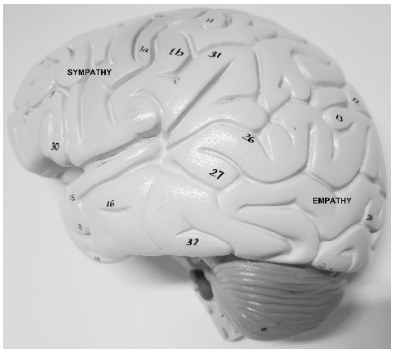

Figure 1. Sympathy and empathy regions

Sympathy can motivate a person to improve a situation, but it can cloud proper design judgment, and complicate relations with the person for whom you are researching and designing. Empathy, on the other hand, helps designers to increase their understanding while remaining objective (Chapman, 2012). Sympathy and empathy are different in another way as well. It is considered "easier" to feel sympathy than to feel empathy. Why is this? When we feel sympathy, we feel for another, but do not understand what the other person is truly feeling. When we are empathetic, we have built an understanding of another's emotions and feelings (Chapman, 2012).

Methodology

Structural equation modelling (SEM) is a class of multivariate models used for learning a causal relationship among variables (exploratory modelling) or for testing whether the model is best fit by given data (confirmatory modelling). A general SEM includes the observed and latent variables, while their relationships are explained by a linear model whose parameters explain the cause or influence from one variable to another (Pruttiakaravanich & Songsiri, 2020). SEM has been widely used in behavioral research, such as in psychology, sociology, business and medical research(Mclntosh & Gonzalez-Lima, 1994;Price, Laird, Fox, & Ingham, 2009).

We analyzed the relationships between six constructs (interaction with authority figures, interaction with the opposite sex, be in evidence, assertive expression of discomfort, interaction with strangers and act in public) and two latent variables (empathy and sympathy), which enable you to analyze sportsmans' attitudes in the social cognition.Was used a database that met the responses from a survey of the"*The Social Abilities Questionnaire"*(Caballo et al., 2012). The survey was applied to a representative sample of 50soccer players in a sport club in Medellin, Colombia. The sample was selected considering a margin of error of 5 % and a confidence level of 90 %, the size of the population was 57 soccer players (equation 1). We used multivariate statistical techniques; regression and factor analysis in the statistical software STATA 16.

$$n = \frac{Z^2(p * q)}{e^2 + \frac{(Z^2(p * q))}{N}} \qquad (1)$$

Where:

n: sample size, *Z*: confidence level, *p*: proportion of the population with the desired characteristic, *q*: proportion of the population without the desired characteristic, *e*: error level willing to commit, *N*: population size.Table 1, presents the description of each variable used in the development of the model (SEM).

Table 1.Social Abilities Questionnaire

Action	Variable	Construct
Having to speak to a teacher	A1	Interaction with authority figures (AA)
Write on the blackboard	A2	
Ask a question in class	A3	
Ask me the teacher in class	A4	
Start a conversation with the girl that i like	A5	Interaction with the opposite sex (AB)
To tell a girl whom i like something from her (example., his smile, his hair)	A6	
Give a kiss for the first time the girl that i like	A7	
Ask him to go out to the girl that i like	A8	
I make a joke in front of others	A9	Be in evidence (AC)
Make a fool of myself in front of others	A10	
I criticize	A11	
Stay without stuttering or voice, the voice that I tremble to speak	A12	
Telling a friend that does not take my things without my permission	A13	Assertive expression of discomfort (AD)
Tell a colleague who i did not like what he has said to me	A14	
Tell a partner who does not bother me when I am working	A15	
To tell a partner that is not always the center of attention	A16	
Being with other kids that don't know	A17	Interaction with strangers (AE)
Playing with a group of guys I know little	A18	
Ask for something to a colleague that almost don't know	A19	
Start talking with guys who don't know	A20	
Participate in a work of theater in the school	A21	Act in public (AF)
Singing in public	A22	
Dancing in front of people	A23	
Play a musical instrument in public	A24	

Source: authors elaboration

Results and discussion

Table 3, presents the results of the Kaiser Meyer Olkin (KMO) test, any KMO is below 0.5, which is why it can be said that factor analysis is valid. The evidence of sphericity rejected at any level of significance considering the results of the Bartlett's sphericity test, the matrix of correlations is not an identity matrix.
Table 3. Results of KMO and Bartlett's sphericity test

Construct	Variable	Measurement of sample adequacy of Kaiser - Meyer - Olkin (KMO)	Approximate Chi square	Bartlett's sphericity test	
				gl	sig
Interaction with authority figures (AA)	A1	,500	27,542	3	,000
	A2	,589	265,587	1	,000
	A3	,579	25,354	1	,000
	A4	,563	112,158	1	,000
Interaction with the opposite sex (AB)	A5	,561	121,589	3	,000
	A6	,532	120,541	1	,000
	A7	,534	107,687	1	,000
	A8	,522	35,547	1	,000
Be in evidence (AC)	A9	,501	36,214	3	,000
	A10	,598	115,897	1	,000
	A11	,554	263,874	1	,000
	A12	,565	24,654	1	,000
Assertive expression of discomfort (AD)	A13	,628	23,987	3	,000
	A14	,596	21,411	1	,000
	A15	,565	22,546	1	,000
	A16	,545	26,879	1	,000
Interaction with strangers (AE)	A17	,678	115,213	3	,000
	A18	,532	27,654	1	,000
	A19	,523	29,874	1	,000
	A20	,541	116,547	1	,000
Act in public (AF)	A21	,514	35,684	3	,000
	A22	,664	112,415	1	,000
	A23	,545	263,112	1	,000
	A24	,537	114,578	1	,000

Source: authors elaboration

In the construction of the SEM model was used the builder tool of the statistical software STATA 16(Stata, 2019). Was developed an analysis of main components of six constructs (interaction with authority figures, interaction with the opposite sex, be in evidence, assertive expression of discomfort, interaction with strangers and act in public). Figure 2, presents the model developed:

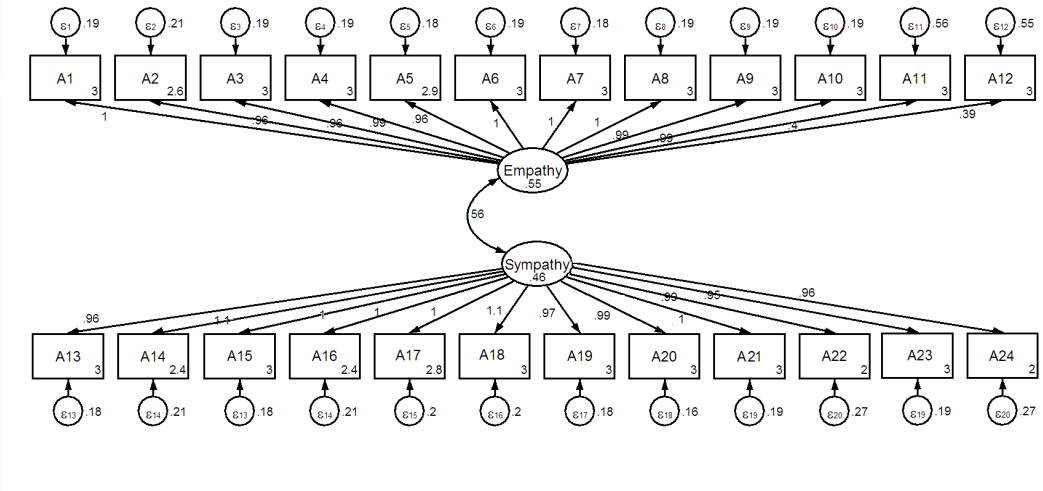

Figure 2. SEM model diagram

Table 5, presents the results of the goodness of fit test: Comparative Fit Index (CFI) and Tucker Lewis Index (TLI), which take values of 0.901 and 0,914 respectively, results that indicate a good fit. Finally, the Coefficient of determination was 0.85, is approaching 1 that indicates a good fit. The lower and upper limits of the statistic RMSEA are 0,051 and 0.25 respectively, which indicates that the setting is good. These results allow us to conclude that, the SEMs model developed is properly adjusted to data.

Table 5. Goodness-of-fit statistics of the estimated model

Fit statistic	Value	Description
Population error		
RMSEA	0.068	Root mean squared error of approximation
90 % CI, lower bound	0.051	
Upper bound	0.25	
p close	0.061	Probability RMSEA <= 0,05
Information criteria		
AIC	14614.413	Akaike's information criterion
BIC	17684.232	Bayesian information criterion
Baseline comparison		
CFI	0.901	Comparative fit index
TLI	0.914	Tucker-Levis index
Size of residuals		
SRMR	0.07	Standardized root mean squared residual
CD	0.85	Coefficient of determination

Source: authors elaboration

All the signs of the coefficients of the slopes are positive, indicating a strong and direct correlation between the latent variables and constructs. On the latent variable empathy, the construct that has greater influence is the interaction with the opposite sex, whose coefficient is 0.99 (average). For its part, the construct that affects most on the latent variable sympathy is the assertive expression of discomfort,with a coefficient of 1,01 (average). There is a direct relationship between the two latent variables (empathy and sympathy), which was estimated with a covariance of 56, indicating that both variables are strongly correlated.

Conclusions

Sport directly influences social cognition. The SEM developed in this work allows identifies the influence of the constructs; interaction with authority figures, interaction with the opposite sex, be in evidence, assertive expression of discomfort, interaction with strangers and act in public on the social cognition abilities. The model identified a positive relationship and direct link between the six constructs and the two latent variables considered (empathy and sympathy). It has also identified a direct correlation between the two latent variables analyzed, for which an increase or decrease in any of them, will generate the same effect in the other.

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