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Ice Hockey Goaltender Performance: Examining The Role Of Basic Psychological Needs And Self-Determined Motivation

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ICE HOCKEY GOALTENDER PERFORMANCE: EXAMINING THE ROLE OF BASIC PSYCHOLOGICAL NEEDS AND SELF-DETERMINED MOTIVATION

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Nathan Dean Speidel
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To generations of misunderstood, under-coached, and sometimes even mistreated ice hockey goaltenders, and to those who envision something better.

ABSTRACT

Ice hockey goaltending is a physically and mentally challenging task within a complex sport. Although goaltending has been shown to contribute more to team success outcomes than any other ice hockey position, goalies are often misunderstood and either under or improperly coached. As a result, goaltenders, coaches, parents, and hockey organizations alike express a need for deeper understanding of the position, especially its mental aspects. Motivation has long been considered a foundational factor for athletic success and continues to be recognized as essential for athlete performance and overall well-being. Therefore, the purpose of this study was to analyze fundamental psychosocial aspects of goaltending by measuring basic psychological needs satisfaction (BPNS), self-determined motivation, and assess how these factors relate to performance.

North American and international ice hockey goaltenders ($N = 180$) ages 18 and older completed a survey measuring participant characteristics, social factors (i.e., number of parents who played hockey and frequency of goalie coaching received), BPNS, motivation, perceived success, and performance. For each measure, descriptive statistics, exploratory factory analysis, and Cronbach's alpha tested for reliability and validity within the context of goaltending. Differences in key study variables were assessed across gender, level of play, starting status (i.e., starter, second string, third string), and number of parents who played hockey. Multiple regressions measured the degree to which social factors, BPNS, motivation, and other covariates predicted goaltender perceived success and performance.

Results indicate that, while elite goaltender BPNS, autonomous motivation, and perceived success levels were high, so too were their controlled motivation and amotivation. BPNS and motivation types differed significantly across level of play and starting status, where professionals and starting goalies demonstrated most optimal psychological and performance outcomes while college and second-string goalies scored lowest. Additionally, social influences such as number of parents who had played hockey negatively associated with psychological and performance constructs, while, conversely, frequency of goalie coaching associated positively. Congruent with SDT, autonomy and relatedness positively predicted autonomous motivation, and competence negatively predicted amotivation. Surprisingly, however, autonomy predicted (nearing significance) an increase in controlled motivation. Finally, social variables, BPNS, and motivation types predicted performance as measured by games played and recent game performance but not by goals against average nor save percentage.

In conclusion, autonomous supportive coaching provides a viable framework for applying the tenants of SDT to sports and, more specifically, ice hockey goaltending. Study findings inform the hockey community how to better support goaltender development within psychosocial contexts and will guide goalie coach education efforts.

Keywords: ice hockey goalie, sports psychology, motivation, performance, basic psychological needs, self-determination theory

CHAPTER I:

INTRODUCTION

Ice hockey goaltending is a physically (Wörner et al., 2019; 2021) and mentally (Gelinas & Munroe-Chandlier, 2006; Miller, 2001; Monnich, 2021; Porter, 2003; Vehviläinen, 2012) challenging role. Goalies have the largest positional impact on team success outcomes (Chan et al., 2012), and therefore the pressure, responsibility, and high-stakes nature of goaltending can result in exceptional levels of stress and anxiety (Gelinas & Munroe-Chandler, 2006; Monnich, 2021; Vehviläinen, 2012). Unlike other hockey positions, goaltenders remain on the ice the entire game and are confined to the area in and around the goal crease. Not only is their job important to team success, but their mistakes – especially those leading to a goal against – are obvious. Furthermore, many aspects of goaltending are reactive in nature and therefore out of a goaltender's control (Clark & Luongo, 2010; Monnich, 2021; USA Hockey, 2020). This largely responsive element of goaltending further distinguishes the position from others in hockey and throughout much of sport. According to authors and professional goalie coaches, Valley and Goldman (2016):

> As a goaltender, you carry a hefty burden on your shoulders. Others may not see it, but you've chosen to face an extensive amount of pressure as the last line of defense. Because of this, you're forced to battle your own mind on a daily basis. Self-doubt, the ebbs and flows of your confidence, the constant fear of failure, and the frustration attached to the physical beatdowns is like a torrential downpour of highs and lows. If you cannot exhibit great mental control and emotional stability, the position can lead you to a very dark place (p. ix).

To provide context around the goaltender psychosocial experience, consider the following scenario: As young as age five, while most hockey players are still learning to skate, an athlete may be presented an opportunity to play in net. This experience will likely involve many novel and even dangerous situations, given the high speeds at which the puck travels. First, the degree to which an athlete is granted choice in this decision to play goalie is critical. Perhaps he or she has long been interested in the position; alternatively, goaltending may seem altogether frightening or otherwise unwelcomed. In either case, one can imagine an athlete's volition impacts the quality of his or her experience, especially in a high-pressure role. Secondly, this specialized job requires equally unique and often expensive equipment. Protective goalie gear, such as goalie-specific skates, leg pads, gloves, helmet, chest protector, stick – and more for the elite goaltender – can feel cumbersome and foreign. Unique skating, positioning, and save techniques are now introduced, all while the goaltender acclimates to new gear.

From the beginning moments of goaltending and throughout a goalie's career, success requires the learning of new and position-specific competencies within a fast-evolving position (Hynes & Smith, 2015). Furthermore, goaltending is among a subset of sport positions that require performing on both an individual and team level. The team and coaches' heavy reliance on a goaltender's performance (Chan et al., 2012) impacts social and emotional dynamics (Battaglia et al., 2018). Finally, goaltending is high stake; historically, only one goalie plays per team per game and, unless pulled, plays the entire time. At the higher levels, one goalie is often chosen as the team's starter, making the other goaltenders' futures uncertain. Compound these and other challenges with the inherent safety risk of goaltending, one can imagine the unique psychological and social complexities of the position.

According to USA Hockey's (2021a) Director of Goaltending, Steve Thompson, indeed many coaches and parents feel ill-prepared to support their goalies and, as a result, intentionally or unintentionally neglect their development. This coaching tendency is understandable, as goaltending is a minority position in hockey; therefore, teams are less likely to possess coaching staff members who have played the position themselves. Despite a coach or parent's own experience in net, goaltending has built a distinct reputation amidst the hockey and sports world. "Goalies are voodoo" (Naples et al., 2018, p. 23) epitomizes a persistent goalie mystique within hockey culture, perhaps given the unique nature of their task, evolution of gear (e.g., Hynes & Smith, 2015), and minority status.

As a result of these coaching deficiencies and goaltender's largely unmet developmental needs, USA Hockey (2021a) has begun new initiatives aimed at goaltender and goalie coach training. More recently, USA Hockey Goaltending has provided opportunities for goalie bronze, silver, and gold coaching certifications (https://www.usahockeygoaltending.com/) through both virtual and in-person education. While these programs are a necessary and excellent start, they are still in their emerging stages and would be significantly bolstered by empirical support, especially around the mental aspects of the position (Thompson, as cited in Monnich 2021). Other independent organizations have started their own work in addressing the mental challenges of goaltending. For example, a non-profit called Lift the Mask (Goldman, 2020) has committed resources and financial support specifically for goaltender mental health. While mental skills and mental health are not synonymous, the formation of these and other organizations imply a need for better understanding of and support for goaltenders and those impacting their psychosocial experiences.

In response to the needs cited above and empirical research deficit around goaltending, the current study examined goaltender psychological needs and motivation. Results will serve as a scholarly contribution to goalie education, performance, and, perhaps to a lesser extent, mental health initiatives. Next, a brief overview of emergent goaltender mental skills scholarship as well as a proposed motivation framework will be provided.

Background Research

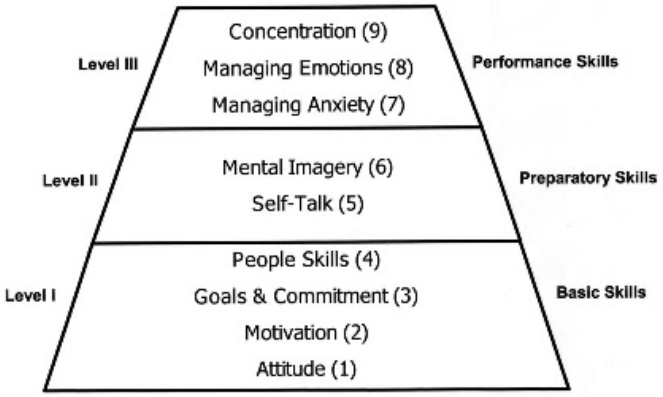
Only recently has empirical research on the mental aspect of goaltending emerged. In 2021, Monnich published a landmark mixed methods study of $N = 115$ ice hockey goalies and goalie coaches (N=35 active goalies and N=80 goalie coaches, all but two of whom played goalie at some point in their life) to determine mental challenges faced by goaltenders along with mental skills they deemed important in handling such challenges. Survey, interview, and focus group results indicated that almost all participants perceived mental challenges as pervasive. These challenges included maintaining focus or concentration, controlling emotions, recovering after allowing a goal, performing consistently, controlling thoughts, anxiety, nervousness, or fear, and dealing with negative thoughts. Other themes emerged such as staying in the present moment, anxiety/doubt, self-awareness, self-improvement, confidence, and competitive attitude.

Survey results indicated that goaltenders see mental skills as important; however, interview and focus group data revealed a great disparity between the mental challenges faced by goalies and their ability to effectively utilize the mental skills and techniques necessary to mitigate them. The most desired mental skills included staying focused, controlling thoughts, arousal regulation, controlling emotions, using self-talk, setting goals, using imagery, and recovering from failure. Such results support Lesyk's (1998) seminal athlete mental skills model

(Figure 1) and further indicate a need for goalies and goalie coaches to better understand and properly address these psychological challenges.

Figure 1

The Nine Mental Skills of Successful Athletes Pyramid



Note: From "The Nine Mental Skills of Successful Athletes," by J. J. Lesyk, 1998, *Annual Conference of the Association for the Advancement of Applied Sports Psychology*, Hyannis. MA (https://www.sportpsych.org/nine-mental-skills-overview). Copyright 1998 by Ohio Center for Sport Psychology.

Adding to empirical goaltender literature and further highlighting the nuances of the goaltending psychosocial experience, Battaglia et al. (2018) qualitatively studied seven youth ice hockey goaltenders' emotions when being removed from a game and replaced by the backup goaltender; this is otherwise known as being *pulled*. Emerging themes from this research included goalies' decreased feelings of self-worth, feeling outcast from teammates, and detrimental effects on relations with teammates and coaches, these especially when being pulled as a form of punishment. As a result, the researchers identified four overarching goalie narratives as follows: the *skate of shame,* the *banished bench*, the *lonely locker room*, and the *silent celebration*. Expanding on these motifs is beyond the scope of this paper; however, one can further gather the social and psychological challenges implied by the above descriptors, especially for goalies who have recently been pulled or receive little to no playing time.

As hypothesized in this study, measuring goaltenders' basic psychological needs, motivation, and their relationship with performance may serve as foundational for further understanding goaltenders, properly supporting them and their coaching, and, as a result, potentially improving both goaltender and team performance. Next, self-determination theory will be introduced as a viable framework for analyzing psychosocial and performance aspects of ice hockey goaltending.

Theoretical Framework Overview

Much attention has been given to the study of human motivation, and findings consistently point toward motivation as key to one's productivity, happiness, and ability to work well with others (Eccles, 2005; Elliot, 1999; Graham & Williams, 2009; McKeachie, 1997; Ryan & Deci, 2000; Ryan & Deci, 2017; Stupnisky et al., 2018; Vallerand & Losier, 1999; Van Etten & Pressley, 2008). Additionally, motivation has long been considered a foundational factor for athletic success (Lesyk, 1998; see Figure 1) and continues to be recognized as essential for athlete performance and overall well-being (Standage & Ryan, 2019).

Sports motivation has been reviewed (Standage & Ryan, 2019; Taylor, 2015) and empirically studied across multiple sport types (e.g., Gillet et al., 2009; Hardwood et al., 2004; Lemyre et al., 2006, Li et al., 2019; Vallerand & Losier, 1999), in tennis (Balaguer et al., 2011), table tennis (Martinent & Decret, 2015), handball (Isoard-Gautheur et al., 2016), gymnastics (Gagné, 2003), and others. However, relatively few psychology studies have focused on ice hockey players and even less on ice hockey goaltenders. Of the goalie-specific works, most are either broadly conceptual in nature or primarily supported by anecdotal evidence. For instance, Goldman and Valley (2014; 2016; 2021) utilized interviews of world-renowned goaltenders to provide insights around the physical, social, and psychological aspects of elite-level goaltending.

Other similar works (e.g., Druzin, 2013; Goldman, 2015) use interviews and personal experiences to disseminate world-leading goalie and goalie coach perspectives. Additionally, several goalie mental training literature reviews have been made accessible (Nordman, 2013; Sipponen, 2018; Vehviläinen, 2012), most of which mention, but neither measure nor deeply elaborate upon empirically-established motivation frameworks. The above sources serve as helpful and necessary starting points in better understanding ice hockey goaltenders; however, there is a clear need for more rigorous, empirical scholarship around the psychosocial aspects of goaltender motivation and performance.

Self-determination theory

Self-determination theory (SDT) is a leading perspective that explains psychological and social factors surrounding human motivation. SDT posits that the degree to which human beings remain naturally curious, engaged, and self-motivated is largely a function of social-contextual conditions (Ryan & Deci, 2000); more specifically, motivation types are predicated upon the degree to which one's basic psychosocial needs (BSNs) of autonomy, competence, and relatedness are either satisfied or frustrated. These BSNs are as follows: *autonomy* is measured by the degree to which one perceives an experience as self-endorsed, purposefully enacted, self-controlled, and whole-heartedly chosen; *competence* can be described as one's perceived ability to successfully carry out a task, sense of efficacy, or believed effectiveness; and *relatedness* is a term embodying how "close, connected, and cared for by important others" one feels (Standage & Ryan, 2019, p. 4) within a particular environment. These BSNs, now defined, parallel many of the themes presented in the goalie experience narrative presented earlier in this chapter. For example, a goaltender's autonomy might manifest in their sense of control surrounding if and how they play the position, competence through the building of position-specific knowledge and

techniques, and relatedness within the often-high-pressure social interactions with teammates, coaches, and parents.

According to SDT, satisfaction of these BSNs predicts higher quality, more self-determined forms of motivation and, in turn, adaptive cognitive, behavioral, and affective outcomes (De Francisco et al., 2018; Ryan & Deci, 2017; Standage & Ryan, 2019). Although previously considered a singular construct, SDT places motivation types on a continuum from intrinsic motivation to amotivation, with intermediate external regulations between (Figure 2).

Figure 2

Self-Determination Continuum with Controlled and Autonomous Motivation Types

TYPE OF MOTIVATION	AMOTIVATION	EXTRINSIC MOTIVATION				INTRINSIC MOTIVATION
TYPE OF REGULATION	Non-regulation	External	Introjection	Identified	Integration	Intrinsic
PERCEIVED LOCUS OF CAUSALITY	Impersonal	External	Somewhat external	Somewhat internal	Internal	Internal
INTERNALIZATION	No	No	Partial	Almost full	Full	Not required
POSITION ON THE AUTONOMY CONTINUUM		← Controlled Motivation →		← Autonomous Motivation →		
DEFINING FEATURES	Lack of intention to act and personal causation	Behave to obtain reward; to avoid punishment or meet external demands	Action to avoid guilt and shame and to attain ego-enhancements and feelings of worth	Action is personally valued / important	Action is identified and aligned with other aspects of the self	Action is based on interest and inherent satisfaction
MOTIVATIONAL QUALITY	Low ←					→ High

Note: From "Self-determination Theory in Sport and Exercise," by M. Standage and R.M. Ryan, in G. Tenenbaum and R.C. Eklund (Eds.), *Handbook of Sport Psychology* (4th ed., pp. 37-56), 2020, John Wiley & Sons, Inc. Copyright 2020 by John Wiley & Sons, Inc.

Intrinsic motivation is a propensity to work at novel tasks out of pure curiosity, enjoyment, and love of learning. *Extrinsic motivation*, on the other hand, is motivation that stems from a secondary aspect of a task (e.g., tangible rewards, avoidance of punishment, negative emotion, evaluation, deadlines) and, unlike intrinsic motivation, not for the inherent sake of the task itself. *Amotivation* is a lack of motivation – a state of passivity, disengagement, and inaction (Ryan & Deci, 2000). In contemporary SDT, Deci and Deci (e.g., 2006, 2017) have aggregated identified, integrated, and intrinsic regulations into *autonomous motivation*. Introjected and external regulatory styles are composited and referred to as *controlled motivation*. *Amotivation* remains its own non-regulated and impersonal construct (see Figure 2). It follows that autonomous motivation can be characterized by an authentic valuing of a task in which one "wholeheartedly endorse[s]…or owns" (Ryan & Deci, 2006, p. 1561) participation. Therefore, controlled motivation can be distinguished by one's desire to act due to motives outside or non-congruent with the self (Ryan & Deci, 2006).

Various literature reviews (Cece et al., 2018; Ntoumanis, 2012; Standage & Ryan, 2019), suggest that relatively little research has focused on how basic psychological needs satisfaction (BSNS) and motivation types affect athletes' objective performance, however. Given that a primary purpose of SDT-centered research is to better understand the psychosocial factors that enhance – or undermine – intrinsic motivation, self-regulation, and well-being (Ryan & Deci, 2000), the study of goaltender BPNS and motivation appears to be an excellent starting point for understanding the goaltender psychosocial experience and the relationship these psychological factors have with performance. With performance as a key study variable, issues with traditional goaltender performance metrics and potential need for alternatives will be presented in the following section.

Issues with Measuring Goaltender Performance

Since the advent of baseball's *sabermetrics* – defined as the use of statistics to deeply analyze player performance and team management (Wolfe et al., 2006), also known as *Moneyball* (Lewis, 2004) – other sports have increasingly adopted this analytical approach over more subjective systems of the past (Porreca & Rocco, 2016). Hockey, although a relatively late adopter, realized significant analytic advancements during the 1990's and early 2000's (Nandakumar & Jensen, 2019). A few notable hockey-specific analytics studies involve modeling the goal-scoring process (Mullet, 1977), the impacts of puck possession and location on hockey strategy (Thomas, 2006), modeling the win-loss percentage using a function of goals scored or allowed (Cochran and Blackstock, 2009), quantifying the contribution of NHL player types to team performance (Chan et al., 2012), and strategies for pulling the goalie (Beaudoin & Swartz, 2010), to name a few.

Throughout many of those studies there emerged a clear distinction between goaltender and non-goaltender positions. First, there exists a disparity between the number of goalie-specific studies and the disproportional impact goaltending has on team success (Chan et al., 2012). Second, separate goaltender performance statistics are used such as classic save percentage, goals against average, and shutouts (Nandakumar & Jensen, 2019), as well as more contemporary metrics such as all shot attempts, clean shots, expected goal models, and hot zones which weights shot attempts by location of release and shot type (Naples et al., 2018). Describing each metric in detail is beyond the scope of this paper; however, such distinction in player profiling and performance metrics alone suggest goaltending as a unique role warranting the use of both team and goalie-specific analytics. Yet, both goalie coaching and reliability quantifying goaltender performance lags (Nandakumar & Jensen, 2019; Naples et al., 2018).

Such a realization affirms a need for improved goalie-specific analytics as well as a deeper understanding of how psychological and social factors might relate to goaltender performance.

The National Hockey League (NHL) provides publicly accessible goaltender performance statistics dating back to 1997 (see http://www.nhl.com/stats/goalies). These metrics are helpful but lack the specificity needed to make analytics truly "*transformative*, altering existing teaching, [coaching], learning, and assessment processes" (Siemens & Long, 2011, p. 38). Professional and recreational hockey analytics such as moneypuck.com, PuckIQ, hockeyviz.com, corsicahockey.com, Hockey Reference, Natural Stat Trick, hockeyanalytics.com, puckerings.com, Hockey Analysis Group (Mason & Foster, 2007) and others (see Nandakumar & Jensen, 2019), have also become instrumental in providing open-sourced datasets and analyses to the public. Sheps (2020) considers this growing online community essential to counter the current culture of hockey analytics resistance, especially felt with "established hockey media personalities [aka the 'Hockey Men']" (p. 92). Naples et al. (2018) agreed, attributing the NHL's analytics resistance to former professional players as team managers, many of whom have not possessed higher degrees and therefore remain opposed to both learning and promoting necessary data analytics literacy. Several writers and researchers implore the NHL and hockey community at large to better utilize and "apply sophisticated analytical methods" (Chan et al., 2012, p. 142) while remaining mindful of the players and coaches whom a Moneyball-like approach will affect. Others agree that better use of analytics is necessary but that limiting factors exist such as a lack of tracking technologies, cost, data availability and usefulness, lack of player cooperation in producing new data, and a general unwillingness of league insiders to adopt a "Moneypuck" (Porreca & Rocco, 2016, p. 6) culture (Mason & Foster, 2007).

Although classic save percentage and goals against average have long been used as the primary goalie performance metrics, their true goalie performance representativeness remains questionable. In their statistical evaluation of NHL goalie performance measures, Naples et al. (2018) found that classic save percentage had weak intra-season consistency of $R = 0.145$ over six seasons; in other words, a goalie's save percentage in one season only weakly predicted their save percentage in future seasons. This was especially evident if the goalie was traded to a new team. Goaltender performance measures such as clean shots, all shot attempts, performance against expected goals, and hot zones appeared to represent goalie performance more reliably. Current available programs such as InStat (https://instatsport.com/hockey) and SIG Gameday (https://stopitgoaltending.com/services-2/) provide platforms which utilize these more sophisticated goaltender analytics. However, as referenced earlier, the time, cost, and data required to track these metrics present significant barriers to their adoption, especially at the non-professional levels.

As a result of their universality and accessibility, save percentage and goals against average were used as objective performance measures within this study. As recommended by Daccord (2021), number of games played was included as a performance variable as was a self-reported performance Likert rating of goaltenders' most recent games and perceived success. Assessing the validity and reliability of classic goaltender metrics such as save percentage, goals against average, and games played was not a principal focus of this study. Yet, relationships between these and other psychological measures served a secondary, more exploratory medium for understanding and improving goalie performance metrics and will be further discussed in the following chapters.

Purpose of the Study

Utilizing self-determination theory as the primary framework, this study aimed to measure goaltender social influences, BPNS, motivation, and assess the relationship these factors have with goaltender perceived success and performance. Results will contribute to the small but growing body of empirical ice hockey goaltending literature and will be used to educate coaches and parents on how to better understand and more optimally support these athletes. See below the research questions that are addressed within this study:

Research Questions

RQ_1: What are goaltenders' levels of BPNS, motivation, perceived success, and performance as measured by save percentage, goals against average, number of games played, and recent game performance?

RQ_2: What are the relationships between social factors, BPNS, motivation, perceived success, performance, and social influences (i.e., number of parents who played hockey and frequency of goalie coaching received)?

RQ_3: Are there significant differences in BPNS and/or motivation across gender, level of play, starter status, and/or number of parents who played hockey?

RQ_4: Do social factors such as frequency of goalie coaching received and/or number of parents who played hockey predict BPNS?

RQ_5: Do social factors and/or BPNS predict goalie motivation?

RQ_6: Do social factors, BPNS, and/or motivation predict goaltender perceived success?

RQ_7: Do social factors, BPNS, and/or motivation predict goaltender performance as measured by save percentage, goals against average, games played, or recent game performance, beyond the effects of age, gender, covid, BMI, and injury?

Note that the inclusion of primary, secondary, and control variables are either justified within the literature review or otherwise rationalized throughout this manuscript. The decision to use BMI within performance analyses was made due to both its logical association with physical activity and the use of BMI and other body composition metric controls in peer reviewed ice hockey performance studies such as Fitzgerald et al, 2018, Gilenstam et al, 2011, and Peterson et al., 2015, to name a few.

Definition of Terms

The following section will define frequently used terms used within this study:

Amotivation – a lack of motivation – a state of passivity, disengagement, and inaction (Ryan & Deci, 2000).

Autonomy – the degree to which one perceives an experience as self-endorsed, purposefully. enacted, self-controlled, and whole-heartedly chosen (Ryan & Deci, 2000).

Autonomous motivation – aggregation of identified, integrated, and intrinsic regulations characterized by an authentic valuing of a task in which one "wholeheartedly endorse[s]…or owns" (Ryan & Deci, 2006, p. 1561).

Autonomous supportive coaching – a style of coaching characterized by coaching practices such as inviting athlete participation in decision making processes, acknwledging athlete emotions, providing choices, and taking personal interest in their athletes (De Francisco et al., 2018).

Basic psychological needs (BPN) – autonomy, competence, and relatedness (Ryan & Deci, 2000).

Basic psychological needs satisfaction (BPNS) – social influences bolstering the three basic psychological needs of autonomy, competence, and/or relatedness (Ryan & Deci, 2000).

Basic psychological needs theory - a cornerstone to and sub-theory of SDT, basic psychological needs theory (BPNT) unifies all other SDT sub-theories (Standage & Ryan, 2019), positing that people have a general predisposition to be curious, engaged, and self-determined so long as three innate needs of autonomy, competence, and relatedness are met.

Basic psychological needs thwarting (BPNT) – social influences compromising the three basic psychological needs of autonomy, competence, and/or relatedness (Ryan & Deci, 2000).

Body mass index (BMI) – a measure of fitness calculated by the ratio of weight to height.

Catch Hand – which hand, left or right, a goalie uses to hold their glove.

Competence – one's perceived ability to successfully carry out a particular task, sense of efficacy, or effectiveness within an environment (Ryan & Deci, 2000).

Competitive play – goalies who were playing or had played in a recognized HS, AAA, junior, college, semi-professional, or professional league in the US or abroad within either the 2019-2020 and/or 2020-2021 seasons. This was not intended to include recreational leagues.

Controlled motivation – a composition of introjected and external regulatory styles characterized by one's desire to act due to motives outside or non-congruent with the self (Ryan & Deci, 2006).

Extrinsic motivation – motivation that stems from a secondary aspect of a task (Ryan & Deci, 2000).

Flow state – mental state resulting from a balance between the challenge of a task and one's skills, clarity of the goal, clear and immediate feedback, high concentration on the task at hand, merging of action and awareness, a high sense of control, and an altered sense of time (Csikszentmihalyi, 1990).

Games played – total number of games a goalie played in their most recent season.

Games played proportion– percent of total team games in which a goalie has played during their most recent season.

Goals against average (GAA) – total number of goals against divided by number of games played.

Intrinsic motivation – a propensity to work at novel tasks out of pure curiosity, enjoyment, and love of learning (Ryan & Deci, 2000).

Motivation – "what moves people to act" (Ryan & Standage, 2019, p. 2) as well as "the energizing, direction, regulation, and persistence of behavior" (Ryan & Deci, 2017, as cited in Ryan & Standage, 2019, p. 2).

Perceived success – the degree to which a goaltender feels successful as in their performance, progress, achievements, and as a goalie overall (adapted from Roberts et al., 1998).

Performance – quantifiable measures of goaltender's effectiveness such as number of games played, save percentage, goals against average, and most recent game self-rated performance.

Relatedness – how "close, connected, and cared for by important others" one feels (Standage & Ryan, 2019, p. 4).

Relationships motivation theory (RMT) – a sub-theory of SDT, which posits that social supports for autonomy are key for important relationships to flourish and to support positive human outcomes (Standage & Ryan, 2019).

Self-determination theory (SDT) – a leading theory that explains psychological and social factors surrounding human motivation (Ryan & Deci, 2000).

Save percentage (SV%) – number of saves (number of shots minus number of goals) divided by the total number of shots faced, sometimes multiplied by 100 to produce a percentage.

Assumptions

This study assumed that participants were North American and international ice hockey goaltenders 18 years of age or older actively playing within the 2020 – 2021 season and/or who had played in the 2019 – 2020 season. Survey questions were assumed to be understood by participants and responses truthful and accurate.

Delimitations

The study sample was bound to active (i.e., 2020 – 2021 season) or recently active (i.e., 2019 – 2020 season) North American and international ice hockey goaltenders ages 18 and older. Participants belonged to high school, midget AAA, junior, college, semi-professional, or professional leagues. These delimitations were made to include only goaltenders who have advanced past youth leagues and into higher, more competitive levels of hockey. In this way, results provide insights into the performance and psychological factors that may differentiate these elite level athletes from other recreational or amateur levels. Additionally, delimiting participants to those who have actively played within the most current seasons was intended to minimize time between survey response and goaltenders' recalled psychological and performance experiences. In an effort to promote transparency, the next section will provide some brief information about the researcher.

Researcher Background

Nate Speidel was born and raised in Hazen, ND where he played youth and high school hockey, almost entirely as a goaltender. After high school, Nate played NAHL Tier II junior hockey with the Bismarck Bobcats and then NCAA D3 college hockey at Saint John's University. His current work involves year-round goalie training and program consulting as founder and owner of Goalrobber Hockey Schools (https://www.goalrobber.com/) and as North

Dakota's USA Hockey Goalie Development Coordinator. Nate coaches with his local youth hockey organizations, high schools, and the University of Mary men's hockey program. He is completing his Ph.D. in quantitative educational research with a focus on human motivation and ice hockey goaltender performance. In prior years, Nate taught high school mathematics, coached chess, and consulted school accreditation efforts at Shiloh Christian School in Bismarck, ND. As a goalie coach and goalie consulting business owner, Nate acknowledges the inherent biases that may influence his research. Therefore, special attention was given to transparency throughout study planning, executing, and reporting.

Summary

Ice hockey goaltending is a unique and challenging position in the world of sports (Druzin, 2013; Fry, 2017; Gelinas & Munroe-Chandler, 2006; Monnich, 2021; Sipponnen, 2018; Vehviläinen, 2012). A goaltender's job is high stakes and most impactful on team success outcomes (Chan et al., 2012). They serve as the last line of defense, and their playing time is both highly competitive and potentially volatile. As a result, goaltenders may be subject to exceptional levels of pressure, stress, and anxiety (Goldman, 2015; Goldman & Valley, 2014; 2016; 2021; Monnich, 2021; USA Hockey, 2020). Additionally, goalies and goalie coaches have expressed challenges in goaltenders' abilities to control their thoughts and emotions while lacking the mental skills to overcome such mental obstacles (Monnich, 2021). Despite many helpful books and interviews written about goaltending (e.g., Druzin, 2013; Fry, 2017; Gelinas & Munroe-Chandler, 2006; Goldman, 2015; Goldman and Valley, 2014; 2016; 2021; Sipponnen, 2018; Vehviläinen, 2012) and goalie coach education initiatives recently begun (USA Hockey, 2021a), relatively little empirical work has been conducted on hockey goaltender psychology and almost none on motivation. Therefore, the purpose of this study is to better understand the

psychosocial aspects of goaltending by measuring goaltenders' BPNS, self-determined motivation, and assess how these factors relate to goaltender goaltender's perceived success and performance. A SDT framework will be utilized. The findings will contribute to empirical goaltender literature and will be used to develop empirically-based goalie coaching education for coaches, parents, and hockey organizations on how to better support these athletes.

Chapter I has outlined the need, purpose, research questions, theoretical framework introduction, significance, delimitations, limitations, terms, and assumptions for the study. In Chapter II, an in-depth review of the literature on SDT, motivation in sport, goaltender psychological skills, goaltender performance, and motivation in the context of ice hockey will be provided. Chapter III is an explanation of research methodology, population, pilot study, and data collection procedures. Chapters IV and V will provide analysis and discussion of the results, respectively, as well as implications for future research.

CHAPTER II:

LITERATURE REVIEW

In this chapter, SDT will be further proposed as a leading motivational metatheory. First, BPNs and self-determined motivation are more deeply reviewed and SDT literature presented in the context of sport. Research surrounding BPNs and self-determined motivation in hockey as well as psychological skills in goaltending are reported. Additionally, moderating factors such as age, gender, sport type, level of play, and autonomy supportive coaching are provided, as are discrepancies within SDT research. Finally, a literature review of R and R Studio is presented to justify primary statistical software chosen for this study.

Self-determination Theory

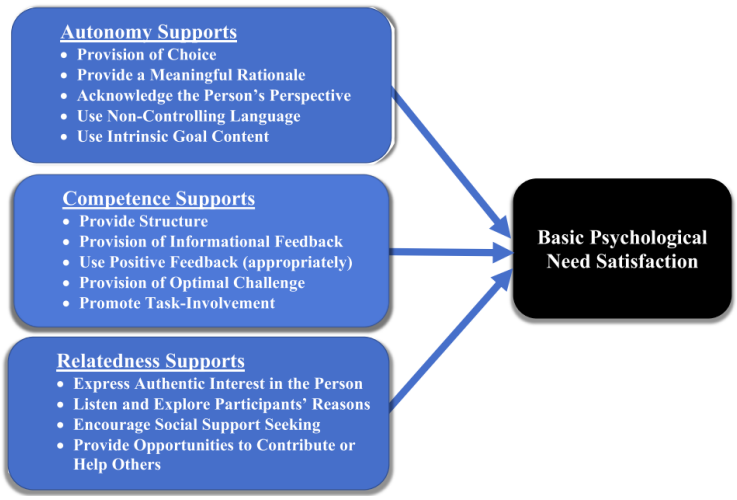
Numerous theoretical frameworks about motivation have emerged including self-determination theory (Ryan & Deci, 2000), subjective task value theory (Eccles, 2005), attribution theory (Graham & Williams, 2009), normative goal theory (Elliot, 1999) and others. Of these, SDT has remained among the leading motivation and personality models for nearly 40 years (Hagger & Chatzisarantis, 2007; Howard et al., 2017; Ntoumanis, 2012; Ryan & Deci, 2017; Standage & Ryan, 2019). The purpose of SDT research is to better understand the psychosocial factors that enhance – or undermine – intrinsic motivation, self-regulation, and well-being (Ryan & Deci, 2000), as well as how the quality of behavioral regulations predict a wide range of human behavior outcomes (Deci & Ryan, 1997; Standage & Ryan, 2019). First, BPNs and basic psychological needs theory will be presented as the modality by which social influencers are theorized to predict motivation and other human behavior-related outcomes.

Basic Psychological Needs

As both a cornerstone to and sub-theory of SDT, basic psychological needs theory unifies all other SDT sub-theories (Standage & Ryan, 2019), positing that people have a general predisposition to be curious, engaged, and self-determined so long as three innate needs are met: (1) *Autonomy* – a sense of self-endorsement, purposeful enactment, and self-control, (2) *Competence* – one's perceived ability to successfully carry out a particular task, sense of efficacy, or perceived effectiveness within an environment, and (3) *Relatedness* – feeling "close, connected, and cared for by important others (Standage & Ryan, 2019, p. 4). Basic psychological needs theory asserts that the degree to which social contexts satisfy or frustrate these needs, in addition to the value one places on a specific task itself (i.e., congruence to identity and authentic self), predicts human well-being as well as the magnitude and quality of motivation (Ryan & Deci, 2000, 2017).

Figure 3

Basic Psychological Needs Concept Map with Supports



Note: From "Self-determination Theory in Sport and Exercise," by M. Standage and R.M. Ryan, in G. Tenenbaum and R.C. Eklund (Eds.), *Handbook of Sport Psychology* (4th ed., pp. 37-56), 2020, John Wiley & Sons, Inc. Copyright 2020 by John Wiley & Sons, Inc.

Figure 3 depicts the BPNs and strategies which support their satisfaction. In the case that these needs are actively thwarted or frustrated, people are likely to experience ill-being and sub-optimal performance and development. It is worth emphasizing SDT's position that human beings are naturally self-motivated and curious, possessing a predisposition to pursue worthwhile and even difficult tasks (Ryan & Deci, 2000). These tendencies of engagement, however, can either be upheld or forestalled by the degree to which social conditions either support and/or actively thwart each person's innate BPNs. The next section delineates the various SDT motivation types, which, as mentioned previously, are theorized to manifest according to the degree one's BPNs are satisfied.

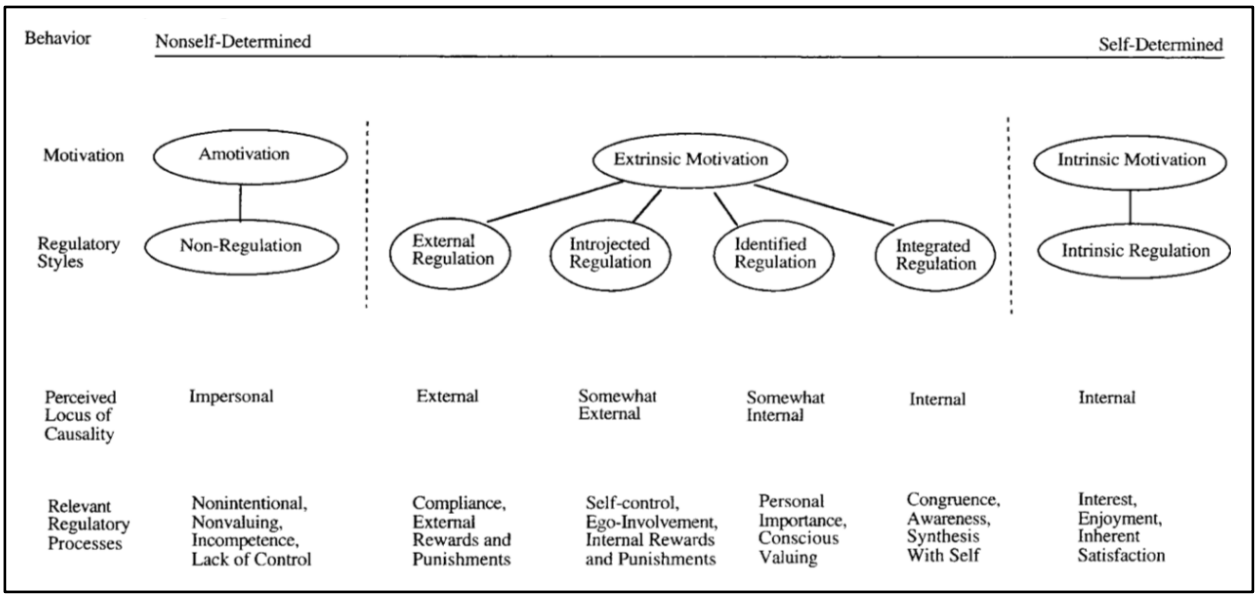
Self-determined Motivation

At a basic level, *intrinsic motivation* is a propensity to work at novel tasks out of pure curiosity, enjoyment, and love of learning. Those who are intrinsically motivated engage in an activity for its own sake and not as a means to another end. Children naturally display these intrinsic tendencies from birth, which serve as "a principal source of enjoyment and vitality throughout life" (Ryan & Deci, 2000, p. 70). *Extrinsic motivation*, on the other hand, is motivation that stems from a secondary aspect of a task (e.g., tangible rewards, avoidance of punishment, negative emotion, evaluation, deadlines) and, unlike intrinsic motivation, not for the inherent sake of the task itself. *Amotivation* is a lack of motivation – a state of passivity, disengagement, and inaction. Although many theories (e.g., Bandura, 1997) treat motivation as a unitary or dichotomous concept (Ryan & Deci, 2000; Standage & Ryan, 2019), Deci and Ryan (1985) pioneered a SDT sub-theory called organismic integration theory (OIT) which expands motivation from a singular construct by way of disaggregating extrinsic motivation into regulatory subcategories based on their perceived level of autonomy, locus of causality (i.e.,

caused by self or by external forces), and internalization (i.e., the degree to which the activity is congruent with one's values and self). See Figure 4 for a visual of this quality-based motivation continuum.

Figure 4

The Self-Determination Continuum



Note: From "Self-determination Theory and the Facilitations of Intrinsic Motivation, Social Development, and Well-being," R.M. Ryan and E.L. Deci (2000). American Psychologist, 55(1), 68-78. Copyright 2020 by American Psychological Association, Inc. https://doi.org/10.1037/0003-066X.55.1.68

In descending order of self-determination, these delineated regulations include intrinsic, integrated, identified, introjected, and external. As stated earlier, *intrinsic regulation* is experienced by those who are interested in and inherently satisfied by a task for the sake of itself. One might partake in an intrinsically motivating activity out of enjoyment, fun, or pure curiosity. On the self-determination continuum, intrinsic motivation is considered the quintessence of motivation (Ryan & Deci, 2000), both serving as the highest quality and most sustainable type (Standage & Ryan, 2019). *Integrated regulation* is the most autonomous (i.e., self-endorsed) of

the extrinsic regulatory styles, in which regulations have been made fully assimilated to other aspects of authentic self and congruent with deep-seated values, goals, and needs. However, integrated regulation can be distinguished from intrinsic regulation by the fact that the immediate action still serves, at least in part, as a means to a separate end. *Identified regulation* falls further down the relative autonomy continuum and is characterized by the valuing or assigning of personal importance to the task, primarily because of its utility in achieving a separate, more desired outcome. *Introjected regulation* is even less self-determined and, although partially internalized, still controlled by obligatory, internal feelings of pressure associated with shame, guilt, and pride (Standage & Ryan, 2019). *External regulation* represents the least self-determined regulation, characterized by feelings of external locus of causality and minimal internalization. Actions driven by external regulation may be motivated by external rewards, social pressure, and to avoid punishment. And, although this regulatory style has the ability to motivate, the motivation is often weak and/or fails to persist over time (Ryan & Deci, 2017).

Notice that extrinsic motivation can vary from completely external perceived locus of causality (i.e., external) to entirely internal and congruent with one's values and identity (i.e., integrated). Again, the fact that these forms of extrinsic regulation generate motivation as means to some other end serve as the hallmark between them and intrinsic motivation. Finally, individuals experiencing *amotivation* are non-regulatory, impersonal, and non-self-determined. They will lack motivation or passively perform the activities in which they are a part (Ryan & Deci, 2000), often because they lack competence, believe a task is trivial, or see no relation between behavior and desired outcomes (Standage & Ryan, 2019).

In contemporary SDT, Ryan and Deci (2006, 2008; 2012; 2017) have demonstrated a more parsimonious version of the self-determination continuum where internalized regulatory

styles (i.e., identified, integrated, and intrinsic) can be collectively considered *autonomous motivation*. External regulatory styles (i.e., introjected and external) are composited and referred to as *controlled motivation*. *Amotivation* remains its own non-regulated and impersonal construct (see Figure 4). In general, autonomous motivation types can be characterized by an authentic valuing of a task in which one "wholeheartedly endorse[s]…or owns" (Ryan & Deci, 2006, p. 1561) participation. Note that autonomy is not synonymous with the simplified idea of choice, as there exit times when people are, in fact, given choices but may not feel truly authentic due to internal or external pressures. Therefore, controlled motivation can be differentiated by one's desire to act due to motives outside or non-congruent with the self (Ryan & Deci, 2006). Refer to Figure 4 for a review of the more contemporary SDT motivation continuum.

Whether using composited (i.e., autonomous and controlled) or delineated (i.e., intrinsic, integrated, identified, introjected, and external) models of regulation, SDT research suggests that the more self-determined types of motivation are associated with many positive behavioral, cognitive, and affective outcomes (e.g., Gillet et al., 2009; Ntoumanis, 2012; Ryan & Deci, 2000; Standage & Ryan, 2019). Studies, such as Howard et al. (2016), however, claim that individuals can possess multiple motivation or regulatory types simultaneously; so long as autonomous motivations are stronger than controlled types, positive outcomes ensue. Additionally, Cerasoli et al. (2014) conducted a meta-analysis which suggested that, while both external regulation and intrinsic motivation were associated with performance quantity, only intrinsic motivation produced performance quality. Equally noteworthy, are findings from a 2017 SDT meta-analysis (Howard et al.) in which results do not support the inclusion of integrated regulation in the self-determination continuum nor any future partitioning of intrinsic motivation (i.e., intrinsic motivation to know, to experience stimulation, and to achieve). Now that basic psychological

needs theory and the SDT theoretical framework has been established, the relationship between BPNs, motivation, and performance in sports will be presented.

Self-determination Theory in Sports

Sports are physically, mentally, and social demanding (Durand-Bush & Salmela, 2002; Gould et al., 2002; Hardwood et al., 2004; Nicholls & Polman, 2007; Ntoumanis & Standage, 2009; Vallerand & Losier, 1999). Therefore, motivation plays a crucial role in maintaining the energy needed to sustain athletic efforts (Cece et al., 2018; Gaudreau et al., 2009; Gillet et al., 2009; Gillet & Vallerand, 2016; Martinent & Decret, 2015). One can reasonably project the tenants of SDT to sport, especially when considering what types of motivation move an athlete toward action, in which direction, to what degree, and over what length of time (Ryan & Deci, 2017). Of sport motivation studies, numerous have confirmed SDT as a valid and reliable framework (e.g., Cece et al., 2018; Martinent & Decret, 2015), and some have developed sport-specific BPN and SDT measures, including Basic Needs Satisfaction in Sport Scale (BNSSS; De Francisco, Parra et al., 2018; Ng et al., 2011), Sport Motivation Scale (SMS; Pelletier et al., 2007), Behavioral Regulation in Sport Questionnaire (BRSQ; Lonsdale et al., 2008), Young Behavioral Regulation in Sport Questionnaire (YBRSQ; Viladrich et al., 2013), Situational Motivation Scale (SiMS; Standage et al., 2003), and others.

As depicted in Figure 3 and Figure 4, an athlete's motivation – as theorized by SDT to apply to people in any context (Ryan & Deci, 2000) – can range from amotivation (i.e., the complete lack of motivation) to intrinsic motivation (i.e., fully self-determined and done for its own sake). Furthermore, SDT can help explain athletes' more nuanced motivational, cognitive, and affective processes (De Francisco et al., 2018). In turn, BPNs and SDT research in the context of sports and sports performance will be addressed next.

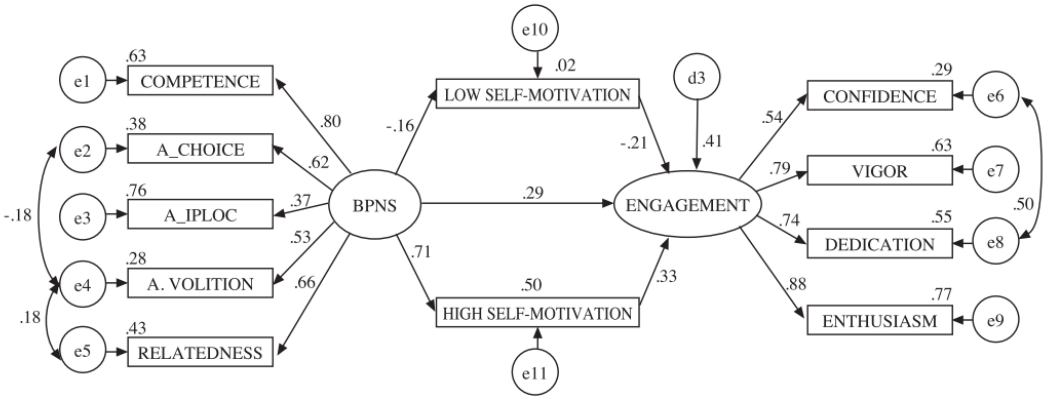
Basic Psychological Needs in Sports

SDT states that the level and type of motivation is predicated upon the degree to which one's basic psychological needs (i.e., autonomy, competence, and relatedness) are met within the context of a particular activity (Ryan & Deci, 2000). Regarding sport, an athletes' autonomy manifests in the sense of volition or authentic choice they have in if and how they participate. Competence can be witnessed in the degree to which an athlete feels efficacious or capable of successfully completing the sport task(s). Finally, relatedness might refer how an athlete feels genuinely cared for and supported by others with whom they regularly interact (e.g., teammates, coaches, parents) (Standage & Ryan, 2019).

Congruent with general SDT, sports motivation studies have found that BPNS and basic psychosocial needs thwarting predict levels of self-determined motivation (Cece et al., 2018). De Fransisco et al. (2018) also found that BPNS predicts self-determined motivation as well as engagement via motivation. See Figure 5 for structural model.

Figure 5

Structural Model Between BPNS, Levels of Self-Motivation, and Engagement Factors



Note: From "The Mediating Role of Sport Self-motivation Between Basic Psychological Needs Satisfaction and Athlete Engagement," by C. De Francisco, C. Arce, E.I. Sanchez-Romero, and M. del Pilar Vilchez, 2018, *Psicothema*, 30(4).

Notice competence demonstrated the highest association with motivation, followed by relatedness and choice (a theorized factor of autonomy), respectively. Given that autonomous or self-determined motivation has been shown to predict athlete performance (Gillet et al., 2010; Gillet et al., 2009; Fernández-Río, 2018; Martinent et al., 2018), one might reasonably conclude that BPNS relates to performance via motivation as well.

In a 2016 meta-analysis of the direct BPN associations with performance in school (N = 16,249), work (N = 9,013), and physical (e.g., exercise and sport; N = 3,852) contexts, Cerasoli and colleagues found that all three BPNs significantly predicted performance, especially quality of work (p = .40). Competence was the most salient performance predictor (p = .37), followed by autonomy (p = .28) and relatedness (p = .25) respectively. Unfortunately, as evidenced above, the proportion of participants from the exercise and sports domains represents only a small proportion of the entire study sample size.

A 2013 study investigated the state of flow in sports (Schüler & Brandstätter) and suggested that *flow* – characterized by balance between the challenge of a task and one's skills, clarity of the goal, clear and immediate feedback, high concentration on the task at hand, merging of action and awareness, a high sense of control, and an altered sense of time (Csikszentmihalyi, 1990) – serves as a mediator between BPN and performance and can be predicted by an athlete's levels of competence (R = .52) and relatedness (R = .24). Note that autonomy was not measured due to its absence in dispositional motives theory.

In a 2019 Li et al. study of 112 university athletes, BPNS was shown to directly predict university athlete injury (β = -0.18) and stress (β = -0.54) whereas basic psychological frustration (BPNF) directly predicted stress (β = .12) but not sports injury. One can reasonably infer the

negative relationship between injury and performance, a primary variable of interest within this study.

Finally, in a study of 736 youth athletes involved in intensive training centers for both individual sports (i.e., judo, dance, track and field, swimming, boxing, cycling, golf, gymnastics, fencing, weightlifting, karate, skinning, tennis, and wakeboarding) and team sports (i.e., basketball, soccer, rugby, handball, hockey, football, and volleyball), Cece et al. (2018) found that, despite BPNS and basic psychological needs thwarting predicting beginning and end-of-season athlete motivation profiles, the satisfaction and/or thwarting of these BPNs was not a significant predictor of mid-season motivational profiles. Cece et al. (2018) posit that BPNS and basic psychological needs thwarting fluctuate across the season and may only predict motivation for reduced periods of time, especially given the complexities of sport and therefore the volatility of sports motivation and performance (Cece et al., 2018; Gillet et al., 2009).

The aforementioned studies suggest BPNs predict sports performance both directly and through various mediating factors such as motivation, flow, engagement, persistence, and injury. Next, motivation and sports performance literature will be reviewed.

Motivation and Sports Performance

Studies endorse the claim that autonomous motivational profiles in sport promote more adaptive behaviors, while more controlled motivations predict maladaptive outcomes (Cece et al., 2018; Fenton et al., 2016; Hodge & Lonsdale, 2011; Ntoumanis, 2012). Additionally, athlete engagement (De Francisco et al., 2018; Lonsdale et al., 2007), persistence (Martinent et al., 2018), flow (Csikszentmihalyi, 1990; Schüler & Brandstätter, 2013), well-being (Balaguer et al., 2011), and sportspersonship (Chantal & Bernache-Asollant, 2003) have been shown to be related to autonomous motivation as compared to ill-being, burnout, dropout (Hodge & Lonsdale, 2011;

Isoard-Gautheur et al., 2016; Lemyre et al., 2006;), and stress/injury (Li et al., 2019) in athletes experiencing controlled motivation and amotivation. A link between several of the aforementioned affective constructs (e.g., flow, persistence, stress) and sports performance are also quite natural (Schüler & Brandstätter, 2013). For example, it seems unlikely that an athlete who is injured (Li et al., 2019) will perform optimally; likewise, an athlete experiencing burnout (Isoard-Gautheur et al., 2016) or who drops out (Hodge & Lonsdale, 2011; Lemyre et al., 2006;) cannot realize any further performance potential. However, relatively fewer works have studied motivation's effects, directly or as mediated by other variables, on objective sports performance and success measures (Ntoumanis, 2012; Standage & Ryan, 2019). Therefore, we will consider several studies that have specifically analyzed the relationship between motivation and sports performance.

A longitudinal study of youth table-tennis players ($N = 159$) involved in intensive training centers (Martinent et al., 2018) found that players who were still playing six years later ($N = 130$) reported lower baseline levels of amotivation ($\eta^2 = .15$) than those who dropped out. Baseline amotivation was also significantly lower for national and/or internationally competitive plays than those who competed at the regional level ($\eta^2 = .18$). Finally, performance at the end of season one, the end of the season six years later, and six-year performance progress (i.e., performance scores at the end of the season six years later minus those at the end of season one) were negatively correlated with introjected and external regulations and amotivation. Performance, in this study, was operationalized as both level of competitive play (i.e., regional, national, or international competition) and table tennis rankings.

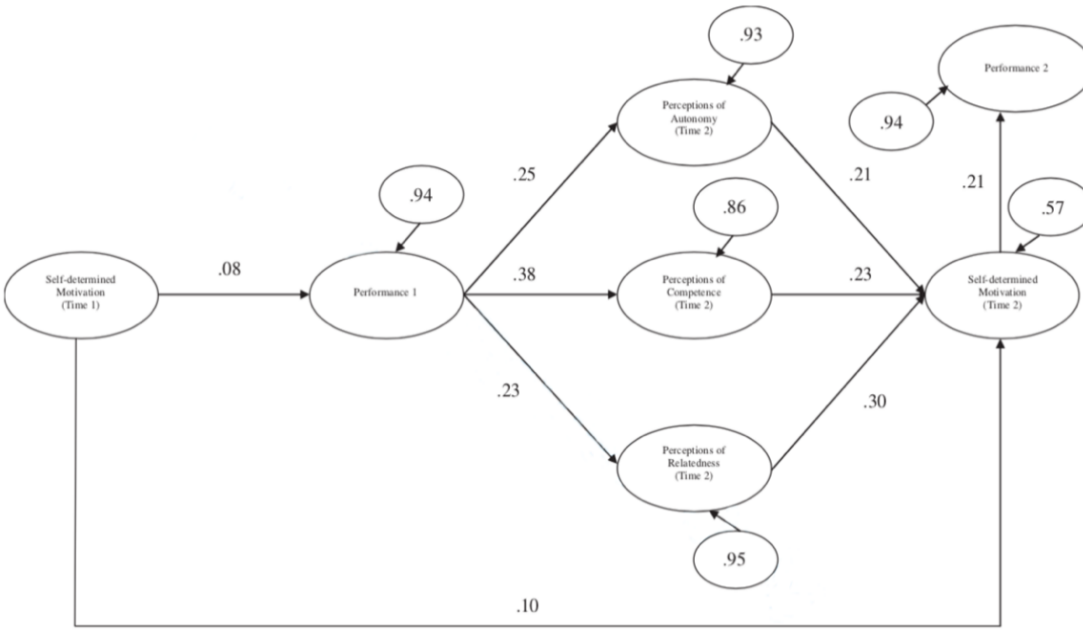
In a 2018 case study, Fernández-Río et al. tested for motivational regulation differences between a world-class athlete (i.e., this athlete achieved 2 Olympic medals, 7 World

championship medals, four European championship medals, and several national championships) and two other high-level athletes (i.e., these athletes were finalists at the World and European championships and several national championships). Results revealed that, although autonomous motivation did not differ significantly across athlete levels, the world-class Olympic athlete demonstrated significantly lower controlled motivation than the two high-level athletes. These findings were accompanied by the world-class athlete's stronger mastery-approach goal dominance and lower performance-avoidance goal pursuits. This study is particularly interesting due to the elite achievement of the athletes within; unfortunately, the three-person sample size is extremely low.

In a longitudinal study of 90 French national, adolescent (ages 13 and 14) tennis players, Gillet et al. (2009) found that the baseline (i.e., start of season one) levels of self-determined motivation was significantly associated with season one and season two sports performance (R = .24), as measured by win percentage. However, only at time 2 (i.e., two years later), and not baseline, self-determined motivation predicted season three performance (R = .25). Along with performance, BPNs served as partial mediators between baseline self-determined motivation and season three performance. These results suggest self-determined motivation as dynamic and temporally sensitive in its ability to predict performance. For example, the resultant best-fitting path model (Figure 6) had a non-significant chi-squared-value of X^2 = 10.58. More will be discussed about the role of BPNs in sports self-determined motivation and performance in forthcoming sections of this paper.

Figure 6

Path Model Between Self-Determined Motivation, Performance, and BPNs

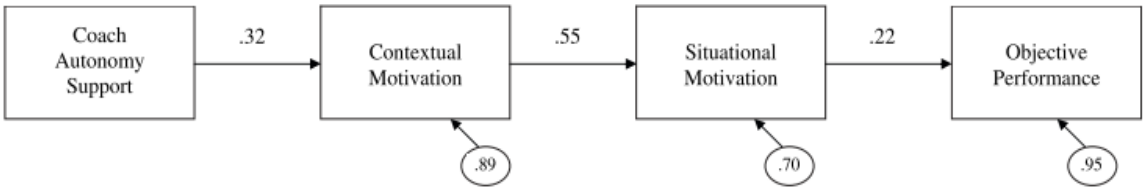


Note: From "A Motivational Model of Performance in the Sport Domain," by N. Gillet, S. Berjot, and L. Gobancé, 2009, *European Journal of Sport Science*, 9(3), 151-158. https://doi.org/10.1080/17461390902736793

To further understand the temporal nature of SDT effects on performance, Gillet et al. (2010) studied the mediating relationship of SDT contextual motivation (i.e., overall motivation in the context of that sport) and situational motivation (i.e., motivation for a particular sport activity at a particular time) between coach autonomy support and objective judo performance as measured by official competition rankings. Finding revealed that situational motivation – but not contextual motivation – had a significant correlation with athlete performance (R = .20), which explained 5% of the judo performance variance. Although the percent of variance explained by motivation was relatively small, the authors argued that even a small increase in elite sport performance has practical significance. See Figure 7 for the structural equation model between coach autonomy support and objective performance via contextual and situational motivation.

Figure 7

SEM Between Coach Autonomy Support, Motivation, and Performance



Note: From "Influence of Coaches' Autonomy Support on Athletes' Motivation and Sport Performance: A Test of the Hierarchical Model of Intrinsic and Extrinsic Motivation" by N. Gillet, R.J. Vallerand, S. Amoura, and B. Baldes, 2010, *Psychology of sport and exercise*, 11(2), 155-161. All coefficients were standardized and were significant ($p < .05$)

The above sampling of sports motivation studies corroborate with SDT's position that autonomous motivation predicts positive outcomes – namely performance in these studies – whereas controlled motivation and amotivation generally associate with sub-optimal outcomes. Next, motivation within hockey and moderating factors will be addressed.

Motivation in Hockey

In a particularly notable empirical study on hockey players, Geaudreau et al. (2009) longitudinally analyzed the affective states of adolescent hockey players over the course of an 11-week season. Results indicated that players' positive affect group membership (e.g., high enthusiasm, activity, alertness, vitality, flow, and satisfaction) and negative affect group membership (e.g., high anxiety, depression, distress, and anger) were partly predicted by players' initial levels of self-determination and basic psychological needs satisfaction. For example, the odds of a player belonging to the high positive affect group compared to belonging to the unstable positive affect group were 1.20 for players with high levels of self-determined motivation and 5.64 for high satisfaction of BPNs. Team selections moderated players' affective trajectories, especially in the low self-determination and low BPNs groups where non-selection

predicted unstable, negative, and maladaptive affect. High academic identity served as a negative affect buffer for those who were not selected to the team. Results indicate the importance of understanding the psychology of competitive athletics and the need for more individualized prevention and intervention. Gaudreau et al. (2009) posit that coping strategies, diversification of self-concept, prioritization of student efforts, and transferability of sport-derived skills, and BPNs support could all benefit the overall wellbeing of elite hockey and other sports athletes. Although this study makes important empirical contributions to the ice hockey literature, there was no goalie-specific application. The unique challenges of goaltending could result in markedly different profiles. These observations further strengthen the need for goalie-specific research.

Moderating Factors

Of the variables that moderate BPN and sport motivation, autonomy supportive coaching was amongst the most salient (Adie & Jowett, 2010; Alcaraz et al., 2015; Banack et al., 2011; Gillet et al., 2010; Jõesaar et al., 2012; Trigueros et al., 2019). Given coaches' critical roles in athletics (Standage & Ryan, 2019; Vallerand & Losier, 1999), their opportunities to influence athletes are many. Furthermore, the coach-athlete relationship is a fitting application for relationships motivation theory (RMT), a sub-theory of SDT, which posits that social supports for autonomy are key for important relationships to flourish and to support positive human outcomes (Standage & Ryan, 2019). Autonomous supportive coaching is characterized by coaching practices such as inviting athlete participation in decision making processes, acknwledging athlete emotions, providing choices, and taking personal interest in his or her athletes (De Francisco, Arce et al., 2018). Table 1 identifies additional examples of need

supportive and need thwarting communication styles while Figure 8 illustrates a proposed structural model between communication style, BPN, motivation, and sports outcomes.

Table 1

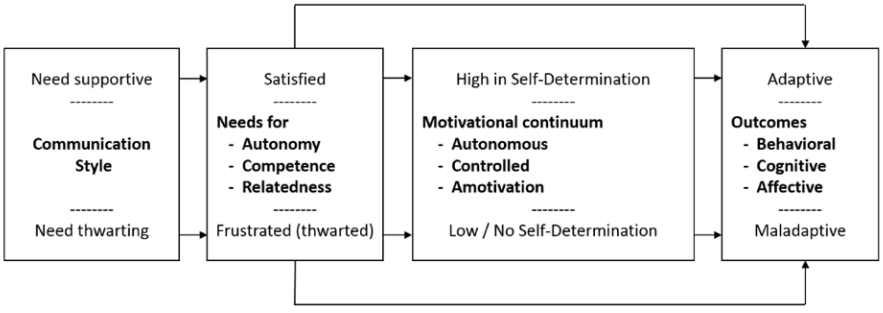
Examples of Need Supportive and Need Thwarting Communication Styles

Need-supportive	Need-thwarting
1. Encourages initiative	1. Discourages initiative and questions from others
2. Allows participation in decision making	2. Trivializes and dismisses others' input and views
3. Provides meaningful explanations for task-engagement	3. Uses excessive monitoring and surveillance
4. Acknowledges any negative feelings	4. Uses a coercive, pressuring, or guilt-inducing communication in order to impose a preconceived way of thinking and behaving.
5. Communicates perspective taking statements	5. Uses intimidating behaviors (e.g., yelling, physical punishment)
6. Offers choices that are relevant to others' goals and values	6. Uses praise in an attempt to control others' behaviors and feelings
7. Gives specific and constructive feedback	7. Deprives others of opportunities to develop their potential
8. Takes personal interest in others	8. Isolates or rejects others

Note: From "The Mediating Role of Sport Self-motivation Between Basic Psychological Needs Satisfaction and Athlete Engagement," by C. De Francisco, C. Arce, E.I. Sanchez-Romero, and M. del Pilar Vilchez De Francisco, Arce et al., (2018). Psicothema, 30(4).

Figure 8

Structural Model Between Communication Style, BPN, Motivation, and Sports Outcomes



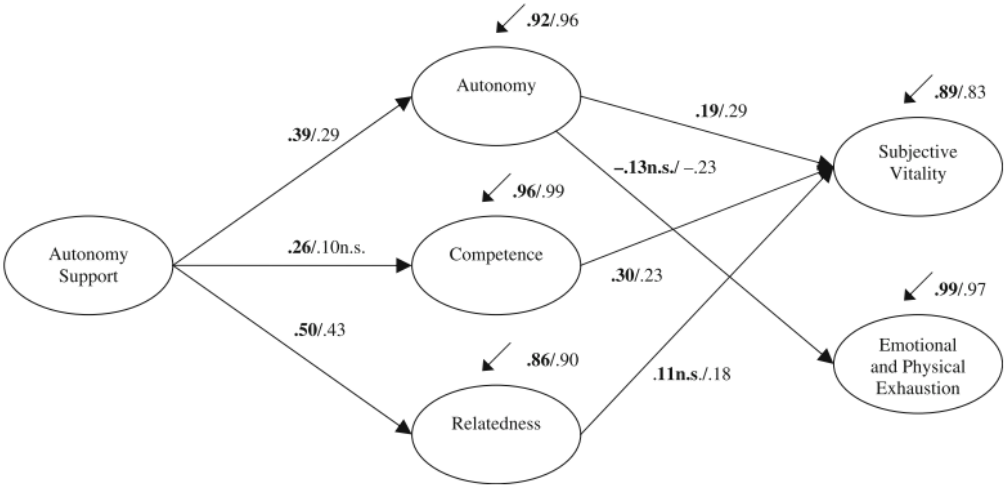
Note: From "The Mediating Role of Sport Self-motivation Between Basic Psychological Needs Satisfaction and Athlete Engagement," by C. De Francisco, C. Arce, E.I. Sanchez-Romero, and M. del Pilar Vilchez (2018). Psicothema, 30(4).

Results of the afformentioned studies unanimously point toward the benefits of autonomy supportive coaching, including increased athlete perceptions of autonomy and relatedness (Banack et al., 2011), prediction of athletes' intrinsic motivation (Jõesaar et al., 2012), facilitating self-determinded motivaiton and performance (Gillet et al., 2010), adaptation of mastery-approach goals (Adie & Jowett, 2010), and increased psychological needs satisfaction and resiliance (Trigueros et al., 2019).

Adie et al. (2008) studied 529 adult athletes (M_{age} = 22.75) in an effort to explore potential gender differences in the relationship between coach autonomy support, basic psychological needs, and vitality in sport. Results corroborate with previous studies in that autonomy supportive coaching generally predicts subjective vitality as well as emotional and physical exhaustion via BPN. See Figure 9 below for structural model pathways.

Figure 9

Baseline Model of Motivational Processes and Well-Being for Male and Female Athletes



Note: From "Autonomy Support, Basic Need Satisfaction and the Optimal Functioning of Adult Male and Female Sport Participants: A Test of Basic Needs Theory," by J.W. Adie, J.L. Duda, and N. Ntoumanis, 2008, *Motivation and Emotion*, 32(3), 189-199. https://doi.org/10.1007/s11031-008-9095-z Standardized path coefficients are presented for male in bold and unbolded for females. Non-significant paths are denoted by n.s.

Except for female competence, there was a significant relationship between autonomy support and the three psychological needs. And, while relatedness was most strongly predicted by autonomy support for both males and females, competence demonstrated the strongest relationship with subjective vitality for males and autonomy for females. Additionally, male relatedness was not significant in predicting vitality. These findings suggest that gender moderates how coach autonomy affects BPNS and how BPNS predicts subjective vitality and emotional and physical exhaustion. Adie et al. (2008) propose that the older age of adult athletes may also play a role in autonomy and competence as stronger predictors than relatedness.

Although SDT positions competence and autonomy as the most salient BPNs (Ryan & Deci, 2000), sports motivation research does not seem to clearly agree on any particular psychological needs factor as more predictive than another. Age, level of play, gender, and sport type appear to moderate the effect that BPNS and/or thwarting have on motivation and performance. For example, some research suggests that younger athletes and team-oriented sports may possess a greater need for relatedness (Gillet et al., 2009). Conversely, in more individualized, intense, technical, or competitive settings, the need for competence supersedes the need for autonomy or relatedness (Adie & Jowett, 2010). Such factors as sports type and level of competition may play a role in athlete's experienced BPNS as well (Gillet et al., 2009). Here emerges a clear need for future research regarding the effect of specific BPNs on an individual level and in varying sports contexts.

Considering other potential moderators, longitudinal studies (Cece et al., 2018; Guadrau et al., 2009; Martinent et al., 2018) suggest time itself as a moderating factor, as demonstrated in the inconsistency of self-determined regulation within athlete profiles over time. Cece et al. (2018) found that self-determined motivation generally declined over the course of a season,

likely given the physical and mental demands of sport (Martinent et al., 2018). Furthermore, less self-determined and lower BPNs groups were more likely to show this decline and demonstrated greater volatility in affective states (Gaudreau et al., 2009). Gaudreau et al. (2009) also found that team selections moderated players' affective trajectories, especially in the low self-determination and low BPNs groups where non-selection predicted an unstable, negative, and maladaptive affect. High academic identity served as a buffer for those who were not selected to the team.

Finally, Schüler and Brandstätter (2013) found that BNS and dispositional motives (i.e., achievement motive, affiliation motive, and power motive) interacted to predict flow – and therefore likely performance – in sport. The data indicated that, in addition to needs satisfaction's positve effect on flow, athletes with high achievement profiles benefit more from competence need satisfaction than those low in the acheievement motive; additionally, individuals with high affiliation-motive levels benefited more from relatedness need satisfaction than those low in this motive. Ultimately, utilizing both needs satisfaction with motive dispotional profiles enhanced the prediction of flow, which is theorized to predict performance. Next, discrepanices within research will be discussed.

Discrepancies Within Research

The collective research cited above generally affirms the tenants of SDT theory; however, some noteworthy discrepancies and questions emerge. First, the above research does not clearly agree on any particular BPN factor as more predictive than another. Age, gender, level of play, and sport type appear to moderate the effect that basic psychological needs satisfaction and/or thwarting have on motivation and various other affective and performance metrics. Although SDT theorizes competence and autonomy as the most salient BPN (Ryan &

Deci, 2000), sports motivation may prove uniquely nuanced. For example, some researchers hypothesize younger athletes and team-oriented sports may possess a greater need for relatedness (Gillet et al., 2009). Conversely, in more individualized, intense, technical, or competitive settings, the need for competence supersedes the need for autonomy or relatedness (Cerasoli et al., 2016; Gillet et al., 2009; Schüler, J., & Brandstätter, 2013).

Second, and perhaps related to the aforementioned BPN discrepancies, confounding findings emerged regarding BPNS, BPNT, and motivation type relationships with performance: The majority of research points toward high levels of BPNS and autonomous motivation as superior and most predictive of performance (Gillet & Vallerand, 2016; Martinent et al., 2018); however, some studies (Cece, et. al., 2018) found that higher levels of BPNT and controlled forms of motivation better predict performance. As counter to SDT's meta-theory, these finding could simply be erroneous and/or an anomaly; however, it has been shown that several motivation types likely operate simultaneously (Meyer & Morin, 2016) or that the nature of certain, more intense or technical sports, reward compliance with controlling influences (Cece et al., 2018). Yet, this controlled motivation and performance relationship was the exception, and not the norm. Additionally, the sustainability of well-being and performance under such controlled motivation remains is contested (Hodge & Lonsdale, 2011; Isoard-Gautheur et al., 2016; Lemyre et al., 2006; Li et al., 2019; Ryan & Deci, 2000).

Finally, the stability of BPNS, BPNT, and motivation type over time was inconsistent (Cece et al., 2018; Martinent & Decret, 2015), which makes performance prediction challenging. It is reasonable to think that motivation may be especially dynamic within the complex and competitive context of sports. Coach and teammate interactions, injuries, and peaks and valleys of season success may reasonably impact motivation at any given moment in time. The

following section will present the sparce literature on psychology and mental skills of goaltending.

Psychological Skills in Goaltending

Ice hockey goaltending is a physically and mentally challenging task (Clark & Luongo, 2010; Miller, 2001; Monnich, 2021; Porter, 2003; Gelinas & Munroe-Chandlier, 2006; Vehviläinen, 2012). The pressure, responsibility, and high-stakes nature of a goaltender often results in exceptional levels of stress and anxiety (Gelinas & Munroe-Chandler, 2006; Monnich, 2021; Vehviläinen, 2012). As a result, goaltenders, coaches, parents, and hockey organizations alike express a need for deeper understanding of the position, especially its mental aspects (Monnich, 2021; USA Hockey, 2020). Some would attribute as much as 90% of goaltenders' performance to their psychology (Fry, 2017; Gelinas & Munroe-Chandler, 2006; Porter, 2003). While this exact proportion remains empirically untested, there is both anecdotal and empirical evidence supporting the significant role psychological factors have on general as well as sports performance (e.g., Hardwood et al., 2004; Ntoumanis & Standage, 2009; Vallerand & Losier, 1999; Gagné, 2003; Rubin, 2017; Ryan & Deci, 2000).

In their article on psychological skills for ice hockey goaltenders, Gelinas and Munroe-Chandler (2006) suggest that concentration, arousal control, imagery, and self-talk are among the most central. *Concentration* is the ability to stay focused on a particular task (Wilson et al., 2006), and the level of one's concentration largely depends on his or her motivation to do so (Porter, 2003). *Arousal* can be thought of as physiological and psychological activation (Weinberg & Gould, 2011). Goaltenders and other elite athletes must strive to find their ideal level of arousal – avoiding excessive excitement or anxiety – to achieve optimal performance (Gelinas & Munroe-Chandler, 2006). *Imagery* is the act of replicating or envisioning a scenario

in one's own mind (Vealey & Greenleaf, 2006), a technique often considered the "central pillar of applied sport psychology" (Perry & Morris, 1995, p. 339). Finally, *self-talk* can be defined as audible or internal statements addressed toward for the sake of instruction or motivation (Hardy et al, 2004). The inner dialog of self-talk plays an important role in sports performance (Munroe-Chandler, 2006). *Motivation*, although not directly addressed, commonly appears within the description of these mental skills.

To address the psychological needs of Finish goaltenders, Vehviläinen (2012) compiled a mental training guide for ice hockey goaltenders. Within his paper, he suggested 12 mental qualities of which goaltenders and goalie coaches should be aware: self-confidence, imagery, emotion control, stress and anxiety, game preparation, game planning, feedback, flow, and *motivation*. Vehviläinen (2012) utilized Weinberg and Gould's (2011) definition of *motivation* as follows – "the direction and intensity of one's effort" (p. 51). Vehviläinen (2012) agreed that motivational sources can be internal (i.e., intrinsic) or external (i.e., extrinsic). He deconstructed motivation into trait-centered, situation-centered, or interactional (Weinberg & Gould, 2011). In defining these terms, *trait-centered* view of motivation attributes motivation to innate, genetic factors. *Situation-centered* view posits that motivation is significantly dependent upon context or task. Finally, the *interactional* view posits an interaction – or moderation – between both traits and situation on motivation. This situational or time-dependent nature of motivation align with several aforementioned studies (Gillet et al., 2010; Guay et al., 2000; Standage et al., 2003).

In 2002, Rogerson and Hrycaiko of the University of Manitoba experimentally examined the effectiveness of relaxation in the form of centering (i.e., a single deep breath before performing their target task) and self-talk techniques (i.e., positioning/focus, self-affirming statements, and mood words) for Junior A level ice hockey goaltenders. Results indicated that

centering and self-talk techniques improved goalie performance in the form of increased save percentage and decreased goals against average. Goaltenders and their coaches self-reported enjoying the process and supported the effectiveness of these mental training skills. The greatest shortcomings of this study were the small sample size of $N = 5$, the lack of advanced quantitative statistics (i.e., no reported tests or effect sizes), and, as discussed in chapter one, the questionable validity of save percentage and (especially) goals against average. Therefore, replication with a larger sample and multiple goalie performance measures is necessary to confirm these study claims. Additionally, although this study focused on psychological and performance components of goaltending, BPNS, motivation, and perceived success were not addressed. This again strengthens the need for additional empirical research on goalie-specific motivation and other goaltender psychological aspects.

The purpose of Monnich's (2021) seminal mixed methods study ($N = 115$ ice hockey goalies and goalie coaches), reported in chapter one, was to determine the mental challenges faced by goaltenders along with what mental skills they deemed important in handling such challenges. Again, survey, interview, and focus group results indicated that almost all participants perceived mental challenges as pervasive. These challenges included maintaining focus or concentration, controlling emotions, recovering after allowing a goal, performing consistently, controlling thoughts, anxiety, nervousness, or fear, and dealing with negative thoughts. Other themes emerged such as staying in the present moment, anxiety/doubt, self-awareness, self-improvement, confidence, and competitive attitude. Survey results indicated that goaltenders see mental skills as important but generally do not possess the mental skills and techniques necessary to mitigate these challenges. The desired mental skills cited included staying focused, controlling thoughts, arousal regulation, controlling emotions, using self-talk,

setting goals, using imagery, and recovering from failure. These results corroborate with Lesyk's (1998) seminal mental skills model (Figure 1) as well as other studies cited within this section.

While the body of literature on goalie psychological skills continues to build, there remains a clear need for goalies and goalie coaches to better understand and properly address these psychological challenges. The final chapter two section will review R and R Studio as a way to justify the significant amount of time and effort invested in learning and utilizing these as the primary data analytics programs for this study.

R as Statistics Software

Choosing a statistics software is an important decision for college students and teachers alike (Fox & Anderson, 2005; Keeling & Pavur, 2007; Mitchell, 2007; Ward, 2013). A 2010 American Sociological Association (ASA) survey (Spalter-Roth et al.) of undergraduate seniors majoring in sociology reported that statistical software proficiency was a skill listed atop their résumés; this finding indicates the importance both social science students and potential employers place on statistical software competence. The current information and big-data eras (Vance, 2009) make analytics software selection decisions even more salient. Moreover, there are many options from which to choose. In a recent article, Muenchen (2019) explores the market share of over 60 available advanced data analytics programs. Of these, SPSS and R were the most cited programs used in scholarly article publications, and both were in the top 20 for use within data scientist jobs. Equally noteworthy is the decline in SPSS professional and scholarly use, while R demonstrates a large upward trend (Fox & Leanage, 2016; Muenchen, 2019). Mitchell (2007) points out that many data analysists' program selections are largely influenced by their peers (i.e., friends, department, professors) and that a more strategic approach is needed (Burns, 2007; Fox & Leanage, 2016; Muenchen, 2019; Ward, 2013).

What is R?

Although often used interchangeably, R is both a programing language and an open-sourced, cooperatively developed data analytics suite (Fox & Leanage, 2016; Grolemund & Wickham, 2017; Ismay & Kim, 2019; The R Foundation, n.d.). R is free and available online (http://www.r-project.org) as part of the GNU (GNU's Not Unix!) free software project (https://www.gnu.org/). The R program utilizes R code to run its myriad functions and packages for organizing data, computing, statistical analyses, and graphical output. R was developed in 1996 by New Zealand professors Ihaka and Gentleman, who desired a more user-friendly statistical analysis experience for their college students (Ihaka, 1998; Ihaka & Gentleman, 1996). As previously mentioned, the R program is software used to execute R code commands. More fittingly, however, R is often referred to as an *environment* in which statistics and other functions are implemented (Grolemund & Wickham, 2017; Ismay & Kim, 2019; The R Foundation, n.d.). RStudio – one of R's leading integrated development environment (IDE) programs – provides a semi-point-and-click interface, meaning the user primarily relies on code commands to run the program but has some ability to work with a cursor, menus, and dialog boxes.

R Strengths and Weaknesses

According to Muenchen (2019), several criteria are important to consider while selecting data analysis tools. These include operating system compatibility, depth and breadth of analyses, extensibility, user interface type (i.e., command-based, menus and dialog boxes, or workflow diagrams), visualization options, large dataset capabilities, interface with other programs, and affordability. Ward (2013) compiled a similar list of criteria to compare statistics software; see a modified table comparing R and SPSS strengths and limitations in Table 2 below.

Table 2

Strengths and Limitations Between R and SPSS Software Packages

	R	SPSS
Data management and manipulation		
Easy data entry	–	+
Spreadsheet-style display for data	+	+
Large data sets processed easily	–	–
Simple recode syntax/procedures	–/+	–
Looping and macro capabilities	+	–
Analytical procedures		
Statistics often taught in undergraduate courses[a]	+	+
Optional complimentary/postestimation statistics	+	+
Advanced statistical analyses	+	–/+
Data weights and complex survey design	+	–/+
"Point-and-click" interface[b]	–/+	+
"Point-and-click" interface can generate syntax	–	+
User-written programs for analyses	+	–
Visual graphics and display		
Basic graphical capabilities	+	+
Visually appealing graphical capabilities	+	+
User-written programs for graphics	+	–
Data value/labels displayed with tabulations	–	+
Direct edits of graphs/tables	–	+
System and logistical features		
Data sets in various formats/extensions allowed	+	+
Data export into Excel® or other programs	+	+
Windows operating systems	+	+
Mac OS	+	+
"Point-and-click" interface	–/+	+
Free online user-written programs	+	–
Perpetual/one-time license "purchase"	+	–/+
Easy uniform installation of updates/additions	–	+
Classroom considerations for instructors		
Programming language/syntax not needed	–	+
Numerous online resources available	+	+
Widely used by businesses in different industries	–/+	–/+
Numerous instructor resources available	+	+
Approximate cost (with one-year license)	+	–
Full version	$0	$1,290
Student version	n/a	$58

Note: Adopted from "What's Better—R, SAS®, SPSS®, or Stata®? Thoughts for Instructors of Statistics and Research Methods Courses," by B.W. Ward, *Journal of Applied Social Science*, *7*(1), 115-120/. 2013. https://doi.org/10.1177/1936724412450570

"–" indicates a limitation; "+" indicates a strength; "–/+" indicates feature is present but is not explicitly a limit/strength. [a]For example, percentage/frequency distribution, measures of central tendency, cross-tabulation, t-test, Pearson correlation, analysis of variance, and ordinary least squares and logistic regression.

[b]A "point-and-click" interface is where an individual uses his or her computer mouse to manually select

As one can see from Table 2, R is both a powerful and versatile software package. It has the capability to execute basic and advanced analyses as well as produce publication-quality visualizations (Burns, 2007; Fox & Anderson, 2005; Wickham, 2016). R's user-written programs (i.e., packages) extend base program capabilities and allow users, themselves, to contribute to the R environment. While R – and specifically RStudio – lack a true point-and-click interface, the resulting command-based system has its benefits, such as greater output customizability, user-analysis interaction, easily reproduced analyses, and the ability to minimize the number of simultaneous opened windows (Fox & Anderson, 2005). Additionally, R interfaces well with other statistics and non-statistics programs and languages. In fact, R was made to both utilize and interact with other languages such as S, C, C++, Fortran, Python, Julia, SQL, and others (Fox & Anderson; 2005; Grolemund & Wickham, 2017; Ismay & Kim, 2019; The R Foundation, 2020). R has the capability to import datasets from Text, Excel, SPSS, SAS, and Stata and output to various formats including MS Word, PDF, HTML, HTML slides, websites, dashboards, and more (https://rmarkdown.rstudio.com/). Lastly – and incredibly – R is free and will remain that way due to its GNU licensing. With all the above strengths, one can see why R might serve as an effective statistics program for undergraduate/graduate students and teachers (Fox & Anderson, 2005), researchers, and data analytics professionals (Muenchen, 2019).

R is not without its weaknesses. One of the most common demerits R receives is its steep learning curve, especially for users new to statistics and/or computer coding (Burns, 2007; Fox & Anderson, 2005; Muenchen, 2014). Learning code, much like learning any language, takes significant time and effort. Coupled with potentially rigorous, new statistics concepts, the coding demand can induce unnecessary, and often quite frustrating, cognitive load on users (Fox & Anderson, 2005) who may often find themselves troubleshooting and looking up commands. A

counterpoint has been presented, however, that the attention to and interaction with code and syntax detail has the capacity to deepen statistical comprehension, if the student is willing to put in the time and focused energy (Burns, 2007; Fox & Anderson, 2005).

Another critique of R is that it can make simple tasks harder than they ought to be (Muenchen, 2014; Fox & Leanage, 2016). Part of this experience is likely due to R's coding requirements; however, other prospective contributors are the shear complexity and capacities of the program. R has multiple ways to accomplish most tasks (The R Foundation, 2020), which, while bolstering R's flexibility, can cause ambiguity and confusion (Muenchen, 2014). Furthermore, R often provides minimal and unformatted output which requires additional prompts to retrieve subsequent information. Minimal output has its benefits too, however: elegance, minimal clutter, efficiency of output as future input, and reduced user cognitive load (Burns, 2007). Lastly, R relies on computer memory for storing and handling large datasets (Burns, 2007; Fox & Leanage, 2016). This can pose issues for users whose devices may be ill-equipped. However, most modern computers should easily handle large datasets using R, as computer memory capabilities continue to grow rapidly (Burns, 2007); if not, sub-setting is always a viable option. Many of the aforementioned challenges can also be remedied by using additional packages, making the "easy things easy as well" (Meuenchen, 2014, para. 2).

Marketability

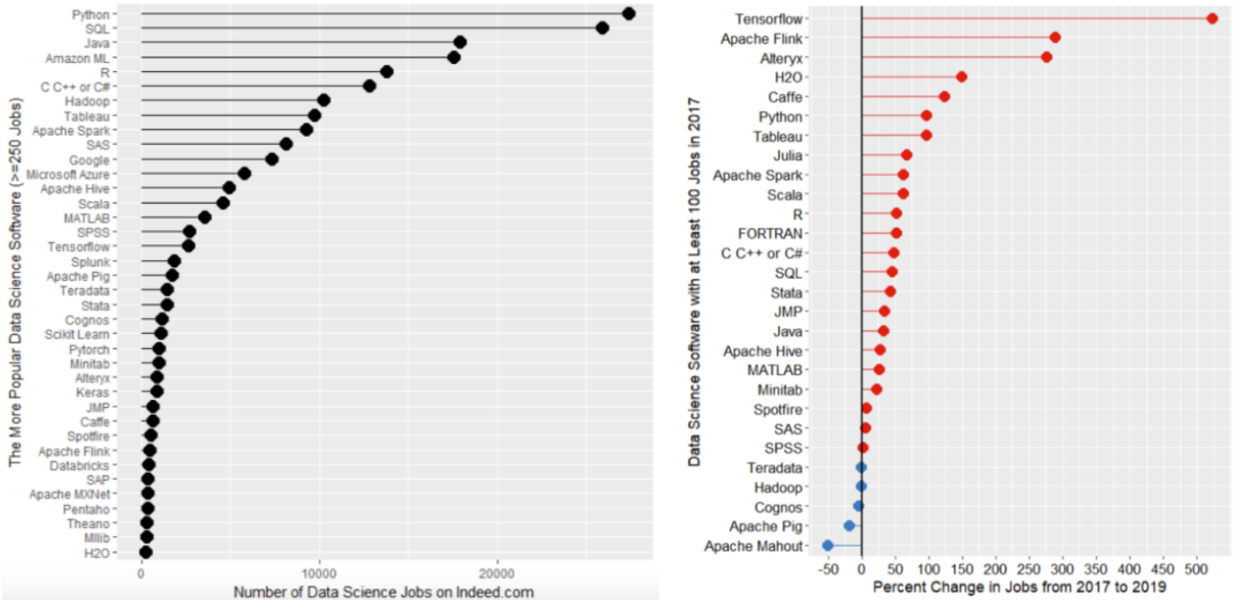
The choice of statistics software can have significant impacts on graduate students and their future success, both within academics and industry (Dobre & Adam, 2014; Grace-Martin, n.d.; Mitchell, 2007; Ward, 2013). Therefore, these decisions should not be made solely on the grounds of peer and department influence – as they often are (Mitchell, 2007) – but, rather, with greater thoughtfulness and intentionality. Data science jobs are in high demand and growing

(Muenchen, 2019). Muenchen recently published a comprehensive analysis of data science software popularity, utilizing job advertisements, scholarly articles, surveys of use, sales, downloads, and other metrics. It should be noted that a wide variety of data analytics programs were featured in his report, including programs specializing in computer coding, machine learning, and artificial intelligence. Additionally, several programs that utilize a SPSS-like GUI and run R code behind the scenes (e.g., JASP, BlueSky Statistics, and Jamovi) were included, as were IBM's SPSS Statistics and SPSS Modeler.

Overall, R ranked fourth and SPSS 15th in number of data science jobs utilizing each as their primary software. R, however, demonstrated a 50% growth in number of jobs from 2017 to 2018 versus SPSS's stagnation at approximately 0% growth (Figure 10).

Figure 10

Data Science Software Job Numbers and Change in Jobs

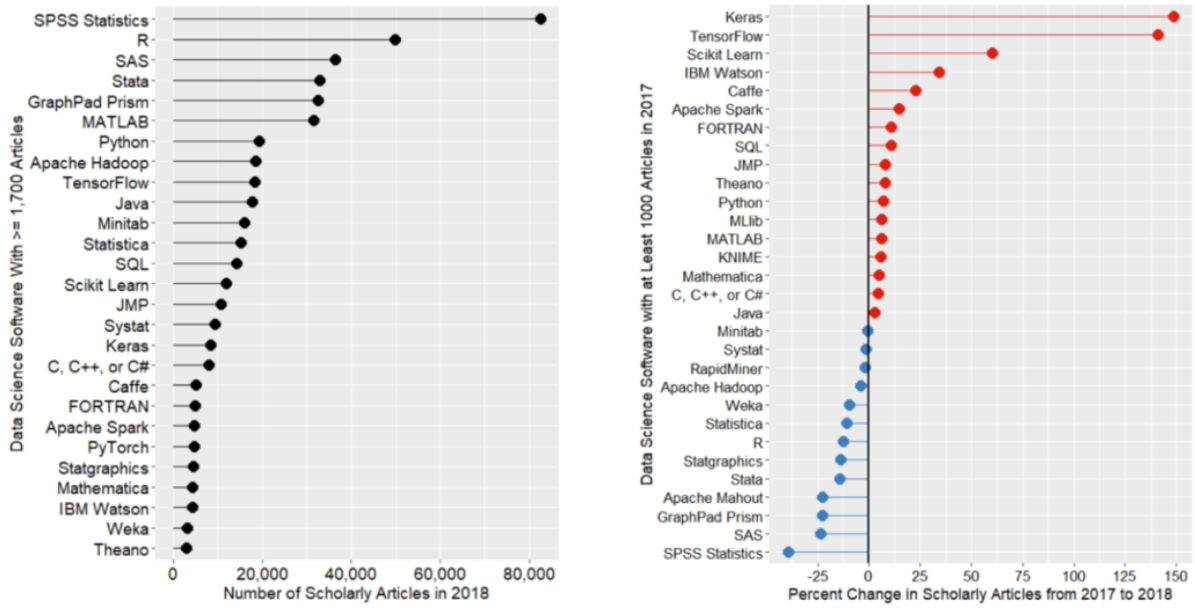


Note: From "The Popularity of Data Analysis Software," by R.A. Muenchen. 2019. http://r4stats.com/popularity

Regarding scholarly articles, SPSS dominated with over 80,000 Google Scholar articles in 2018, while R placed second with approximately 50,000 articles. Both R and SPSS showed a decline in scholarly article citations from 2017 to 2018, in which R fell approximately 10% and SPSS almost 40% (Figure 11).

Figure 11

Number and Change in Scholarly Article References for Data Science Software

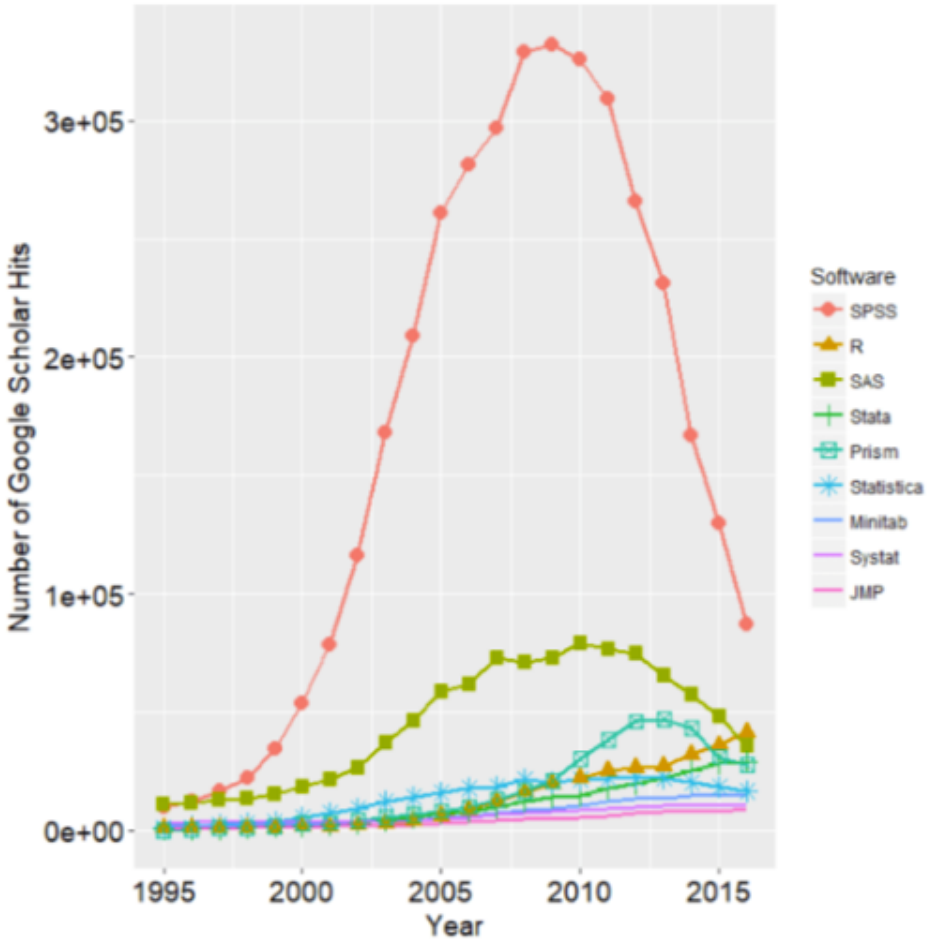


Note: From "The Popularity of Data Analysis Software," by R.A. Muenchen. 2019. http://r4stats.com/popularity

Furthermore, Figure 12 provides a visual comparison between the top programs cited in scholarly articles over the past 20 years.

Figure 12

Top Data Analytics Programs Cited in Scholarly Articles over 20 Year Period

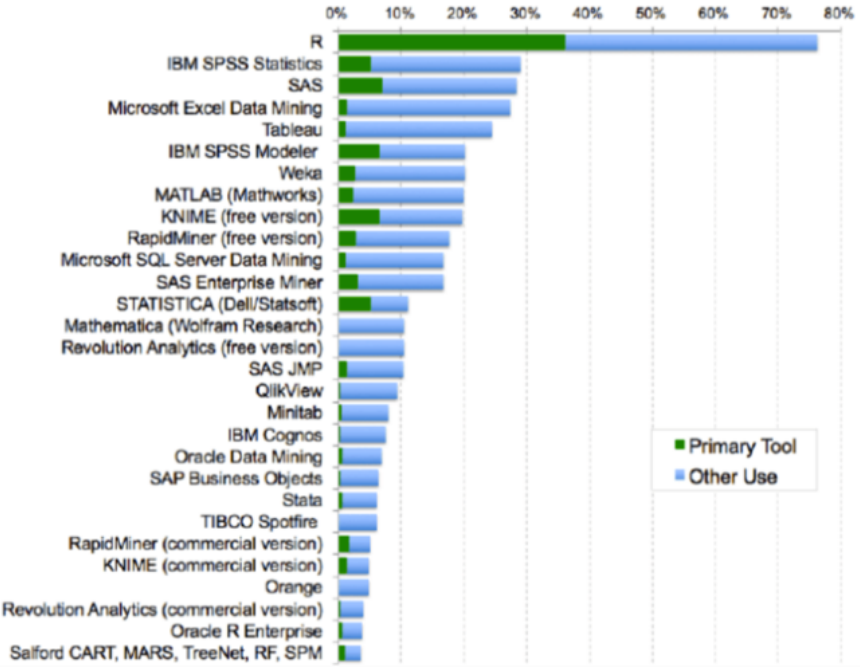


Note: From "The Popularity of Data Analysis Software," by R.A. Muenchen. 2019. http://r4stats.com/popularity

Finally, in 2015, Rexer Analytics conducted a survey about analytics tool use. Of the 1,220-person sample, 35% used R as their primary tool and 5% SPSS Statistics. See Figure 13.

Figure 13

Analytics Tools Used by 2015 Rexer Analytics Online Survey Participants



Note: From "The Popularity of Data Analysis Software," by R.A. Muenchen. 2019. http://r4stats.com/popularity

As evidenced in the findings above, Muenchen (2019) concludes his article by noting R's dominance and rising popularly in statistics and the social sciences. He also highlights the rise of software that uses a workflow or flowchart approach, such as SPSS Modeler, SAS Studio, and Microsoft Azure Machine Learning, to name a few. Numerous articles complement Muenchen's findings: In a 2009, the New York Times featured an article entitled "Data Analytics Captivated by R's Power" (Vance). The author cited industry-leading companies such as Google, Pfizer, Merck, Bank of America, the InterContinental hotels Group, and Shell who regularly use R. Within the article, associate director of clinical statistics at Pfizer, Max Kuhn, describes R as a "second language" (para. 23) for graduate school students entering the workforce. With similar praise, Dobre and Adam (2014) recognize the growing use of R within government agencies

across the globe. The Journal of Statistical Software (JSS), a periodical with the mission to "provid[e] an outlet for work on free statistical software, promoting free statistical software and open-access publishing…," reported that an incredible 577 out of 768 (75%) of all-time JSS articles have discussed R (Fox & Leanage, 2016). R is, quite apparently, a popular data analytics program that is on the rise.

R Conclusion

Choosing a statistics software is an important decision for college students and teachers alike (Fox & Anderson, 2005; Keeling & Pavur, 2007; Mitchell, 2007; Ward, 2013). The decision will likely have implications affecting the teaching and learning experience and will likely impact student marketability as well (Muenchen, 2019). Although SPSS has long been the program standard within academia, R has attracted much attention over recent years (Muenchen, 2019). SPSS is more user-friendly and long-established within many social science research communities. But SPSS lacks the same power, flexibility, and open-sourced nature of R. A user's choice in program may very well rest on intended purposes for its use. For those needing a program for either a limited time or to run relatively standard to moderately advanced statistics, SPSS is probably a sufficient option. As Burns (2007) stated, "If [all] I need [is] to find a plausible sounding hypothesis test that gives me a p-value less than 5% so I can publish my work," (p. 1) don't use R – use a more traditional statistics package such as SPSS. In other words, R is not for those who simply want to dabble with data. For instructors who have course timeline restrictions, the superior learnability and familiarity of SPSS may better suit your needs (Ward, 2013). Conversely, for students, instructors, and professionals with long-term intentions, advanced, or customized computing needs, R is probably the way to go (Fox & Anderson, 2005). Alternatively, several researchers advocate for knowing more than one program to utilize each of

their respective strengths (Mitchell, 2007; Grace-Martin, n.d.). For example, one may consider Excel or SPSS for data management and/or basic statistical analyses and then export those data sets into R for more complex or customized work.

Summary

In this chapter, SDT – as well one of its major sub-theories, basic psychological needs theory – was presented as a leading motivational metatheory, and SDT and BPN literature was reviewed in the context of sport. Research surrounding motivation in hockey and psychosocial skills within goaltending were explored and moderating factors such as age, gender, sport type, level of play, and autonomy supportive coaching reviewed. SDT continues to provide a valid and time-tested theoretical framework for measuring BSNS and motivation types across contexts, including sport. While the collective research generally affirms the tenants of SDT theory, some noteworthy discrepancies emerged. Autonomous supportive coaching appears to be an influential factor in supporting basic psychological needs and more self-determined motivation types. Findings from the reviewed literature informed the current study. The next chapter focuses on the methodology of this study, including the design, study population, instruments, data collection, and data analysis.

CHAPTER III:

METHODS

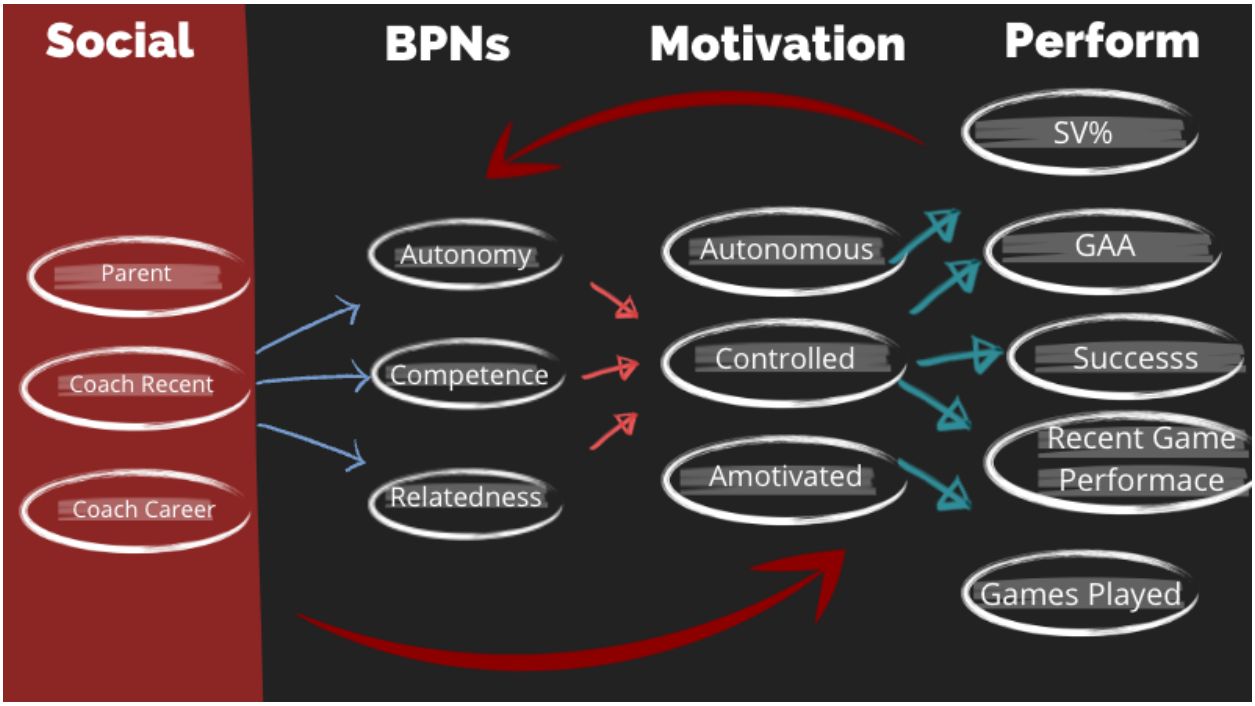
The purpose of this study was to measure goaltenders' BPNS, self-determined motivation, and then to assess the relationship these factors have with goaltender's perceived success and performance. The following chapter will outline how the study was conducted including research design, philosophical approach, statistics software, pilot study, research questions and hypotheses, participants and setting, data collection, instrumentation, data analysis, limitations, and ethical considerations.

Research Design

This study utilized a quantitative survey design, which served as an effective medium for collecting a combination of both objective (e.g., save percentage, goals against average, number of games played) and perception (e.g., BPNS, motivation, recent game performance, perceived success) data across goaltenders from various elite playing levels and locations. As justified in the previous chapters, SDT was identified as a valid theoretical framework for measuring goaltenders' BPNs and self-determined motivation. Furthermore, a review of prior qualitative and quantitative research suggests a relationship between social conditions, BPNS, motivation, and various positive outcomes. Figure 14 depicts a proposed, modified model representing the hypothesized relationship between social influences (i.e., number of parents who played hockey and amount of goalie coaching received), BPNS (i.e., autonomy, competence, and relatedness), motivation types (i.e., amotivation, controlled, autonomous), and outcomes (i.e., performance) within the context of ice hockey goaltending. The current pilot and dissertation studies tested this proposed goaltender psychosocial/performance model using various quantitative analyses, which will be elaborated up in upcoming sections.

Figure 14

Hypothesized Structural Model Between Social Influences, BPNs, Motivation, & Performance



Note: Adapted from Coach Autonomy Support, Motivation, and Objective Performance SEM in Gillet et al., 2010 and Communication Style, BPNS, Motivation, and Adaptive Outcomes in De Francisco et al., 2018.

Philosophical Approach

A post-positivism philosophy embraces the scientific and quantitative aspects of any given phenomenon while recognizing that absolute reality can neither be perfectly measured nor completely understood (Panhwar et al., 2017). Post-positivism, therefore, is an appropriate philosophical lens through which to study the physically and mentally complex position of goaltending. Goaltender psychology and motivation are understandably subjected to each individual's perceived experiences, while many of their classical performance metrics are more objective in nature. Such a post-positivist paradigm suggests that the results of this study have potential to meaningfully compliment the abundant qualitative and anecdotal literature around

goaltending psychology and performance. Therefore, this study will help to further approach, while never having fully described or wholly understood, these complex goaltending realities.

Statistics Software

Following an extensive literature review comparing SPSS (IBM Corporation, 2020), R (https://www.r-project.org/), and other programs, the decision was made to utilize a combination of statistical software for this study. Excel was used for the initial review and cleaning of datasets. R served as the primary analysis program for reasons cited in the literature review chapter, such as its flexibility, open-sourced nature, code reproducibility & transparency, and its no-cost status. Another open-sourced, free, online statistical software, Jamovi (https://www.jamovi.org/), was added relatively late in the study. Jamovi possesses a point-and-click GUI which utilizes R and R code to produce its visualizations and analyses. This program served as a helpful supplement and to verify and enrich R analyses. Upon request, any Excel, R, and/or Jamovi files or code can and will be shared. Next, the pilot study used to inform this dissertation research will be reported.

Pilot Study

The scarcity of scholarly work around goaltending psychology warranted additional, preliminary efforts. Therefore, a goaltender motivation pilot study was conducted in 2019 to inform subsequent dissertation design, research questions, analyses, and to test instrument validity in the context of goaltending. Pilot study research questions, hypotheses, participants and settings, data collection, measures, results, and limitations are included in the current methods chapter, instead of the results chapter, to underscore their primary, exploratory, and dissertation-informing purposes. The pilot study research questions were as follows:

RQ_{Pilot1}: What are goaltenders' levels of BPNS, motivation, performance, and perceived success?

RQ_{Pilot2}: What are the relationships between BPNS, motivation, performance, and perceived success?

RQ_{Pilot3}: Are there significant differences in BPNS, motivation, performance, and/or perceived success across gender, location, level of play, parent as former player, and frequency of goalie coaching received?

RQ_{Pilot4}: Does age predict goalie motivation?

RQ_{Pilot5}: Does BPNS predict goalie motivation?

RQ_{Pilot6}: Does BPNS and/or motivation predict goaltender perceived success and/or performance as measured by goals against average and/or save percentage?

Hypothesis

It was hypothesized that BPNS would predict motivation levels and that both BPNS and motivation would predict goaltender performance. However, due to the exploratory nature of some study and discrepancies within the literature, the anticipated results of other research questions were uncertain. As cited in the literature review, BPNS and motivation types can vary across factors such as age, gender, sport type, level of play, and social influences. The extent to which these variations would exist in the context of goaltending, if at all, was unclear, further strengthening the rationale for pilot study.

Research Procedures

The following section will address participants and setting, data collection, measures, data analysis, results, and will close with a summary for the pilot study.

Participants and Setting

The population of this pilot study was active United State ice hockey goaltenders 12 to 18 years of age. Participants reported belonging to youth, high school, and midget AAA hockey programs primarily throughout the US Midwest. This sample might best be described as a convenience sample, as the researcher utilized the listserv from his goalie coaching company. The intended population to represented was all North American youth goaltenders ages 12 – 18. Ethical permission to conduct the survey was obtained from University of North Dakota's (UND) Institutional Review Board (IRB).

Data Collection

Using Qualtrics (https://www.qualtrics.com), an electronic survey invitation (see Appendix A) was distributed to the parents or guardians of approximately 200 youth hockey goaltenders ages 12 – 18. Given minor status of these goaltenders, parents were asked to forward or share the survey with their child. Goaltenders were given approximately three weeks to voluntarily participate. Of the 200 goaltenders, 61 completed the survey – a response rate of 30%. Upon closure of the survey, data was downloaded in the form of a .csv file and stored on a password protected computer.

Measures

Most variables included in the pilot study were justified through the literature review. Several variables, however, were exploratory in nature (e.g., number of parents who played hockey, goalie's catch hand). The inclusion of these exploratory variables was rationalized by their potential to further categorize participants and to represent easily-reported, quantifiable social factors within the context of goaltending. The following are measures from the pilot study survey (see Appendix B).

Participant characteristics. Eight items were related to goaltender demographics and grouping variables. These included gender, age, race, whether goalies played during the current and/or previous seasons, location, level of play, and years of playing experience.

Social Factors. Three items were intended to measure social aspects around participants' goaltending experience. Items included whether either parent played hockey, whether either parent played goalie, and how often a goalie received goalie coaching. The goalie coaching question read "On average, how often do you receive goalie coaching?" and participants responded on a 5-point Likert scale with 1 = *never* to 5 = *more than once a week*.

Modified Basic Needs Satisfaction in Sports. The three BPNS factors of autonomy, competence, and relatedness were assessed using four modified items each from the Basic Needs Satisfaction in Sports Scale (BNSSS, De Francisco et al., 2018). All responses were based on a 5-point Likert scale with 1 = *strongly disagree* to 5 = *strongly agree*. For example, auto1 question read "As a goalie, I get opportunities to make my own choices." For comp1, "I am good at being a goalie." For relate1, "I have close relationships with people in hockey."

Motivation. The five factors within SDT motivation are intrinsic/integrated, identified, introjected, external, and amotivation. Each of these factors were assessed using four modified items each from Lonsdale et al. (2008) Basic Regulation in Sports Questions (BRSQ) to measure motivation. All responses were based on a 5-point Likert scale with 1 = *strongly disagree* to 5 = *strongly agree*. For example, intrinsic1 read "I am a goalie because I enjoy it." For identiy1, "I am a goalie because I learn things that are useful to me in other areas of my life." For introject1, "I am a goalie because I would feel bad if I quit." For external1, "I am a goalie because if I don't play others will be unhappy with me." For amotiv1, "I am a goalie, but I question why I continue."

Perceived Success. This five-item scale was used to measure goaltenders' subjective perceived success based on a measure created by Roberts et al. (1998). All responses were based on 5-point Likert scales with 1= *very unsuccessful* to 5 = *very successful*. For example, success 1 reads "Since you began playing goalie, how successful do you feel you are as a goalie overall?"

Performance. In the pilot study, performance was assessed using cumulative classical save percentage and goals against average. The questions read "What was your save percentage this past season?" and "What was your goals against average this past season?"

Data Analysis

Pilot study data review and cleaning was executed using Excel. Data analysis was completed by the researcher utilizing R as the primary data analytics program. For research question number one, "What are goaltenders' levels of BPNS, motivation, performance, and perceived success?" descriptive statistics were run on each variable and assumptions of normality assessed. Means and standard deviations were reported. Confirmatory factor analysis was used to test item reliability within goaltender BPNS, motivation, and perceived success. Variables measuring the same construct were averaged. For research question number two, "What are the relationships between BPNS, motivation, performance, and perceived success?" Pearson's correlation coefficient was calculated between quantitative variables, and significant correlations were reported. For research question number three, "Are there significant differences in BPNs, motivation, performance, and/or perceived success across gender, location, level of play, parent as player, and frequency of goalie coaching received?" variables were tested for homogeneity of variance then mean difference tests run. Group difference *t*-tests and ANOVAs were utilized for their respective variables. For research question number four, "Does age predict goalie motivation?" multiple regressions was used. Gender and whether goalie's

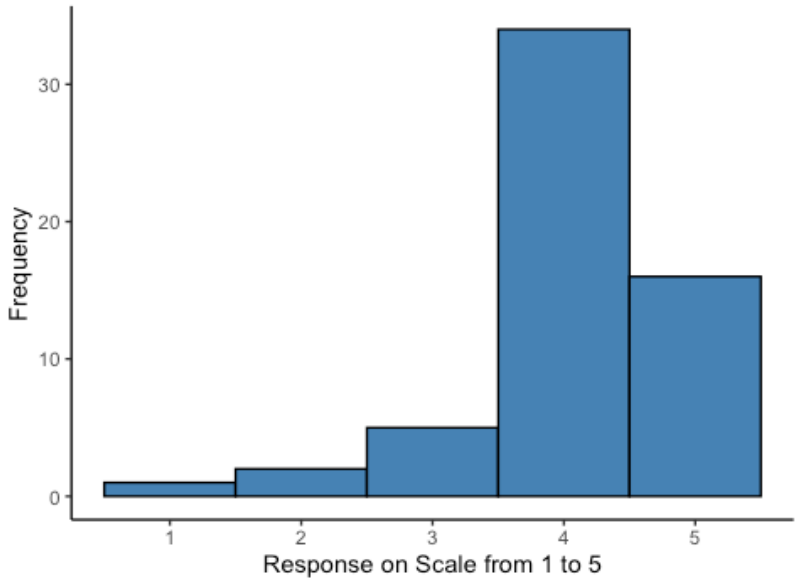
parents played hockey were tested for an interaction effect. For research question number five, "Does BPNS predict goalie motivation?" multiple regressions was used to test whether levels of BPNS predict motivation types. For research question number six, "Does BPNS and/or motivation predict goaltender performance and/or perceived success?" multiple regressions was used to test whether levels of BPNS or motivation predict perceived success and/or performance.

Results

Descriptive statistics were run on each variable and assumptions of normality assessed. According to Lei and Lomax (2005), a skewness between 1.0 and 2.3 is moderately nonnormal and above 2.3 severely nonnormal. Byrne (2010) proports that a kurtosis above 7.0 is an indicator of nonnormality. Several pilot study survey items were moderately skewed and lacked variability. For example, autonomy1 "As a goalie, I get opportunities to make my own choices" was moderately skewed left (see Figure 15), with a skewness of -1.28 and kurtosis = 2.66).

Figure 15

Distribution Study Autonomy Question 1 (Pilot)



Note: Autonomy was measured on a Likert scale of 1 = *strongly disagree* to 5 = *strongly agree*.

Items within each construct (e.g., autonomy) were later averaged, which improved distributions. Principal components analysis was used to confirm factors within BPNS, motivation, and perceived success (Table 3)

Table 3

Correlation of Subscale Constructs and Measures of Internal Consistency for BPNS, Motivation, and Perceived Success (Pilot)

Construct	Items	Subscale	C2	C3	C4	C5	C6	C7	Cronbach Alpha
C1	auto 1, 2, 3, 4	autonomy	.53*	.38*	.44*	-.31*	-.37	.48*	.51
C2	comp 1, 2, 3, 4	competence		.14	.42*	.26	-.48*	.62*	.74
C3	relate 1, 2, 3, 4	relatedness			.43*	-.10	.01	.31*	.71
C4	auton 1, 2, 3, 4	autonomous				-.11	-.46*	.38*	.80
C5	control 1, 2, 3, 4	controlled					.50*	.13	.82
C6	amotiv 1, 2, 3, 4	amotivation						-.29*	.84
C7	success 1, 2, 3, 4	success							.74

Note: * $p < .05$.

Notice that most constructs were above the acceptable $\alpha = .70$ (Warner, 2012) except for autonomy, which demonstrated an $\alpha = .51$. However, given the strong theoretical SDT framework, questions based upon established measures (i.e., BNSSS; De Francisco, Parra et al., 2018), and that dropping other autonomy items did not significantly improve alpha (dropping autonomy1 or autonomy2 increased alpha by only .04), all autonomy items were retained. For the dissertation survey, autonomy items were reconsidered to improve construct validity.

For research question number one, “What are goaltenders’ levels of BPNS, motivation, perceived success, and performance?” descriptive statistics were analyzed per each construct (see Table 4) and histograms were used to visualize distributions (see Figure 16).

Table 4

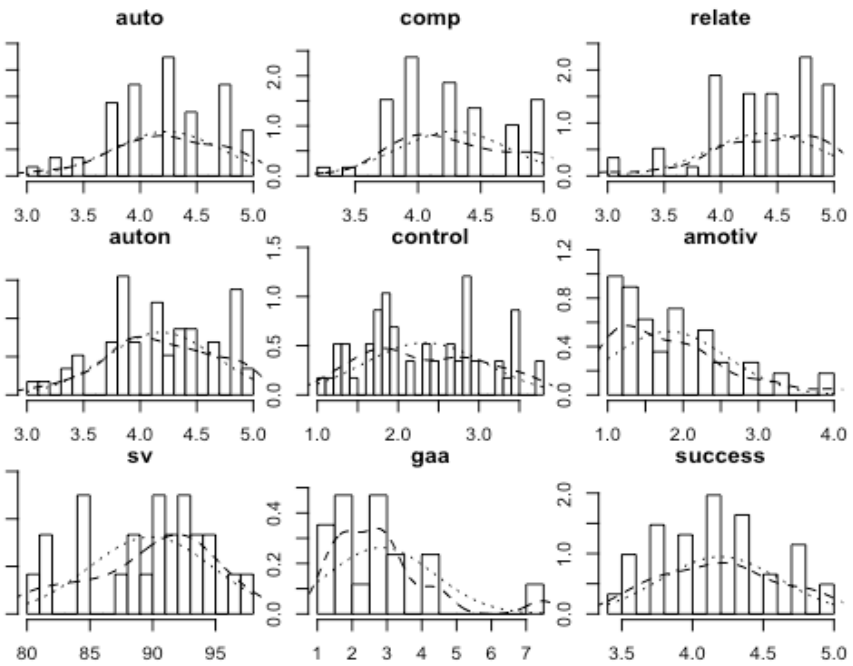
Descriptive Statistics of Goaltender Motivation Pilot Study, Sample Size, Mean, Standard Deviation, Skewness, and Kurtosis (Pilot)

Construct	Description	N	*M*	*SD*	*Skew*	*k*
Auto	Average of autonomy BPNS items	58	4.24	0.48	-0.31	-0.46
Comp	Average of competence BPNS items	59	4.28	0.45	0.13	-0.91
Relate	Average of relatedness BPNS items	58	4.39	0.50	-0.80	0.26
Auton	Average of autonomous motivation items	58	4.19	0.49	-0.19	-0.62
Control	Average of controlled motivation items	58	2.33	0.75	0.19	-1.13
Amotiv	Average of amotivation items	56	1.81	0.76	1.03	0.56
Sv	Save percentage	24	89.87	4.93	-0.46	-0.81
GAA	Goals against average	17	2.84	1.52	1.57	2.41
Success	Average of perceived success	61	4.20	0.42	0.12	-0.88

Note: [a] For BPNS, motivation types, and perceived success a Likert scale of 1 = *strongly disagree* and 5 = *strongly agree* was used. [b] SV% is calculated by cumulative saves divided by cumulative shots against [c] GAA is calculated by total goals against divided by number of games played.

Figure 16

Distribution of Continuous Variables (Pilot)

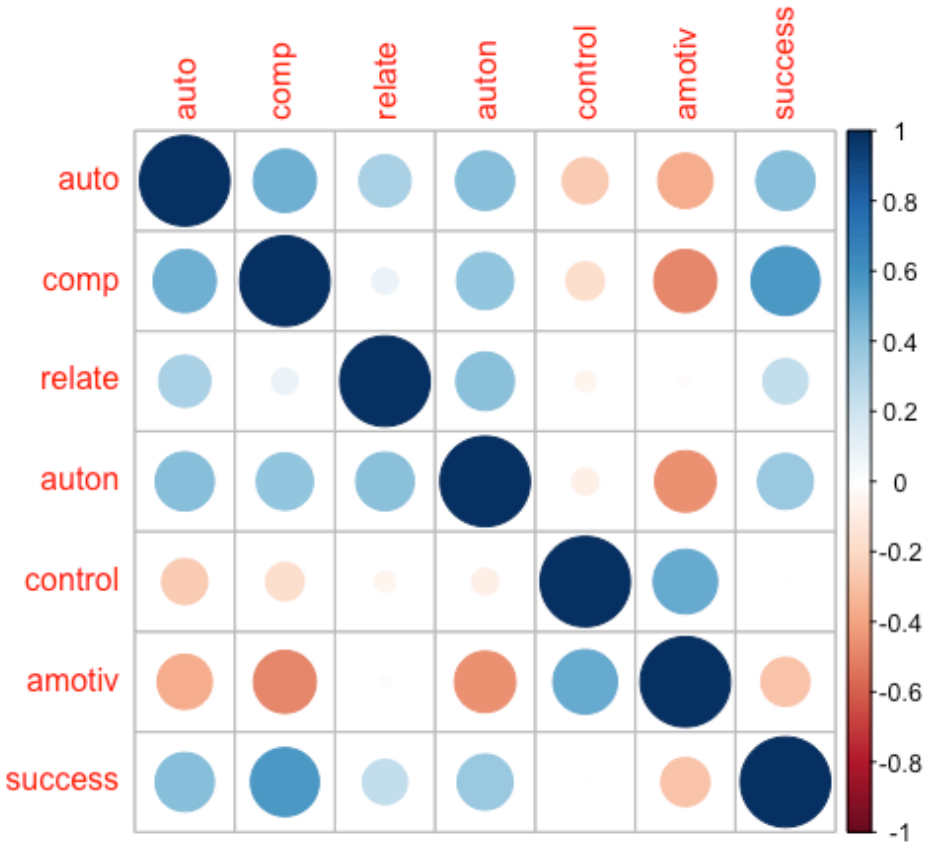


Notice that normality is acceptable for most constructs except for goals against average. This lack of normality is likely due to the low response rate of the goals against average item ($N = 17$). Similarly, save percentage had a much lower sample size than other variables ($N = 24$). These low response rates may have been due to many youth goaltenders' lack of statistical tracking. As a result, the perceived success construct was utilized as the primary performance metric for the pilot study.

For research question two, "What are the relationships between BPNS, motivation, perceived success, and performance?" Pearson's correlation coefficients were calculated between constructs (see Figure 17).

Figure 17

Correlogram of Correlations Between Constructs (Pilot)



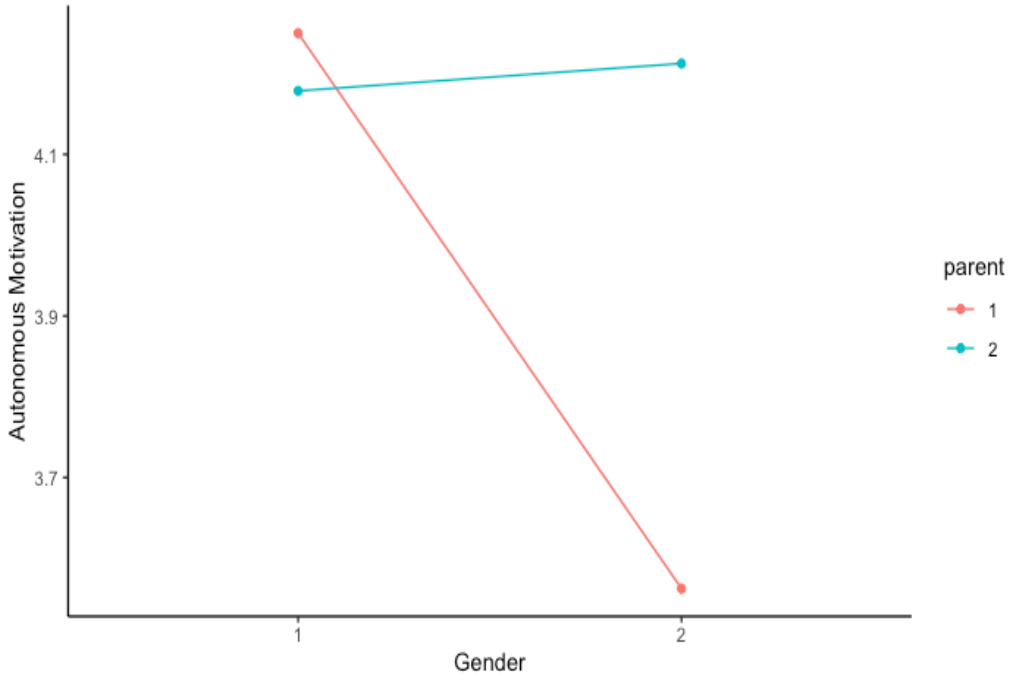
The relationship between most constructs was significant. Some of the strongest correlations were between competence and success (R =. 62), autonomy and competence (R = .53), controlled motivation and amotivation (R = .50), competence and amotivation (R = -.48), and autonomy and success (R = .48). Except for controlled motivation, all constructs demonstrated significant relationships with perceived success. These results largely corroborate with SDT; however, relatedness did not have a significant relationship with controlled motivation or amotivation. This result would imply that the feelings of being cared for by and connected to important others may not be associated with less self-determined forms of motivation in youth ice hockey goaltenders. Significant correlations between all BPNS factors and both autonomous motivation and perceived success support SDT tenets as well as the current study hypothesis.

Regarding research question number three, "Are there significant differences in BPNS, motivation, perceived success, and/or performance across gender, location, level of play, parent as player, and frequency of goalie coaching received?" variables were tested for homogeneity of variance then mean difference tests such as *t*-tests and ANOVA conducted. Minimal significant results were noted when measuring differences between the aforementioned categories. Males, however, demonstrated significantly higher levels perceived success than females, $t(20) = 2.16$, $p < .05$. This result warrants further investigation in the role gender plays in goaltenders' psychological perceptions. The lack of significant differences across level of play, parent as player, and frequency of goalie coaching received did not support the study hypothesis. However, the relatively low sample size (N = 61 and as low as N = 17 for save percentage) may have contributed to decreased statistical power of these tests.

Gender and whether goalie's parents played hockey was tested for an interaction effect on motivation. Note that previously the data demonstrated no significant difference in motivation between goalies whose parents played hockey and those whose parents had not. Interestingly, however, an interaction between gender and parent as player can be seen when measuring goaltender motivation (i.e., autonomous, controlled, and amotivation). See Figure 18 below for an example using autonomous motivation.

Figure 18

Autonomous Motivation Across Gender and Parent as Player (Pilot)



Note: Autonomous motivation was measured on a Likert scale of 1 = *strongly disagree* to 5 = *strongly agree*. For gender 1 = *male* and 2 = *female*. For the parent variable 1 = *yes, at least one parent played hockey* and 2 = no, *neither parent played hockey*.

This interaction suggested a potential role gender has in goaltender motivation. Specifically, for goalies whose parents had played hockey, there were noticeably lower levels of autonomous motivation for females than males, while, for goaltenders whose parents had not

played hockey, a smaller difference between male and female autonomous motivation was evident. It is important to note that these interactions were not statistically significant. Like many of the pilot study analyses, however, small sample size was likely a factor.

For research question number four, "Does age predict goalie motivation?" a simple linear regression model was used with age as the independent variable and each motivation type (i.e., amotivation, controlled motivation, and autonomous motivation) as the dependent variables. A significant regression equation was found for age predicting amotivation ($F(1, 54) = 8.36$) but not for other types of motivation. See Table 5.

Table 5

Predicting Amotivation from Age (Pilot)

Predictors	Autonomy		
	B	*SE*	β
(Intercept)	-.07	.66	
Age	.13	.05	.37**
R^2		.13***	

Note: $^{+}p = .06$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Rationale for age predicting amotivation but not autonomous or controlled motivation types is uncertain. According to Chandler and Connell (1987; as cited in Ryan & Deci, 2000), regulatory styles tended to become more internalized and self-regulated as children age. One explanation is that as youth goaltenders age and teams become more competitive, second or third string goalies begin to experience less playing time and, as a result, become amotived. However, number of games played and starting status were not measured in this pilot study. Results continue to inform the dissertation study design.

For research question number five, "Do BPNS significantly predict goalie motivation?" multiple regressions was used to test if autonomy, competence, and relatedness predict

autonomous, controlled, and/or amotivation. Significant models were found for autonomous motivation ($F(3, 53) = 8.97$) and amotivation ($F(3, 51) = 6.02$) but not for controlled motivation ($F(3, 53) = 2.13$, $R^2 = .11$, $p > .05$). For the autonomous motivation model, competence and relatedness were statistically significant predictors, and for the amotivation competence was statistically significant (Tables 6 and 7).

Table 6

Predicting Autonomous Motivation from Autonomy, Competence, and Relatedness (Pilot)

Predictors	Autonomous Motivation		
	B	*SE*	β
(Intercept)	.66	.68	
Autonomy	.17	.14	0.17
Competence	.32	.14	0.29*
Relatedness	.33	.12	0.33**
R^2		.34***	

Note: $^{+}p = .06$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Table 7

Predicting Amotivation from Autonomy, Competence, and Relatedness (Pilot)

Predictors	Amotivation		
	B	*SE*	β
(Intercept)	5.52	1.19	
Autonomy	-0.35	0.24	-.21
Competence	-0.67	0.24	-.39**
Relatedness	0.14	0.20	.09
R^2		.26**	

Note: $^{+}p = .06$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

These findings suggest competence is an especially important factor when predicting goaltender motivation. These results align with numerous other studies demonstrating competence as an especially predictive BPNs (De Francisco et al., 2018; Cerasoli et al., 2016; Schüler & Brandstätter, 2013). Surprisingly, however, the BPN of autonomy was not a

significant predictor of any motivation type. One possible explanation is that, given goaltending's highly technical nature, competence supersedes the other BPNs. For all motivation type models, the covariates of age, gender, and goalie coaching frequency did not noticeably improve the effect sizes. See Table 8 for autonomous motivation model (F (6, 50) = 4.46).

Table 8

Predicting Autonomous Motivation from BPNS, Age, Gender, and Coaching (Pilot)

Predictors	Autonomous Motivation		
	B	*SE*	β
Intercept	.28	.96	
Autonomy	.15	.15	.15
Competence	.35	.15	.32*
Relatedness	.33	.12	.33**
Age	.01	.03	.02
Gender [a]	.07	.14	.06
Coach	.04	.06	.09
R^2		.35**	

Note: [a] 0 = *female* and 1 = *male*.
+ p = .06; * p < .05; ** p < .01; *** p < .001.

For research question number six, "Do BPNS and/or motivation predict goaltender perceived success and/or performance?" multiple regressions was used to test whether levels of BPNS and/or motivation predict goalies' performance and/or perceived success. Age, gender, and goalie coaching frequency were used as covariates. Findings reveal that collectively BPNs (i.e., autonomy, competence, relatedness) and motivation levels (i.e., autonomous, controlled, and amotivation) significantly predict goaltenders' perceived success, F(6, 48) = 5.51). However, competence was again the only significantly predictive variable in the model (see Table 9).

Table 9

Predicting Perceived Success from BPNS and Motivation (Pilot)

Predictors	Perceived Success		
	B	*SE*	β
(Intercept)	0.97	.72	
Autonomy	0.12	.12	0.14
Competence	0.43	.13	0.47**
Relatedness	0.12	.11	0.15
Autonomous	0.04	.12	0.05
Controlled	0.09	.07	0.17
Amotivated	-0.04	.08	-0.07
R^2		.41**	

Note: $^{+}$ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$.

This finding further supports the importance of competence within the youth goaltender experience. The covariates of age, gender, and amount of goalie coaching received did not significantly change the effect size. One rationalization is that competence is especially important in youth hockey, as goalies are building foundational knowledge and skillsets. Regarding performance (i.e., save percentage and goals against average), the model of BPNs and motivation types were not significant with or without covariates. Recall that save percentage and goals against average sample sizes were quite small, which posed challenges for these and other statistical tests. Alternatively, these results involving the use of save percentage and goals against average may serve as further evidence challenging their usefulness as goalie performance metrics (Daccord, 2021).

Limitations

The sample size of $N = 61$ created issues with statistical power and generalizability. The below-average internal reliability of the autonomy construct ($\alpha = .51$) may have been a resultant sample size issue and suggests that these averaged items may not properly represent the intended

latent variable of autonomy. As a result, some pilot study analyses involving autonomy could be untrustworthy. However, this sample size was among the largest the researcher had found regarding empirical ice hockey goalie psychology research at that time. Efforts were made to substantially increase the sample size for the dissertation study.

Upon preliminary review of the data, there appeared to be a low completion rate of objective performance measures such as save percentage and goals against average. Many youth goaltenders may not track goalie statistics. The dissertation study of goaltenders 18 years and older provided a much more robust set of performance analytics.

Pilot study data indicated low variability on most every BPNS, motivation, and perceived success scale. The reason behind this lack of variance is unknown; however, one possibility is that some of the younger goalies (as young as age 12) may not have understood the questions. Another explanation is that, given the listserv utilized, most goaltenders who participated in the survey were both within relatively close proximity and had, in at least some capacity, trained with the same group of coaches.

Finally, this study is not longitudinal, experimental, nor quasi-experimental. Rather, inferential and predictive statistics were utilized to establish a better understanding of the current goaltender psychological and performance realities as well as their relationships with one another. These analyses therefore do not have the power to imply causation.

Summary

To summarize the above findings, 61 youth ice hockey goalies ages 12 – 18 participated in a survey measuring their characteristics, BPNS, motivation, perceived success, and performance. Data was cleaned, construct items averaged, and factor analysis run on the latent variables of autonomy, competence, relatedness, amotivation, controlled motivation, autonomous

motivation, and perceived success. These aforementioned factors were confirmed using principal components analysis and all except autonomy demonstrated internal consistency. Due to the use of previously established and modified scales, strong theoretical underpinnings, and the fact that dropping items did not improve Cronbach's alpha, autonomy was kept for us in study analyses.

Results demonstrated that, counter to the study hypothesis, BPNs levels were relatively high, autonomous motivation was high, controlled motivation relatively low, and amotivation was low. On average, perceived success scored relatively high as well. Performance metrics of save percentage (n = 24) and goals against averages (n = 17) were both within reasonable ranges; although, goals against average possessed moderate skewness. Due to the low save percentage and goals against average sub-sample sizes, the perceived success variable was utilized as the primary performance metric. Relationships between most BPNS, motivation, and perceived success constructs were significant. As SDT asserts, all BPNS significantly correlated with autonomous motivation; also, all BPNS and motivation types, except for controlled motivation, positively associated with perceived success. The data indicated that, of the group differences tested, the only significant result was higher male perceived success than female. Although no significant difference was found in autonomous motivation across whether or not goalie parents had played hockey, and interaction between autonomous motivation and gender was observed; namely, results demonstrated a much smaller (although non-significant) difference between male and female autonomous motivation when neither parent had played hockey than between males and females whose parents had played.

When attempting to use BPNS to predict motivation, significant multiple regression models were found for autonomous motivation and amotivation. For autonomous motivation both competence and autonomy were significant predictors, and only competence was

significantly predictive of amotivation. Finally, the model using BPNS, all motivation types, and age, gender, and goalie coaching frequency significantly predicted goalies' perceived success; competence was the only significant factor. Neither save percentage nor goals against average models using those same predictors were significant.

The primary purpose of the pilot study was to test instrument validity in the context of goaltending and to inform the dissertation. The exploratory nature of goaltender-specific scholarship and low sample size may have contributed to relatively few significant results. Yet, the pilot study arguably served its intended, dissertation-informing purposes. Numerous adjustments to the study design and survey items were made. Next, the dissertation study will be addressed.

Dissertation Study

As noted above, the pilot study and literature review informed this dissertation. One notable difference was the recruitment of an older goaltender population, those 18 years and older who had recently played competitively (e.g., juniors, college, professional). This increase in age and experience provided greater insights into elite-level goaltender psychology and performance. Furthermore, older goaltenders were more likely to know their performance metrics, such as save percentage, goals against average, and number of games played, thereby increasing the number of responses to those important measures. Below are the dissertation research questions which were modified or expanded based on pilot study results and continued literature review.

Research Questions

RQ_1: What are goaltenders' levels of BPNS, motivation, perceived success, and performance as measured by save percentage, goals against average, number of games played, and recent game performance?

RQ_2: What are the relationships between social factors, BPNS, motivation, perceived success, performance, and social influences (i.e., number of parents who played hockey and frequency of goalie coaching received)?

RQ_3: Are there significant differences in BPNS and/or motivation across gender, level of play, starter status, and/or number of parents who played hockey?

RQ_4: Do social factors such as frequency of goalie coaching received and/or number of parents who played hockey predict BPNS?

RQ_5: Do social factors and/or BPNS predict goalie motivation?

RQ_6: Do social factors, BPNS, and/or motivation predict goaltender perceived success?

RQ_7: Do social factors, BPNS, and/or motivation predict goaltender performance as measured by save percentage, goals against average, games played, or recent game performance, beyond the effects of age, gender, covid, BMI, and injury?

Research Procedures

The following section will address participants and setting, data collection methods, survey measures, an explanation of the data analysis, ethical considerations, and limitations of the dissertation study.

Participants and Setting

The population of this study was North American and international ice hockey goaltenders ages 18 and older. These athletes belonged to high school, midget AAA, junior,

college, semi-professional, or professional leagues throughout the US, Canada, and internationally. An electronic survey (see Appendix B) was distributed through social media (see Appendix C for digital poster and Appendix D for social media script) and email (see Appendix D for recruitment email). Contacts and contact lists were obtained through organizations such as USA Hockey, NCAA, ACHA, junior hockey leagues, and international goaltender groups such as The Goalie Guild, Network Goaltending, and the researcher's other personal and professional coaching networks. Ethical permission to conduct the survey was obtained from University of North Dakota's (UND) Institutional Review Board (IRB). See Appendix F.

Data Collection

Using Qualtrics, an electronic survey (see Appendix B) was distributed to an approximated 500 North American and international ice hockey goaltenders through various goaltending databases, HS/Junior/College/Pro hockey associations, their respective networks, and social media. Reminder emails and social media posts were sent three weeks after the initial survey launch. The survey was closed two weeks later and survey data downloaded. Ethical permission to conduct the survey was obtained from University of North Dakota's (UND) Institutional Review Board (IRB).

Measures

Pilot study results and continued literature review informed numerous changes to the dissertation survey. Several items were added to the participant characteristics including height, weight, country of origin, location, race, playing experience, catch hand, starting status, whether the goalie played in their team's last game, injury frequency, frequency of goalie coaching received, and if the goaltender plans to play in the next season. Also, given lower than expected internal reliability in the pilot, several BPN and motivation items were modified with the

intention of improving their variance and reliability. Lastly, items were added to expand the number and type of metrics used to measure goalie performance; these additional measures included number of games played, percentage of games played, most recent game performance, and most recent game outcome. Below is a more detailed description of each measure category.

Participant characteristics. There were 22 items related to demographics and goaltender information. These include gender, age, height, weight, country of origin, state/province of origin, race, years of hockey experience, years of goalie experience, number of parents who played hockey, number of parents who played goalie, catch hand, current playing status, level of play, starting status (i.e., starter, second string, third string), injury frequency, amount of goalie coaching received during most recent season, amount of goalie coaching received throughout career, and anticipated likelihood of playing next year. The goalie coaching received questions was modified to read "On average, how often have you received goalie-specific coaching during your most recent season (or throughout career)?" and participants responded on a 5-point Likert scale with 1 = *never* to 5 = *very often*.

Modified Basic Needs Satisfaction in Sports. The three BPNS factors of autonomy, competence, and relatedness were assessed, this time using five, instead of four, modified items from the Basic Needs Satisfaction in Sports Scale (BNSSS, De Francisco et al., 2018). Five BPNS items were modified to improve internal reliability and to accommodate an older, more experienced goalie population. The items added were autonomy5 "As a goalie, I feel in control," comp5 "As a goalie, I feel competent to achieve my objectives," and relate5 "In hockey, I feel included." All responses were based on a 5-point Likert scale with 1= *strongly disagree* to 5 = *strongly agree*.

Motivation. The five factors within SDT motivation are intrinsic/integrated, identified, introjected, external, and amotivation. Each of these factors were assessed using five modified items from Lonsdale et al. (2008) Basic Regulation in Sports Questions (BRSQ) to measure motivation. These were collapsed into autonomous motivation, controlled motivation, and amotivation. Three of the pilot study motivation items were modified to improve internal reliability. All responses were based on a 5-point Likert scale with 1= *strongly disagree* to 5 = *strongly agree*. For example, intrinsic1 reads "I am a goalie because I enjoy it." For indentiy1, "I am a goalie because it helps me learn things that are useful in other areas of my life." For introject1, "I am a goalie because I would feel bad if I quit." For external1, "I am a goalie because if I don't play others will be unhappy with me." For amotiv1, "I am a goalie, but I question why I continue."

Perceived Success. This six-item scale was used to measure goaltenders' subjective perceived success and was based off a measure created by Roberts et al. (1998). One item was added to this scale after piloting the study – success6 reads "As a goalie, how successful do you feel about your recent goaltending accomplishments?" All responses are based on a 5-point Likert scale with 1= *very unsuccessful* to 5 = *very successful*.

Performance. In the pilot study, performance was measured using cumulative classical save percentage and goals against average. However, several items were added to the dissertation performance metrics including number of games played, percentage of total games played, most recent game performance, and most recent game outcome. The most recent game performance question read "How would you rate your performance in the last game you played?" as rated on a 5-point Likert scale with 1 = *poor* to 5 = *excellent*.

Explanation of Data Analysis

Data analysis was completed utilizing R as the primary data analytics program. For research question number one, "What are goaltenders' levels of BPNS, motivation, perceived success, and performance (i.e., sv perc, gaa, games played, recent game performance)?" descriptive statistics was run on each variable and assumptions of normality assessed. Means and standard deviations were reported. Exploratory factor analysis was used to test internal reliability of BPNS, motivation, and perceived success factors. Once confirmed, variables measuring the same construct were averaged. For research question number two, "What are the relationships between BPNS, motivation, performance, and perceived success?" Pearson's correlation coefficient was calculated between quantitative variables, and significant correlations were reported. For research question number three, "Are there significant differences in BPNS and/or motivation across gender, level of play, starter status, number of parents who played hockey, frequency of goalie coaching received, and/or covid?" variables were tested for homogeneity of variance then mean difference tests conducted. For their respectively appropriate variables *t*-tests and ANOVAs were utilized. Gender and whether goalie's parents played hockey was tested for an interaction effect.

For research question number four, "Do social factors such as amount of goalie coaching received and/or number of parents who played hockey BPNS?" multiple regressions was used. For research question number five, "Does BPNS predict goalie motivation?" multiple regressions was used to test the association between these variables. For research question number six, "Do social factors, BPNS, and/or motivation predict goaltender perceived success?" a multiple regressions model was used to test whether number of parents who played hockey, frequency of recent and/or career goalie coaching, BPNS, and/or motivation predicted perceived success.

Finally, for research question seven, “Do social factors, BPNS, and/or motivation predict goaltender performance” hierarchical multiple regressions was used to measure if number of parents who played hockey, frequency of recent and/or career goalie coaching, BPNS, and motivation type predicted goalie performance as measured by save percentage, GAA, games played, or recent game performance. Age, gender, covid, and injury were used as covariates in each of the regression models; BMI was added as an additional control variable for performance models. Results are reported in chapter four.

Ethical Considerations

Several ethical issues surround the pilot and dissertation studies. First, it is important to acknowledge the researcher’s goalie playing experience, goalie coaching involvement, and affiliation with and ownership of a goalie training/consulting company. While these roles provide potentially valuable insights into the goaltender experience, they serve as liabilities in the form of potential biases and conflicts of interest. Perceived problems, research purposes, study significance, assumptions, and interpretation of results may have been consciously or subconsciously influenced by the researcher’s background. For example, the researcher’s own goalie experience and goalie coaching network likely influenced the volume, direction, and type of literature reviewed. Similarly, the participant sample was likely impacted by the researcher’s available network reach and therefore potentially misrepresentative of the population of interest. Secondly, the researcher’s affiliation with goalie coaching and a goalie consulting company may have impacted the study research questions, hypotheses, and especially the interpretation of any results involving the frequency of goalie coaching received.

Now that we have discussed participants and setting, data collection methods, survey measures, an explanation of the data analysis, ethical considerations, and limitations of the dissertation study, the dissertation results will be presented in the next chapter.

CHAPTER IV:

RESULTS

The purpose of this study was to better understand the psychosocial elements of goaltending by measuring goaltenders' BPNS, self-determined motivation, and assess how these factors relate to goaltender performance. North American and international ice hockey goaltenders
(N = 180) ages 18 and older completed a survey measuring participant characteristics, BPNS, motivation, perceived success, and performance. Results will inform the hockey community on how to better support goaltender development within psychosocial contexts. In this chapter, the results of the study are shared. First, the data cleaning process is discussed, then demographics and participant information reported, and finally each research question analysis is presented.

Explanation of Data Analysis

The following sections will elaborate on data cleaning, sample size, participant characteristics, factor analysis, averaging of latent variables, and preliminary correlations between these latent variables.

Data Cleaning and Sample Size

Upon survey closure, the dataset was downloaded from Qualtrics as a .csv file. Data was previewed and cleaned. The original number of responses was N = 244 which included all participants who opened the survey. The sample size reduced to N = 237 when considering only those who responded to one or more survey items. After eliminating participants who answered the demographics questions but none or very few other survey items, a sample size N = 219 resulted. A sample size of N = 204 followed once considering only participants who answered at least half of all survey questions and confirmed they had played competitively within either the

2019-2020 or 2020-2022 seasons. Outliers for age were calculated and participants over the age of 40 were removed. This decision was further justified when recognizing regulations that disallow hockey players of this age to play juniors (USA Hockey, 2021) or college hockey (NCAA, 2021); additionally, very few ice hockey goalies play professionally after age 40 (e.g., https://www.nhl.com/player). The resulting sample size was *N*=189. Finally, upon further examination, additional participants' ages did not align with their reported most current level of play (e.g., juniors, college, pro). Therefore, these participants were removed as well, resulting in a final *N* = 180 for analysis.

Participant Characteristics

Data analyses were completed utilizing R (https://www.r-project.org/) as the primary data analytics program. Jamovi (https://www.jamovi.org/) was used as an additional statistics program to confirm or supplement results when needed. Descriptive statistics were run on each variable and assumptions of normality assessed. See Table 10 below for participant characteristics.

Table 10

Participant Characteristics

Measure	*n*	%
Gender		
Male	145	80.6
Female	35	19.4
Level of Play		
HS/Midget/AAA	10	5.8
Juniors	32	18.7
ACHA or College Club	46	26.9
NCAA College	55	32.2
Professional	28	16.4
Country of Play		
United States	142	78.9
Canada	16	8.9
Czech Republic	5	2.8
Germany	4	2.2
Finland	3	1.7
Switzerland	1	0.6
Australia	2	1.1
Austria	1	0.6
Italy	1	0.6
Russia	1	0.6
Slovak Republic	1	0.6
Sweden	3	1.7
Role		
Starter	87	50.6
Second String	65	37.8
Third String	20	11.6

Note: (N = 180). Participants were on average 23.6 years old (SD = 4.6).

Most of the study participants were male goaltenders playing competitive hockey within either the United States or Canada; however, study participants had most recently played in a total of 12 different countries. Given the influence of the Covid 19 pandemic, goalies could qualify for the survey if they had played in either the 2019-2020 or 2020-2021seasons. All but 21 goalies (11.7%) reported playing in the then current 2020-2021 season, 12 (6.6%) of whom did not participate due Covid cancelations. Participants were asked how Covid affected their season:

Of the 159 participants who played in 2020-2021, 11 goalies (5.0%) responded with “No, not affected,” 94 goalies (52.2%) responded "Yes, delayed/interrupted,” and 66 goalies (36.7%) responded “Yes, cancelled.” Due to the pandemic’s effect on many teams’ seasons, Covid was used as a control variable in most of the study’s regression models which will be reported later.

Factor Analysis

Next, the latent variables of BPNs (i.e., autonomy, competence, and relatedness), motivation/regulation types (i.e., amotivated, external, introjected, identified, integrated, and intrinsic), and perceived success were factor analyzed. All the items within these constructs displayed approximately normal distributions. See Table 11 and 12 below for exploratory factor analysis results.

Table 11

Results From a Factor Analysis of Basic Psychological Needs Satisfaction Items

BPNS item	Factor loading		
	1	2	3
Factor 1: Autonomy			
Auto1. As a goalie, I get opportunities to make my own decisions.	**.66**	−.03	.08
Auto2. Being a goalie is genuinely what I want to be doing right now.	**.74**	−.09	.11
Auto3. I play goalie the way I want.	**.71**	−.05	.00
Auto4. As a goalie, I am pursuing objectives that are my own.	**.43**	.06	.28
Auto5. As a goalie, I feel in control.	.16	**.54**	.25
Factor 2: Competence			
Comp1. I am a capable goalie.	**.81**	−.09	.11
Comp2. As a goalie, I can overcome challenges.	**.77**	−.16	.02
Comp3. I am a skilled goaltender.	**.50**	.11	.29
Comp4. I have the ability to perform well as a goalie.	**.60**	.12	.27
Comp5. As a goalie, I feel competent to achieve my objectives.	.25	**.38**	**.38**
Factor 3: Relatedness			
Relate1. I have close relationships with people in hockey.	**.82**	.15	−.23
Relate2. There are people in hockey who care about me.	**.65**	.24	−.12
Relate3. I care about others in hockey.	**.72**	.00	−.05
Relate4. In hockey, there are people who I can trust.	**.50**	**.44**	−.04
Relate5. In hockey, I feel included.	-.10	**.80**	−.04

Note: N = 180. The extraction method was exploratory factor analysis with an oblimin rotation. Factor loadings above .30 are in bold. Adapted from "Preliminary empirical validation of the "Basic Needs Satisfaction in Sport Scale" with a sample of Spanish athletes," by C. De Francisco, F.J. Parra, C. Arce, and M.D. Vílchez, 2018, *Frontiers in psychology*, *9*, 1057. (https://doi.org/10.3389/fpsyg.2018.01057). Copyright 2018 by De Francisco, Parra, Arce and Vilchez. CC BY.

Notice that BPN items primarily loaded onto one factor. There are a few plausible explanations for this outcome. One is that the BPNs of autonomy, competence, and relatedness are naturally intercorrelated. This not only seems reasonable (e.g., one who perceives greater competence could feel more autonomous or related to others, especially within competitive sport contexts) but is theorized to be true (Ryan & Deci, 2000). Alternatively, it is possible that the items were either not representative of their respective constructs or ill-adapted to the context of goaltending. Given the strong theoretical underpinnings of BPNS within the SDT framework and considering items were adapted from the empirically validated Basic Needs Satisfaction in Sports Scale (De Francisco, Parra et al., 2018), Cronbach's Alpha was used to further test for BPNS item reliability, which will be reported later. Now we will look at the exploratory factor analysis results for motivation types. See Table 12.

Table 12

Results From Factor Analysis of Motivation Types

Motivation items	Factor loading		
	1	2	3
Stem: I am a goalie…			
Factor 1: Autonomous			
Intrin1. ... because I enjoy it.	.08	**.48**	−.49
Intrin2. ... because it's an opportunity to just be who I am.	−.14	**.62**	.21
Intrin3. ... because it's fun.	.09	**.67**	−.36
Intrin4. ... because it allows me to be true to myself.	−.10	**.52**	.20
Ident1. ... because it helps me learn things that are useful in other areas of my life.	.01	**.68**	.05
Ident2. ... because it makes me a more well-rounded person.	.04	**.72**	.13
Ident3. ... because I value the skills that come from being a goalie.	−.04	**.78**	−.10
Ident4. ... because it is one of the best ways to spend time with my friends.	.14	**.49**	.10
Factor 2: Controlled			
Intro1. ... because I would feel bad if I quit.	**.68**	.07	.02
Intro2. ... because I would feel like a failure if I stopped playing.	**.84**	−.05	−.07
Intro3. ... because I must play to feel good about myself.	**.65**	.20	−.09
Intro4. ... because if I quit, I would feel guilty.	**.79**	−.11	.08
Ext1. ... because if I don't play others will be unhappy with me.	**.73**	.00	.15
Ext2. ... because I feel outside pressure to play.	**.65**	−.06	.21
Ext3. ... because people push me to play.	**.42**	.27	.17
Ext4. ... because other people think being a goalie is admirable.	**.63**	.05	.09
Factor 3: Amotivation			
Amotiv1. ..., but I question why I continue.	.18	.01	**.70**
Amotiv2. ..., but I wonder "what's the point?"	.19	−.13	**.62**
Amotiv3. ..., but the reasons why are not clear to me anymore.	.14	.17	**.76**
Amotiv4. ..., but I question why I am putting myself through this.	.12	−.06	**.76**

Note: N = 180. The extraction method was exploratory factor analysis with an oblimin rotation. Factor loadings above .30 are in bold. Adapted from "The Behavioral Regulation in Sport Questionnaire (BRSQ): Instrument development and initial validity evidence," by C. Lonsdale, K. Hodge, and E. A. Rose, 2008, *Journal of sport and exercise psychology*, 30(3), 323-355 (https://doi.org/10.1123/jsep.30.3.323). Copyright 2008 by Human Kinetics, Inc.

Notice all constructs within motivation loaded to their theoretical factors. As predicted by contemporary SDT, intrinsic and identified motivation regulatory types loaded onto one factor (i.e., autonomous motivation) as did introjected and external (i.e., controlled motivation).

Finally, perceived success items all demonstrated sufficient loadings (Table 13).

Table 13

Results From a Factor Analysis of Perceived Success Items

Success item	Factor loading
	1
Stem: As a goalie, how SUCCESSFUL do you feel…	
Factor 1: Success	
Succ1. ... you are as a goalie overall?	**.59**
Succ2. ... about your performance in games?	**.73**
Succ3. ... in achieving the objectives you've set for yourself?	**.83**
Succ4. ... in the recent progress you've made?	**.71**
Succ5. ... in achieving desirable outcomes?	**.75**
Succ6. ... about your recent goaltending accomplishments?	**.65**

Note: N = 180. The extraction method was exploratory factor analysis with an oblimin rotation. Factor loadings above .30 are in bold. Adapted from "Achievement goals in sport: The development and validation of the Perception of Success Questionnaire," by G.C. Roberts, D.C. Treasure, and G. Balague, 1998, *Journal of Sports Sciences*, *16*(4), 337-347 (https://doi.org/10.1080/02640419808559362)

Cronbach's Alpha was used to further test item reliability within latent variables BPNS, motivatio, and perceived success. See Table 14.

Table 14

Correlation of Subscale Constructs and Measures of Internal Consistency for BPNS, Motivation, and Perceived Success

Construct	Items	Subscale	C1	C2	C3	C4	C5	C6	Cronbach Alpha
C1	auto 1,2,3,4,5	autonomy							.78
C2	comp 1,2,3,4,5	competence	.79**						.84
C3	relate 1,2,3 4,5	relatedness	.71**	.72**					.80
C4	auton 1,2,3,4	autonomous	.65**	.58**	.61**				.83
C5	control 1,2,3,4	controlled	-.01	-.18*	-.13	.08			.90
C6	amotiv 1,2,3,4	amotivation	-.28**	-.38**	-.27**	-.19*	.72**		.91
C7	success1,2,3,4,5,6	success	.52**	.49**	.42**	.62**	.23**	-.03	.86

Note: $^{*}p < .05$, $^{**}p < .01$.

All constructs demonstrated strong internal consistency of $\alpha > .70$ (Warner, 2012). Alpha for autonomy was improved from the pilot study. As a result, construct items were averaged. As demonstrated in the Table 14, most constructs show significant relationships with one another. The strongest of these appeared between the BPNs of autonomy, competence, and relatedness. Each of the BPNs correlated highly with autonomous motivation. Controlled motivation related (negatively) with only the BPNs of competence but not with autonomy or relatedness. As anticipated, amotivation negatively correlated with each BPNs and autonomous motivation but positively correlated with controlled motivation. Perceived success demonstrated a strong positive relationship with most all constructs; however, surprisingly, there was no association with amotivation. Now that we have reviewed the data cleaning, participant characteristics, internal reliability, averaging of latent variables, and preliminary correlations between constructs, the results for each study research question will be addressed.

Research Question Analysis and Results

This section is organized by research question. Results for each will be discussed briefly; key findings will be further considered in chapter 5.

Research Question 1: Descriptives

For research question number one, "What are goaltenders' levels of BPNS, motivation, perceived success, and performance?" descriptive statistics were run on each construct. Assumptions of normality were checked both numerically and using histograms to visualize distributions. Note that for save percentage and goals against average only goalies who had played three or more games were included to achieve more accurate representations of these goalie performance metrics. After omitting responses from participants with fewer than three games played, outliers were eliminated for both save percentage and goals against average. The resulting sample subset sizes and descriptive statistics are displayed in Table 15.

Table 15

Descriptive Statistics of Goaltender Motivation Pilot Study, Sample Size, Mean, Standard Deviation, Skewness, and Kurtosis

Variable	Description	N	*M*	*SD*	*Skew*	*k*
Auto	Average of autonomy BPNS items	180	3.96	0.72	-0.96	0.31
Comp	Average of competence BPNS items	179	4.18	0.69	-0.87	-0.01
Relate	Average of relatedness BPNS items	179	4.13	0.66	-0.79	0.16
Auton	Ave of autonomous motivation items	180	3.98	0.65	-0.96	0.36
Control	Average of controlled motivation items	180	3.20	0.97	-0.17	-0.88
Amotiv	Average of amotivation items	180	2.92	1.19	-0.12	-1.20
Success	Average of perceived success	179	3.74	0.74	-0.65	-0.25
SV%	Season Save percentage	130	90.32	2.70	-0.21	0.17
GAA	Season Goals against average	127	2.49	0.72	0.64	0.16
Games	Number of games played in season	180	9.60	8.88	1.55	2.41
Game%	Percent of games played in season	180	44.56	28.41	0.21	-0.93
Game Perf	Recent game performance	179	3.40	0.96	-0.24	-0.14

Note: [a] For BPNS and motivation types, and perceived success a Likert scale of 1= *strongly disagree* and 5 = *strongly agree* was used. [b] For recent game performance, a Likert scale of 1 = *poor* and 5 = *excellent* was used. [c] SV% is calculated by cumulative saves made divided by cumulative shots against [d] GAA is calculated by total goals against divided by number of games played.

All BPNS means were relatively high with competence as the highest and autonomy as the lowest. Autonomous motivation was the highest scoring motivation type while controlled motivation and amotivation averages were near the middle possible value. The perceived success mean was moderately high and recent game performance near the middle Likert scale value. Following the aforementioned subsetting and outlier removal, both save percentage and goals against average means and variations appeared reasonable. Notice that number of games played was the only (moderately) non-normally distributed variable; this outcome makes sense, however, given the way Covid-19 affected various region and hockey league seasons.

High BPNS means suggest that, on average, goaltenders at these elite hockey levels (e.g., juniors, college, professional) perceived their BPNs as having been met. There are a couple ways to interpret these results: First, one might infer that, generally, goaltender autonomy, competence, and relatedness is higher than hypothesized and that their specialization within hockey does not appear to be a significant psychosocial liability. Alternatively, it is possible these results are associated with the elite levels of hockey in which the study participants were playing. As cited in several studies, BPNS and motivation type have been shown to predict perseverance (Martinent et al., 2018) and level of athletic play (Fernández-Río et al., 2018; Gillet et al., 2009; Martinent et al, 2018;). The degree to which BPNs and self-determined motivation types vary across goalie sub-categorizations (e.g., starter status, parents having played hockey, Covid's effect on the season, etc...) and the degree to which any variation in BPNS factors may relate to goaltenders' perceived success or performance will be addressed in the forthcoming research questions.

Research Question 2: Correlations

For research question two, "What are the relationships between social factors, BPNS, motivation, perceived success, and performance?" Pearson's correlation coefficients were calculated between the primary variables as well as between numerous other exploratory variables of interest. See additional correlations in Table 16.

Table 16

Correlations for Study Primary and Exploratory Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Autonomy [a]	—												
2. Competence [a]	.79**	—											
3. Relatedness [a]	.71**	.72**	—										
4. Autonomous [a]	.65**	.58**	.61**	—									
5. Controlled [a]	-.01	-.18*	-.13	.08	—								
6. Amotivation [a]	-.28**	-.38*	-.27**	-.19**	.72**	—							
7. Success [a]	.52**	.49**	.42**	.62**	.23**	-.03	—						
8. Save percent	.11	.15*	.11	.03	-.05	-.21*	.14	—					
9. Goals against	.14	.11	.07	.12	-.06	-.11	-.12	-.40**	—				
10. Games played	.36**	.25**	.29**	.19**	.01	-.28**	.20**	.26**	.07	—			
11. Recent game [b]	.43**	.43**	.29**	.34**	-.11	-.26**	.38**	.37**	-.02	.17*	—		
12. Parents [c]	-.19*	-.31**	-.18*	-.08	.41**	.43**	.12	-.14	-.14	-.17*	-.12	—	
13. Coach recent [d]	.22**	.18*	.15*	.08	-.03	-.13	.28**	.20*	-.28**	.18*	.17*	.04	—
14. Coach career [e]	.28**	.37**	.34**	.27**	-.25**	-.36**	.20**	.08	.05	.21**	.29**	-.17*	.38**

Note: [a] For BPNS, motivation types, and perceived success a Likert scale of 1= *strongly disagree* and 5 = *strongly agree* was used. [b] For recent game performance, a Likert scale of 1 = *poor* and 5 = *excellent* was used. [c] Parents represents the number of parents who played hockey, [d] Coach recent represents the amount of goalie coaching received over the most recent season on a Likert scale of 1 = *never* to 5 = *very often*. [e] Coach career represents the amount of goalie coaching received over a goalie's career on a Likert scale of 1 = *never* to 5 = *very often*.
* $p < .05$. ** $p < .01$.

The relationships between many study variables were significant. Since some relationships had been discussed earlier, most attention will be given to performance (e.g., save

percentage, goals against average, games played, recent game performance) and social (e.g., number of parents who played hockey and frequency of goalie coaching received) variables. Note that, according to Cohen (1998) correlations $R = .10$ will be considered *small* or *weak*, $R = .30$ *moderate*, and $R = .50$ *large* or *strong*. As seen in Table 16, each BPN illustrated strong positive correlations with one another. Additionally, they demonstrate a strong positive association with autonomous motivation and moderate, negative correlation with amotivation. Competence is the only BPN that demonstrated a significant (and negative) relationship with controlled motivation. All BPNs and motivation types showed a moderate to strong positive correlation with perceived success except for amotivation, which demonstrated a weak, negative, and non-significant relationship.

Regarding performance variables, save percentage and goal against average showed very few significant relationships with other study variables. Save percentage did, however, moderately, positively correlate with competence, number of games played, recent game performance, and frequency of recent goalie coaching, as well as negatively with amotivation and goals against average. The fact that save percentage and goals against average demonstrated a moderate, negative correlation is intuitive as usually, but not always, a goalie's save percentage will decrease as they allow more goals against. Notice that the number of games played and recent game performance both significantly associate with almost every other variable. Such results may imply number of games played and recent game performance as having captured a better representation of goaltender performance than do the more traditional save percentage and goals against metrics. Such an interpretation aligns well with professional goalie coach and former NHL goaltending scout, Daccord's (2021) insights as shared in his book *How to be Goalie Parent,* in which he antidotally cites number of games played as the best predictor of

future success and NHL draft likelihood. Recent game performance serves as a more temporally-sensitive – albeit subjective and self-reported – measure of goaltender efficacy. Notice that number of games played and recent game performance demonstrated a significant relationship with save percentage but not with goals against average which, again, provides further evidence that save percentage, although itself a questionable performance measure, may be more representative of goalie performance than goals against average.

Finally, we consider social variables – how many of the goalie's parents played hockey and the frequency of goalie coaching received during a goaltender's most recent season and throughout a goalie's career. All three of these variables demonstrated significant correlations with many other key study variables. The most salient results included moderate, negative correlations between number of parents having played hockey and each of BPNs. Additionally, this parent variable possessed significantly positive correlations with controlled motivation and amotivation as well as a negative association with number of games played. Frequency of recent goalie coaching received, however, exhibited relatively converse effects, correlating positively with each BPN, perceived success, and all performance metrics. Even more pronounced are the associations between frequency of career goalie coaching with all but save percentage and goals against average, both with which recent goalie coaching correlates. The aforementioned outcomes suggest that the hockey playing experience of goalie parents generally associates with suboptimal psychological and performance outcomes while goalie coaching frequency generally relates to both desirable psychological and performance measures. Lastly, notice the disparity between the positively correlated parent/perceived success relationship and negatively correlated parent/performance relationship juxtaposed with the congruent positively correlated goalie coaching/perceived success and positively correlated coaching/performance relationship. One

interpretation of this contrast is a sort of unrealistic optimism or distortion of reality within the hockey-playing-experienced parent and goalie relationship. In other words, goalies of parents who played hockey may believe they are successful when, in fact, objective performance measures show otherwise, while the perceptions of goalies who have received goalie coaching more accurately align with their performance metrics. Much more research needs to be conducted to understand and properly interpret many of these relationships and their true roles in goaltender psychology and performance. More on the interpretation and application will be discussed in chapter five.

Although preliminary, the above results support the hypothesis that both parents and goalie coaches play a role in satisfying and/or thwarting goaltenders BPNs, that BPNs relate to motivation types, and that social influences, BPNs, and motivation generally correlate with a goaltender's performance when measured by games played and recent game performance. Save percentage and goals against average did not correlate well with most other key study variables, which continues to challenge save percentage and goals against averages measures' goalie performance representativeness.

Other variables of interest were measured in this study but were not included in the above correlation matrix. Of these were the goaltender's age, gender, BMI, to what extent Covid affected the season, weeks into the season, goalie's starting status (i.e., first, second, or third string), team success, percent of the season a goalie was injured, and whether the goalie planned to continue playing the following season. Most of these variables demonstrated enough significant relationships to either be further explored with forthcoming statistical tests and/or to be included as control variables in later regression models.

The above results largely corroborate with self-determination meta theory and its basic psychological needs sub-theory and support the researcher's proposed framework (see Figure 12). Next, differences in primary study variables will be reported.

Research Question 3: Testing Differences

Research question number three was, "Are there significant differences in BPNS and/or motivation across gender, level of play, starter status, and/or number of parents who played hockey?" Variables were tested for normality and homogeneity of variance then mean difference tests such as *t*-tests and ANOVA were conducted. Theory, literature presented in chapter two, and correlations explored in research question two helped prioritize included variables.

Gender

First, Welch's *t*-test was used to measure differences in BPNS and motivation types across gender (Table 17).

Table 17

Differences in BPNS and Motivation Across Gender

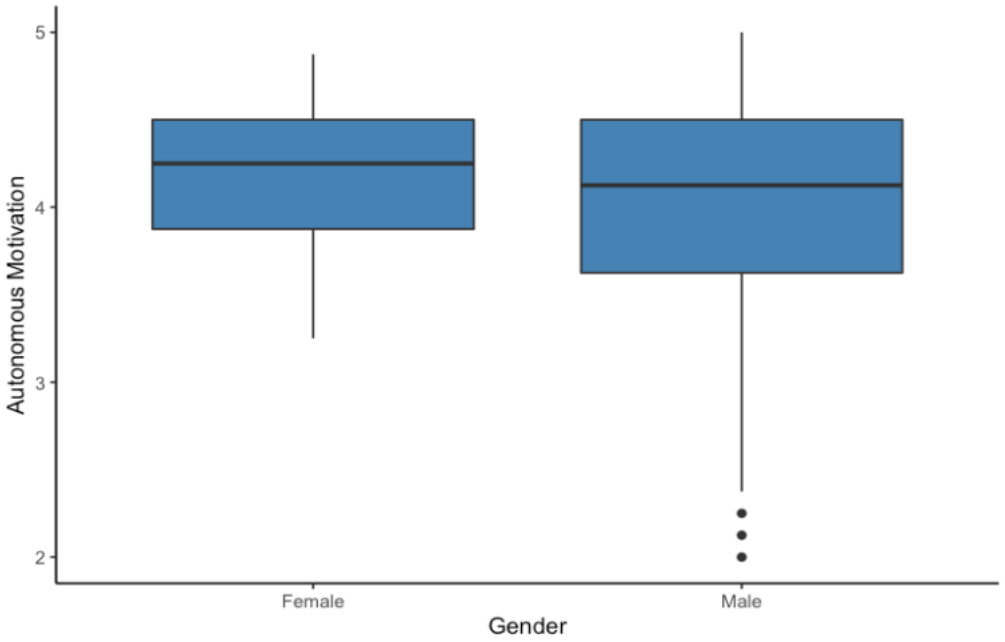
BPNS & Motivation	Female		Male		*t*(178)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Autonomy	3.93	0.525	3.97	0.764	-0.378	.707	-0.063
Competence	4.14	0.626	4.19	0.700	-0.374	0.710	-0.068
Relatedness	4.18	0.635	4.12	0.661	0.544	0.588	0.101
Autonomous	4.18	0.393	3.93	0.693	2.795	.006	0.436
Controlled	3.31	0.985	3.17	0.971	0.757	0.453	0.143
Amotivated	3.04	1.164	2.88	1.198	0.718	0.476	0.134

Note: Each BPNS and motivation variable was measured on a 5-point Likert scale of 1= *strongly disagree* to 5 = *strongly agree*. Mean parameter values for each of the analyses are shown for females (n = 35) and males (n =145), as well as the results of *t*-tests (assuming unequal variance) comparing the parameter estimates between the two genders.

Females demonstrated higher levels of all BPNS and motivation except for autonomy and competence; however, autonomous motivation was the only variable which differed significantly between male and female goaltenders. See Figure 19 for a boxplot visualizing these significant differences and their distributions.

Figure 19

Autonomous Motivation Across Gender Boxplot



Note: Autonomous motivation was measured on a Likert scale of 1= *strongly disagree* and 5 = *strongly agree*.

Notice too, however, that the variation for male goaltender autonomous motivation appears larger than females. These results suggest that although the BPNs of both genders are, on average, relatively satisfied and equal, female goaltenders collectively demonstrate higher and more consistent autonomous motivation (i.e., internalized, personally valued, aligned with self, and based on their interests and inherent satisfaction). The reason for this gender difference is uncertain. SDT suggests that BPNS and motivation are largely a result of social influences (Ryan

& Deci, 2000; Standage & Ryan, 2019). Parents' hockey playing experience served as a natural and easily measured social factor. Results of parents' hockey playing experience, BPNS, and motivation will be provided next.

Parents

Parents serve an important and influential role in their children's lives (Deci & Ryan, 2008; Grolnick et al., 1997, as cited in Ryan & Deci, 2000). Additionally, involvement in youth hockey has been shown to impact players' playing experience and emotions (Jeffery-Tosoni & Fraser-Thomas, 2015). As a convenient, exploratory starting point, the number of goalies' parents who had played hockey was measured. The survey question read "Did your parents play hockey?" with response options "Yes, both played," "Yes, one of my parents played," and "No, neither of my parents played." BPNS, motivation, perceived success, and performance as measured by number of games played were tested across these parent-related responses (Table 18). Note that number of games played was chosen as the performance metric given its associations with most other study variables as reported in the research question one section.

Table 18

Means, Standard Deviation, and BPNS, Motivation, Perceived Success, and Performance Differences Across Number of Parents who Played Hockey

Measure	Neither Parent		One Parent		Both Parents		$F(1,168)$	η^2
	M	*SD*	*M*	*SD*	*M*	*SD*		
Autonomy	4.12	0.52	3.94	0.77	3.75	0.85	3.57^{*}	.04
Competence	4.40	0.54	4.19	0.700	3.82	0.81	8.15^{***}	.10
Relatedness	4.22	0.58	4.18	0.63	3.88	0.76	2.95	.04
Autonomous	4.04	0.56	3.98	0.67	3.89	0.76	0.61	.01
Controlled	2.76	0.90	3.21	0.96	3.87	0.69	24.84^{***}	.17
Amotivated	2.44	1.18	2.81	1.12	3.88	0.72	34.60^{***}	.20
Success	3.67	0.71	3.71	0.75	3.91	0.77	1.38	.01
Games Played	11.07	8.99	9.82	10.19	6.85	4.10	6.20^{***}	.03

Note: Each BPNS, motivation, and perceived success variable was measured on a Likert scale of 1= *strongly disagree* and 5 = *strongly agree*. Mean parameter values for each of the analyses are shown for neither parent (n = 61), one parent (n = 80), and both parents (n =39), as well as the results of ANOVA (assuming unequal variance) comparing the parameter estimates between the number of parents who had played hockey.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Interestingly, all BPNS, motivation, perceived success, and games played means were more optimal as the number of parents who had played hockey decreased. For example, perceived autonomy, competence, relatedness, autonomous motivation, success, and games played were highest for goalies who reported neither parent having played hockey. Conversely, the data indicated higher levels of controlled motivation and amotivation for this same group; all but the differences for relatedness, autonomy, and perceived success were statistically significant. These results substantiate previously reported correlation matrix results, suggesting that goalies' perceived BPNS and experienced motivation types differ across parents' hockey

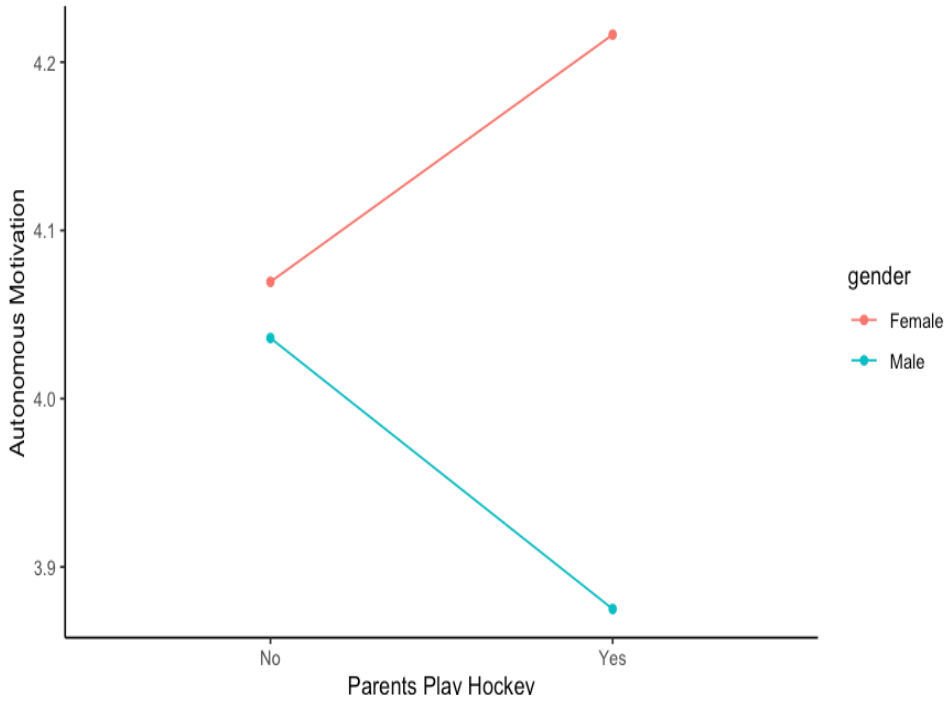
playing experience. More specifically, one or more parents having had played hockey generally related to lower BPNS, lower autonomous motivation, and higher levels of controlled motivation and amotivation.

Gender & Parent Interaction

Since autonomous motivation is the highest quality motivation type (Ryan & Deci, 2000; Standage & Ryan, 2019) and showed a significant difference between female and male goaltenders, we will next consider potential interactions between gender and parents as players within autonomous motivation (Figure 20). Responses were collapsed to whether either parent had played hockey or not.

Figure 20

Autonomous Motivation: Gender & Parent Play Experience Interaction



Note: Autonomous motivation was measured on a Likert scale of 1 = *strongly disagree* to 5 = *strongly agree*.

Notice that female goalies' autonomous motivation is higher whether or not at least one of their parents played hockey; however, this discrepancy is markedly pronounced when at least one parent had played hockey. Specifically, for goalies whose parents had played hockey, there were noticeably higher levels of autonomous motivation for females than males, while, for goaltenders whose parents had not played, a far smaller difference between male and female autonomous motivation was evident. It is important to note that this interaction was not statistically significant, $F(3, 176) = 1.26$, $\eta^2 = .0007$, $p = 0.262$). The relatively small proportion of female to male goalies as well the small cell size for female goalies whose parents did not play hockey (Table 19) may play a role. Nevertheless, such findings suggest potential nuances within and amongst factors and their association with psychological aspects goaltending. One explanation is that, since hockey has been a historically male-dominated sport, females may be afforded space for lower parental expectation and, therefore, higher autonomous motivation. However, this explanation is only speculative, since gender of parents was not measured within this study.

Table 19

Frequencies of goalies by whether parents played hockey and gender

	Gender	
At least One Parent Played Hockey	Female	Male
No	9	52
Yes	26	93

Given the already high number of variables within this study, forthcoming analyses did not include interactions. The gender and parent interface serves as an easily understood example to underscore the importance of research question probing and avoiding oversimplifications

Level of Play

Now we will consider whether BPNS and/or motivation vary across level of play. Goaltenders' participating in this study reported having played at the high school/midget/AAA/19U, juniors, ACHA or college club, NCAA D3 college, NCAA D1 college, semi-professional, professional, or "other" levels. To create sufficient cell sizes for each category, several categories were collapsed, and one altogether eliminated. The HS/midget/AAA category was small (n =10) and therefore combined with Juniors and Major Juniors into the category called *Juniors*. The categories of ACHA or College Club, NCAA D3 College, NCAA D1 College were combined into a *College* category. Semi-professional and professional goalies were collapsed into the category of *Professional*, again to improve cell size. Lastly, the decision was made to eliminate the *Other* group, as alternate text responses within this option had been previously categorized leaving a very small subgroup of responses that could not be rightly discerned. Table 20 below compares BPNS, motivation, perceived success, and number of games played across level of play.

Table 20

Means, Standard Deviation, and BPNS, Motivation, Perceived Success, and Performance Differences Across Level of Play

Measure	Juniors		College		Pro		$F(1, 168)$	η^2
	M	*SD*	*M*	*SD*	*M*	*SD*		
Autonomy	4.16	0.52	3.76	0.82	4.29	0.42	11.32***	.09
Competence	4.30	0.57	4.03	0.75	4.45	0.50	6.42**	.06
Relatedness	4.15	0.63	4.06	0.72	4.28	0.45	1.95	.02
Autonomous	4.00	0.60	3.87	0.71	4.25	0.47	5.77**	.05
Controlled	2.81	1.02	3.38	0.89	3.11	1.04	5.10**	.06
Amotivated	2.57	1.16	3.10	1.10	2.71	1.42	3.54*	.04
Success	3.55	0.82	3.72	0.75	4.08	0.50	6.76**	.05
Games Played	10.36	6.19	8.89	9.33	10.18	10.03	0.64	.01

Note: Each BPNS and motivation variable was measured on a scale of 1-5. Mean parameter values for each of the analyses are shown for juniors (n = 42), college (n = 101), and pro (n =28), as well as the results of ANOVA (assuming unequal variance) comparing the parameter estimates between levels of play.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Results illustrated that autonomy, competence, autonomous motivation, controlled motivation, amotivation, and perceived success all varied across level of play. Of those, professional goalies demonstrated the more optimal levels of BPNS, autonomous motivation, and perceived success. Junior goaltenders displayed the lowest controlled motivation and amotivation. Except for perceived success, college goaltenders demonstrated the least optimal measure levels. Follow up post-hoc Games-Howell tests (assuming unequal variance) further confirmed these findings in which, compared to college goalies, professional goalies displayed significantly higher levels of autonomy ($p < .001$), competence ($p < .01$), autonomous motivation ($p < .01$), and perceived success ($p < .05$). Professionals, compared to junior goaltenders, had

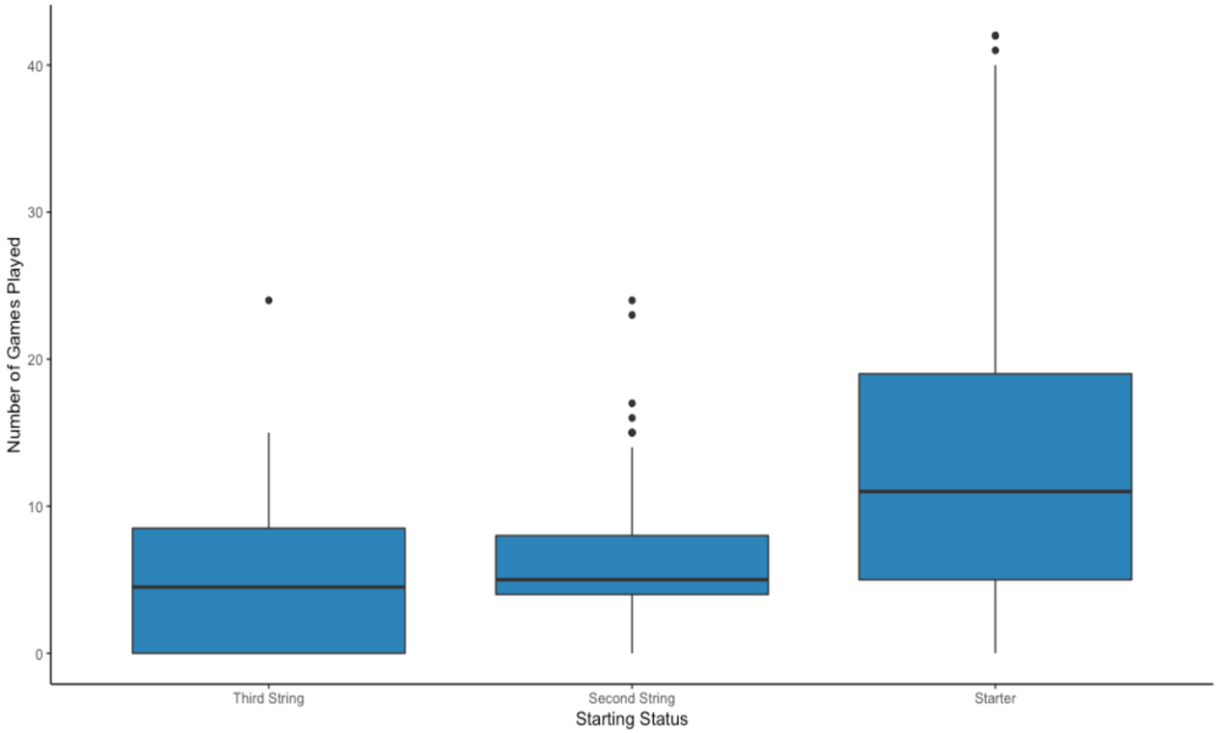
significantly higher levels of perceived success ($p < .01$). Finally, college goalies, compared to those in juniors had significantly lower autonomy ($p < .01$) and higher controlled motivation ($p < .01$) and amotivation ($p < .05$). Professional's more optimal levels supports the hypothesis associating BPNS and autonomous motivation with performance – as measured by playing level, in this instance. College goaltenders' comparatively lower levels of BPNS and high controlled motivation and amotivation is an interesting finding. The only explanation of these differences involves the potential role academics plays in the college goaltender's psychological experience. More research is needed to shed light onto these issues. Next, starter status will be addressed.

Starting Status

Goaltending is unique in that one goaltender usually plays the entire game, unless they are *pulled* from the game (Battaglia et al., 2018). Furthermore, teams often establish a rank-ordering of goaltenders based upon ability and performance. Historically, the first string or *starter* goaltender usually receives the majority of playing time and plays during the higher stake games. The second string or *backup* goaltender usually receives less games played and/or plays in games that may be deemed less important. If a starter is well established as the superior goaltender, the second string goalie may receive few to no games. The third string goalie tends to receive minimal time in net, usually in the occasion of first and/or second-string goalies' injury or during less challenging or none-conference games. Figure 21 below confirms this starting status/games played trend for the study participants. All Games Howell comparisons were significant at the $p < .001$ level between all but the second string and third string goaltenders.

Figure 21

Games Played Across Starting Status Boxplot



Note: Number of games played represents those from the goaltender's most recent season.

Next, ANOVA was used to test BPSN, motivation, perceived success, and performance differences across starting status (Table 21).

Table 21

Means, Standard Deviation, and BPNS, Motivation, Perceived Success, and Performance Differences Across Goaltender Role

Measure	Third String		Second String		Starter		$F(1,168)$	η^2
	M	*SD*	*M*	*SD*	*M*	*SD*		
Autonomy	3.64	0.80	3.73	0.79	4.20	0.59	10.68^{***}	.12
Competence	4.06	0.71	3.90	0.76	4.39	0.55	10.17^{***}	.11
Relatedness	4.12	0.73	3.91	0.70	4.29	0.58	6.20^{**}	.07
Autonomous	3.81	0.62	3.79	0.76	4.15	0.53	6.75^{**}	.08
Controlled	2.98	0.87	3.48	0.88	3.11	1.01	4.01^{*}	.04
Amotivated	2.92	1.01	3.50	1.02	2.55	1.17	14.10^{***}	.14
Success	3.47	0.80	3.50	0.84	3.98	0.59	9.40^{***}	.10
SV%	91.91	3.02	88.90	2.24	91.00	2.42	12.62^{***}	.17
GAA	2.53	0.80	2.50	0.71	2.47	0.63	0.04	.00
Games Played	5.60	6.40	6.52	4.97	13.11	10.50	14.28^{***}	.15

Note: Each BPNS and motivation variable was measured on a scale of 1-5. Mean parameter values for each of the analyses are shown for third string (n = 20), second string (n = 65), and starter (n =87), as well as the results of ANOVA (assuming unequal variance) comparing the parameter estimates between levels of play.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

This study hypothesized that starting goaltenders would report having performed better as evidenced by higher save percentage, goals against average, and number of games played. Additionally, starting goaltenders were anticipated to report more optimal levels of BPNS and motivation. The data largely supported these anticipated results. Games-Howell post-hoc tests demonstrated several significant mean differences between starter and second-string goalies such as starter's higher perceived autonomy ($p < .001$), competence ($p < .001$), relatedness ($p < .01$), autonomous motivation ($p < .01$), perceived success ($p < .001$), and save percentage ($p < .001$) and lower levels of controlled motivation ($p < .05$) and amotivation ($p < .001$). However,

between starters and third string goalies, results illustrated far fewer differences such as starters higher autonomy ($p < .05$) and perceived success ($p < .05$). These results suggest, while starters experience more optimal psychological states, second stringer goalies may experience the least-optimal psychological states, even compared to third-string goalies. Furthermore, compared to second string goalies, third-string goalies demonstrated (non-significantly) higher levels of competence ($p = .68$), relatedness ($p = .51$), and autonomous motivation ($p = .08$), and lower levels of controlled motivation ($p = .08$) and amotivation ($p = .08$). Medvec et al. (1995) conducted research on first, second, and third place Olympians, in which second place finishers experienced the least optimal emotional states compared to first and third place finishers. The researchers attributed such psychological tendencies to third place athletes' *downward comparison* (e.g., for goalies, not being on the team) juxtaposed to second place finishers *upward comparison* (e.g., for goalies, being the starter). The differences between third string, second string, and starting goaltenders within this study affirm those findings. Now we will move on to research question four.

Research Question 4: Social Factors Predicting BPNS

For research question number four, "Do social factors such as amount of goalie coaching received and/or number of parents who played hockey predict BPNS?" a multiple regressions model was tested for autonomy, competence, and relatedness. Age, gender, Covid's effect on season length, BMI, and percent of the season spent injured were used as covariates within each model which are presented below.

Autonomy

Multiple regressions demonstrated that greater frequency of goalie coaching received over a goalie's career was associated with higher levels of perceived autonomy, even after

controlling for age, gender, Covid, and injury. In practical terms, on average, for every 1-point increase in the Likert scale response to career goalie coaching received, autonomy increased 0.15 points. The number of parents who played hockey did not show a significant relationship with autonomy, however. The control variables of Covid's impact on the season and injury percentage demonstrated negative associations with autonomy. The overall model was found to be significant, $F(7, 163) = 5.59$ (see Table 22).

Table 22

Goalie Coaching Frequency and Parents as Players Predicting Autonomy

Predictors	Autonomy		
	B	*SE*	β
(Intercept)	3.66	.38	
Age	.00	.01	.00
Gender[a]	.03	.13	.01
Covid	-.25	.09	-.20**
Injury	-.01	.00	-.14+
Coach Recent	.08	.05	.13
Coach Career	.15	.06	.20*
Parents Played Hockey	-.08	.08	-.08
R^2		.19***	

Note: [a] 0 = *female* and 1 = *male*.
+ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$.

Interestingly, although the parent hockey experience variable and autonomy demonstrated significant correlations in research question one, their relationship was no longer significant once age, gender, Covid, and injury were controlled. Additionally, the fact that career goalie coaching, but not recent goalie coaching, association with autonomy is noteworthy.

Competence

Frequency of goalie coaching throughout a goalie's career again had a positive association with perceived competence. The number of parents who played hockey had a negative association. The overall model was significant, $F(7, 162) = 7.62$. See Table 23.

Table 23

Goalie Coaching Frequency and Parents as Players Predicting Competence

Predictors	Competence		
	B	*SE*	β
(Intercept)	3.85	.35	
Age	-.01	.01	-.04
Gender[a]	.05	.12	.03
Covid	-.11	.09	-.10
Injury	-.01	.00	-.17*
Coach Recent	.05	.05	.08
Coach Career	.20	.05	.28***
Parents Play Hockey	-.16	.07	-.17*
R^2		.25***	

Note: [a] 0 = *female* and 1 = *male*.
+ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$.

These results align with prior study outcomes, affirming the negative association parents' playing experience appears to have with goaltenders' BPN and the positive association between goalie coaching and BPNS. Again, frequency of career goalie coaching, but not recent goalie coaching, predicted perceived goalie competence.

Relatedness

The model in which social factors predicted perceived relatedness was also significant, $F(7, 162) = 4.90$. Greater career goalie coaching frequency was significantly associated with greater perceived relatedness. While recent goalie coaching frequency demonstrated a positive

relationship with perceived relatedness, it again was not significant. All other variables showed a negative non-significant relationship with relatedness. See Table 24.

Table 24

Goalie Coaching Frequency and Parents as Players Predicting Relatedness

Predictors	Relatedness		
	B	*SE*	β
(Intercept)	4.00	0.35	.00***
Age	-.01	.01	-.08
Gender[a]	-.04	.12	-.03
Covid	-.12	.08	-.11
Injury	.00	.00	-.12
Coach Recent	.04	.05	.07
Coach Career	.18	.06	.26**
Parents Play Hockey	-.06	.07	-.07
R^2		.17***	

Note: [a] 0 = *female* and 1 = *male*.
+ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$

The above multiple regression analyses provided exploratory insights into the associations between social influences and goaltenders' psychological experience as measured by BPNS. The frequency of career goalie coaching received demonstrated a significantly positive association with each of the BPNs, even beyond the effects of age, gender, Covid, and injury percentage. While not significant, frequency of recent goalie coaching received related positively to each BPN. Greater number of parents who played hockey within a goalie's family was associated with significantly lower levels of perceived competence and, although non-significant, lower levels of autonomy and relatedness. The reasons for a positive association between amount of goalie coaching received and BPNS seems reasonable, especially in terms of a goalie's perceived competence; the more goalie-specific instruction a goaltender receives, the more skilled they will likely become. Similarly, it seems logical that more frequent goalie

coaching may result in a feeling of being cared for by important others. And finally, one is more likely to feel autonomous when they have the skill and support system in place to be successful at their position.

The role of parents' experience playing hockey may be a bit more nuanced. One hypothesis is that parents' hockey-playing experience may be accompanied by greater external expectations, some of which may be unrealistic and/or outdated. Goaltending has evolved rapidly through the past several decades, and the standards by which parents played may no longer be relevant today. Conversely, parents who did not play hockey may provide greater space for goaltender autonomy as well as outside resources or training which might foster autonomous supportive coaching. Given the observational nature of this study, causation cannot be inferred. Therefore, further research is necessary to better understand these relationships.

Research Question 5: BPNS Predicting Motivation

For research question number five, "Do BPNS predict goalie motivation?" multiple regressions was used to test if autonomy, competence, and/or relatedness predict autonomous motivation, controlled motivation, and amotivation. Age, gender, Covid's impact on the season, and injury percentage served as control variables.

Autonomous Motivation

Multiple regression analysis illustrated that higher levels of autonomy and relatedness were associated with autonomous motivation, even after controlling for age, gender, Covid, and injury. The overall model was found to be significant, $F(7, 161) = 25.27$. See Table 25.

Table 25

BPNS Predicting Autonomous Motivation

Predictors	Autonomous Motivation		
	B	*SE*	β
(Intercept)	.80	.35	
Age	.01	.01	.09
Gender[a]	-.27	.09	-.17**
Covid	.06	.06	.06
Injury	.00	.00	-.01
Autonomy	.29	.09	.33**
Competence	.17	.09	.18
Relatedness	.28	.09	.29**
R^2		.52***	

Note: [a] 0 = *female* and 1 = *male*.
+ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$.

These results largely support SDT and its basic psychological needs sub-theory in BPNS as a precursor for autonomous motivation. Additionally, with the exception of the non-significance of competence, associations support this study's hypothesized framework. The relationship between gender and autonomous motivation within this model continues to suggest differences in experienced autonomous motivation between males and females, even after accounting for age, covid, and injury. This difference aligns with Adie et al. (2008) in that gender may moderate the relationships between BPNS and motivation.

Controlled Motivation

The overall controlled motivation model was found to be significant, $F(7, 161) = 2.47$. However, after accounting for age, gender, Covid, and injury, no BPNS variables were significant predictors of controlled motivation. See Table 26.

Table 26

BPNS Predicting Controlled Motivation

Predictors	Controlled Motivation		
	B	*SE*	β
(Intercept)	3.13	.71	
Age	.03	.02	.15
Gender[a]	-.25	.18	-.10
Covid	-.02	.13	-.01
Injury	.01	.00	.14
Autonomy	.34	.17	.26^{+}
Competence	-.33	.19	-.24
Relatedness	-.12	.17	-.08
R^2		.10*	

Note: [a] 0 = *female* and 1 = *male*.
$^{+}$ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$

These results, especially the autonomy and controlled motivation relationship, run somewhat counter to SDT but corroborate with research question one correlations. One explanation to this finding is – given the elite level of goalie participants, including professional athletes – potential prevalence of external rewards or the attainment of ego-enhancing outcomes may result in higher levels of controlled motivation despite their perceived BPNS. Another rationalization is that the unique, high-pressure position of goaltending involves additional, unaccounted factors which may supersede or buffer the associations of BPNS with controlled motivation. Finally, BPNS may simply not predict goaltender's controlled motivation. Replication of this study would be needed to bolster such claims.

Amotivation

Multiple regression analysis demonstrated that greater levels of perceived competence was associated with lower levels of amotivation, even after controlling for age, gender, Covid, and injury. The overall model was found to be significant, $F(7, 163) = 5.59$. See Table 27 below

Table 27

BPNS Predicting Amotivation

Predictors	Amotivation		
	B	*SE*	β
(Intercept)	3.31	.80	
Age	.04	.02	.17*
Gender[a]	-.22	.20	-.08
Covid	.40	.15	.20**
Injury	.01	.00	.14+
Autonomy	.22	.20	.13
Competence	-.62	.21	-.36**
Relatedness	-.04	.19	-.02
R^2		.26***	

Note: [a] 0 = *female* and 1 = *male*.
+ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$

The association between competence and amotivation seems logical, given the technical nature of goaltending. Especially at the elite levels, if a goaltender feels incompetent, it is reasonable that they will struggle to stay motivated. These findings again suggest that competence is an especially important factor when predicting goaltender motivation.

In summary, after accounting for age, gender, Covid, and injury, autonomy and relatedness predicted autonomous motivation, no BPNS factors predicted controlled motivation, and only competence predicted amotivation. The inconsistent and sometimes counter-SDT findings are confounding. More research needs to be conducted to better understand the relationship between goaltender BPNS, motivation, and other potentially moderating variables.

Next, results for social factors, BPNS, and motivation type predicting perceived success will be reported.

Research Question 6: Social Factors, BPNS, and Motivation Predicting Perceived Success

For research question number six, "Do social factors, BPNS, and/or motivation predict goaltender perceived success?" multiple regression was again used to assess the social, BPNS, motivation model hypothesized in this study. Age, gender, Covid, BMI, and injury served as control variables. Findings revealed that the overall model was significant, $F(14, 151) = 13.16$. See Table 28.

Table 28

Social Factors, BPNS, and Motivation Predicting Perceived Success

Predictors	Perceived Success		
	B	*SE*	β
(Intercept)	.76	.57	
Age	.00	.01	.02
Gender[a]	-.02	.11	-.01
Covid	.02	.08	.02
BMI	-.04	.02	-.15*
Injury	.00	.00	.05
Parents	.15	.06	.15*
Coach_Career	-.01	.05	-.01
Coach_Recent	.13	.04	.20**
Autonomy	.09	.11	.09
Competence	.31	.11	.30**
Relatedness	-.06	.11	-.05
Autonomous	.52	.10	.46***
Controlled	.15	.07	.20*
Amotivation	-.01	.07	-.01
R^2		.55***	

Note: [a] 0 = *female* and 1 = *male*.
+ $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$

Higher frequency of recent goalie coaching and greater competence, autonomous motivation, and controlled motivation predicted higher perceived success. Findings add to a trend in goalie coaching frequency and competence's associations with more optimal outcomes. Controlled motivation predicting perceived success may reveal both that numerous motivation

types can operate simultaneously (Meyer & Morin, 2016) and, that, as the Cece et al. (2018) findings suggest, perceived goaltender success may be associated with compliance. This controlled motivation/perceived success result also aligns with the idea that goaltenders must learn to operate successfully amidst an environment largely out of their control (Clark & Luongo, 201; Monnich, 2021; USA Hockey, 2020). The final research question tests whether social factors, BPNS, and motivation predict goaltender performance.

Research Question 7: Social Factors, BPNS, and Motivation Predicting Performance

Research question number seven was, "Do social factors, BPNS, and/or motivation predict goaltender performance as measured by save percentage, gaa, games played, or recent game performance?" Multiple regressions was used to analyze models predicting each of the previously listed performance metrics. Age, gender, Covid, BMI, and percent of the season spent injured were used as covariates. As anticipated, models for save percentage and goals against average were non-significant, $F(14, 103) = 0.98$, $R^2 = .12$, $p = .478$ and $F(14, 101) = 1.557$, $R^2 = .18$, $p = .105$, respectively. For the save percentage model, recent goalie coaching was the only significant predictor variable ($B = 0.49$, $\beta = .21$, $p < .05$). For the goals against average model, recent goalie coaching was also the only significant predictor ($B = -0.25$, $\beta = -.38$, $p < .001$). For self-reported recent game performance which read "How would you rate your performance in the last game you played?" 1 = *Poor* and 5 = *Excellent*, the model was significant, $F(11, 154) = 4.81$, $R^2 = .26$, $p = < .001$; however, no individual predictor variables were significant.

Finally, hierarchical multiple regression analysis was used for games played to test potential mediating associations amongst the proposed social, BNPS, motivation, and performance framework steps. A four-step regression procedure was used to examine the direct

and indirect relationships between independent, mediating, and dependent variables. These procedures assessed the influence of age, gender, Covid, BMI, and injury in Step 1; those variables along with social variables in Step 2; adding BPNS in Step 3; and finally adding motivation types into Step 4. This variable progression was chosen because step 1 variables were considered exogenous and BPNS and motivation are hypothesized to be mediating variables between social influences and performance outcomes. See Table 29 for results.

Table 29

Hierarchical Regression for BPNS and Motivation Predicting Games Played

Variable	*B*	*SE*	β	R^2	ΔR^2
Step 1					
(Intercept)	.94	7.19		.12**	.12**
Age	.15	.15	.08		
Gender[a]	2.13	1.67	.10		
Covid	-4.43	1.17	-.29***		
BMI	.39	.26	.11		
Injury	-.02	.04	-.05		
Step 2					
(Intercept)	-6.04	7.77		.17***	.05**
Age	.23	.15	.12		
Gender[a]	1.66	1.67	.07		
Covid	-3.94	1.16	-.26***		
BMI	.35	.26	.10		
Injury	-.01	.04	-.02		
Parent	-1.10	.97	-.09		
Coach Career	1.31	.95	.14		
Coach Recent	.70	.62	.09		
Step 3					
(Intercept)	-11.22	8.31		.22***	.06**
Age	.25	.15	.13		
Gender[a]	1.81	1.63	.08		
Covid	-3.19	1.16	-.21**		
BMI	.18	.26	.05		
Injury	-.00	.04	-.01		
Parent Hockey	-1.28	.96	-.11		
Coach Career	1.08	.77	.12		
Coach Recent	.44	.61	.06		
Autonomy	3.60	1.56	.30*		
Competence	-2.99	1.69	-.23		
Relatedness	1.86	1.52	.14		
Step 4					
(Intercept)	-10.27	8.27		.32***	.10***
Age	.31	.15	.16*		
Gender[a]	1.59	1.58	.07		
Covid	-1.37	1.17	-.09		
BMI	.18	.25	.05		
Injury	.00	.04	.00		
Parent Hockey	-1.69	.96	-.14		
Coach Career	.96	.75	.11		
Coach Recent	.37	.59	.05		
Autonomy	3.38	1.54	.28*		
Competence	-3.80	1.64	-.30*		
Relatedness	2.71	1.50	.20		
Autonomous	-1.48	1.39	-.11		
Controlled	4.54	1.08	.48***		
Amotivation	-3.99	.93	-.53***		

Note: [a] 0 = *female* and 1 = *male*; + $p = .06$; * $p < .05$; ** $p < .01$; *** $p < .001$

In Step 1 of the model, $F(5, 161) = 4.32$, Covid predicted number of games played. Adding social factors of number of parents having played hockey, frequency of recent goalie coaching received, and frequency of career goalie coaching received in Step 2 resulted in a significant increment to R^2, $F_{inc}(3, 158) = 2.97$, $p < .05$; however, no additional variables were significant. Adding the three BPNs to the model in Step 3 resulted in a significant increment to R^2, $F_{inc}(3, 155) = 3.73$, $p < .05$; and autonomy predicted more games played, beyond the effects of Covid. Finally, adding motivation types in Step 4 resulted in another significant increment to R^2, $F_{inc}(3, 152) = 6.95$, $p < .001$; autonomy and controlled motivation predicted more games played while competence and amotivation predicted less games played.

These hierarchical regression results align with the hypothesized study model (Figure 15) in that certain BPNs and motivation types predict performance as measured by number of games played. However, results do not affirm a meaningful association between games played and parents' experience playing hockey nor frequency of goalie coaching received. Furthermore, these social factors and games played do not appear to be mediated by BPNS and/or motivation type. The strong overall R^2 effect size provides a potentially useful model for both practical and theoretical purposes. For example, a coach, team, or organization may be interested in the ability to predict 33% of variance in a goaltender's number of games played using the model predictors.

In summary, the recent game performance and number of games played models were significant. The recent game performance model had no significant predictors. However, as suggested in the Gillet et al. (2010) study on judo performance, one could argue that even a small increase in elite sport performance has practical significance. Therefore, a 11.8% and 17.8% explained variance in save percentage and goals against average, respectively, could have practice significance in elite levels of hockey. Furthermore, a frequency of recent goalie

coaching received and save percentage beta value of 0.49 can be practically interpreted as a increase of .49% save percentage for every one Likert scale increase in frequency of recent goalie coaching received. Therefore, the average difference between a goalie's save percentage who receives no goalie coaching and one who receives goalie coaching *very often* is, on average almost a 2% higher save percentage. At the elite levels, this can be the difference between an average and a league-leading save percentage.

Conclusion

In this chapter, the results of the study were presented. First, the data cleaning process was discussed, then demographics and participant information was reported, and finally each research question analysis was presented. Although BPNS items did not load onto their theorized, unique factors, motivation types and perceived success loaded sufficiently onto theirs. Averaging respective items along with subsequent factor analyses demonstrated sufficiently strong internal consistency for each of the BPNS, motivation types, and perceived success factors via Cronbach's Alpha. Descriptive statistics illustrated reasonable averages, variation, and variable distributions. All BPN averages were moderately high as was autonomous motivation and perceived success. Controlled motivation and amotivation averages were near the middle possible value. Regarding the analysis of direct relationships between variables, number of parents who played hockey demonstrated non-optimal relationships with BPNS, motivation types, and games played. Conversely, frequency of goalie coaching possessed optimal associations with BPNS, motivation types, and most performance variables. Each BPNs variable had a strong, positive correlation with one another as well as with moderate to strong correlations with autonomous motivation, amotivation, perceived success, games played, and recent game performance. When testing for differences, autonomous motivation was the only variable that

differed across gender. Autonomy, competence, controlled motivation, amotivation, and games played differed significantly across number of parents who played hockey. Additionally, professional goalies demonstrated significantly more optimal levels of most BPNS and motivation types except for relatedness. Regarding starting status, starting goalies had significantly higher levels of most key study variables, especially when compared to second string – but not always third string – goaltenders. Finally, models with frequency of recent goalie coaching, frequency of career goalie coaching, and number of parents who played hockey predictors were significant for all three BPNs; frequency of career goalie coaching was a significant predictor in each model as was the number of parents who played hockey within the competence model.

For BPNS predicting motivation types, all models were found to be significant; autonomy and relatedness predicted autonomous motivation and competence predicted amotivation. For social factors, BPNS, and motivation predicting perceived success, the model was found to be significant; number of parents who played hockey, frequency of recent goalie coaching, competence, autonomous motivation, and controlled motivation were significant predictors. And finally, multiple regression models for social factors, BPNS, and motivation predicting performance as measured by save percentage, goals against average, recent game performance, and number of games played, only the recent game performance and games played models were significant; no individual variables were significantly predictive of recent game performance. For the hierarchical multiple regression games played model, each step of was found to be significant with significant increases in R^2 for each added step. In the final step, autonomy, competence, controlled motivation, and amotivation were found to be significant

predictors of games played. The next and final chapter will focus on the key study findings, implications, recommendations for practice, and suggested future research.

CHAPTER V:

DISSCUSION, LIMITATIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter provides a discussion of key study findings along with implications, applications, and recommendations for future research. To start, a study overview is provided. Then, the most salient results are summarized and conclusions drawn from these collective findings. After addressing this study's limitations, implications for coach, parent, goalie, and hockey organizations will be addressed. Finally, this chapter offers recommendations for future research within both hockey and broader domains.

Overview of Study

The purpose of this study was to measure several goaltender social factors, BPNS, self-determined motivation, and then to assess the relationship these factors have with goaltender's perceived success and performance. Findings from this study are intended to inform parents, coaches, and hockey organizations on how to better understand and support the specialized position of goaltending.

This research utilized a quantitative survey design which served as an effective medium for collecting a combination of both objective (e.g., save percentage, goals against average, number of games played, recent performance) and perception (e.g., BPNS, motivation, perceived game performance, perceived success) data about goaltenders from various elite playing levels and locations. The population of interest was North American and international ice hockey goaltenders ages 18 and older. These athletes belonged to high school, midget AAA, junior, college, semi-professional, or professional leagues throughout the US, Canada, and other international countries. As justified in the previous chapters, SDT was identified as a validated theoretical framework for measuring goaltenders' BPNs and motivation. Furthermore, a review

of prior qualitative and quantitative research suggests a relationship between social factors, BPNS, motivation, and various positive outcomes (De Francisco et al., 2018; Gillet et al., 2010). Figure 15 depicts the proposed, modified model representing a hypothesized relationship between goaltender social influences (i.e., parents as hockey players and amount of goalie coaching received), BPNs (i.e., autonomy, competence, and relatedness), motivation types (i.e., amotivation, controlled, autonomous), perceived success, and various outcomes including performance (i.e., save percentage, goals against average, number of games played). The current pilot and dissertation studies tested this proposed goaltender psychosocial/performance model using various quantitative analyses which were reported in chapter four. Below are a review of the dissertation research questions:

RQ_1: What are goaltenders' levels of BPNS, motivation, perceived success, and performance as measured by save percentage, goals against average, number of games played, and recent game performance?

RQ_2: What are the relationships between social factors, BPNS, motivation, perceived success, performance, and social influences (i.e., number of parents who played hockey and frequency of goalie coaching received)?

RQ_3: Are there significant differences in BPNS and/or motivation across gender, level of play, starter status, and/or number of parents who played hockey?

RQ_4: Do social factors such as frequency of goalie coaching received and/or number of parents who played hockey predict BPNS?

RQ_5: Do social factors and/or BPNS predict goalie motivation?

RQ_6: Do social factors, BPNS, and/or motivation predict goaltender perceived success?

RQ_7: Do social factors, BPNS, and/or motivation predict goaltender performance as measured by save percentage, goals against average, games played, or recent game performance, beyond the effects of age, gender, covid, BMI, and injury?

Discussion

This section will be organized according to both the sequence of this study's hypothesized model (Figure 12) and significance of results. First, it worth noting that, on average, goaltenders' BPNS, motivation type, and perceived success levels were more optimal than initially hypothesized. Namely, goalie autonomy, competence, relatedness, autonomous motivation, and perceived success were relatively high. Controlled motivation was slightly higher than the middle possible value, and amotivation was slightly lower than the middle possible value. The data implies that generally, goaltenders BPNs are being satisfied; furthermore, they are experiencing high quality, self-determined motivation for reasons that are internalized, integrated, aligned with aspects of the self, and based on authentic interest and the inherent satisfaction (Standage & Ryan, 2019). Additionally, however, participant's levels of controlled motivation and amotivation were moderately high, which indicates that they may simultaneously experience motivation for reasons that are external, partially or not at all internalized, to avoid guilt and shame, enhance the ego, obtain rewards, or avoid punishment; goalies, if amotivated may altogether lack intention to act. According to Howard et al. (2016) people have been shown to experience multiple motivation types at the same time and that, so long as autonomous motivations are stronger than controlled types, positive outcomes ensue. Such a multi-motivation type state seems especially plausible for goaltenders, as they may be enjoying their goaltending tasks while still experiencing the inherent last-line-of-defense pressures that accompany their position.

Yet, significant differences in BPNS and motivation appeared when further delineating goaltenders by level of play and starting status. For level of play, professionals demonstrated the most optimal BPNS, motivation, and perceived success. College goaltenders show the least optimal of these measures. These play-level results align with research purporting BPNS and self-determined motivation's association with general physical performance (Cerasoli et al., 2016) and athlete engagement (De Francisco, et al, 2018) as well as more elite level athletes' lower reported levels of amotivation (Martinent et al., 2018) and controlled motivation (Fernández-Río et al., 2018; Martinent et al., 2018). The role of academics and academic identity in athlete motivation (Gaudreau et al., 2009) provides a viable rationale for less optimal college goaltender BPNS and motivation, which could serve as a future study variable. When considering starting status, significant differences in BPNS, motivation, and perceived success were found. As anticipated, starting goaltenders demonstrated most ideal results in almost all measures; however, a surprising trend emerged as second string goalies, and not third string, possessed least optimal BPNS and motivation responses. A disproportionately higher number of significant differences between starter and second string compared to those between the starter and third string confirmed this trend. Such findings align with seminal work conducted by Medvec et al. (1995), in which they concluded that bronze Olympic medalists tended to be happier than those who had won silver. The researchers attributed such psychological tendencies to third place athletes' *downward comparison* (e.g., to not being on the team) juxtaposed to second place finishers *upward comparison* (e.g., achieving starter status). As will be discussed in the upcoming implications for practice section, coaches, parents, and teammates may do well to give special attention in fostering BPNS of non-starting goalies, especial those with second string status.

Social conditions and influences – such as parents and coaches – that are theorized to either enhance or undermine BPNs and motivation (Ryan & Deci, 2000) will be addressed next. Across numerous study analyses, the number of parents who had played hockey demonstrated negative associations with several higher quality constructs (e.g., autonomy, competence, relatedness, games played) and positive associations with lower quality ones, namely controlled motivation and amotivation. Note that this parent variable, although significant in early study analyses, became non-significant in the autonomy, relatedness, and games played multiple regression models when controlled for exogenous variables. In contrast, frequency of goalie coaching received, associated positively with BPNS, autonomous motivation, perceived success, and performance, even beyond the effects of control variables. Specifically, frequency of career (but not recent) goalie coaching predicted each BPNs and motivation type (even when including control variables), whereas frequency of recent (but not career) goalie coaching predicted perceived success, save percentage, and goals against average. Although included in Step 4 of the games played hierarchical regressions model, neither career nor recent goalie coaching appeared to be significant predictors. Compared to the parent variable, goalie coaching tended to have a generally positive relationship with psychological and performance measures. It is important to note, however, that both parent and goalie coaching variables were rather rudimentary and, aside from their theoretical SDT social qualification, relatively exploratory in nature. Therefore, the results involving the study's social variables should be treated with care.

Regarding the relationship between BPNS and motivation types, preliminary correlations showed significant associations between each BPN and both autonomous motivation and amotivation. Only competence and relatedness associated with controlled motivation. After controlling for age, gender, Covid, and injury, only autonomy and relatedness predicted

autonomous motivation and competence predicted amotivation. Interestingly, autonomy predicted (nearing significance) an increase in controlled motivation and amotivation within their respective models. Both the autonomy and relatedness association with autonomous motivation and competence's association with amotivation align with SDT. Within the sports and physical activity motivation literature, competence appeared as a salient factor predicting motivation and performance, especially in more individualized, intense, technical, or competitive settings (Adie & Jowett, 2010; Cerasoli et al., 2016; Gillet et al., 2009; Schüler & Brandstätter, 2013). While autonomy's positive association with controlled motivation and amotivation is counter to SDT, a Cece et al. (2018) study obtained similar results with adolescent athletes in intensive training centers; such results were attributed to the "win-at all costs atmosphere...high demands placed on youth athletes by coaches, and/or the compulsory nature of sport...lead[ing] to actively undermine the need for autonomy..." (p. 194). Such environmental norms may lead to internalization and even integration of these external demands. Again, given the high-pressure nature of goaltending, this explanation seems plausible.

Finally, an examination of social variables, BPNS, and motivation types predicting performance resulted in significant models for recent game performance and number of games played. Within the recent game performance model, no individual predictor variables were significant. For the number of games played model, all steps of the model were significant. Other than the control Covid variable, autonomy was a significant predictor in Step 3 and autonomy, and competence, controlled motivation, and amotivation significant predictors in Step 4. Counter to SDT, competence predicted a lower number of games played and controlled motivation predicted a higher number of games played. Like earlier Cece et al. (2018) justification, it is possible that controlled motivation behaviors are rewarded by stakeholders within the elite

hockey culture. However, the negative association between competence and number of games played remains unclear.

In general, the classical goalie performance metrics of save percentage and goals against average showed few significant associations with other study variables. As hypothesized, number of games played – and to a lesser extent, recent game performance – demonstrated far more and far stronger associations. As an example, neither goals against nor save percentage correlated with perceived success while both recent game performance and number of games played did. These observations support the criticism toward save percentage and goals against average as representative goalie performance metrics. Now that the key findings have been discussed, implications for practice will be addressed.

Implication for Practice

As supported by study results, various applications will be presented for goalies, parents, coaches, and hockey organizations to better enable optimal goaltender experience and performance. This section will be organized from general to specific principles and best practices. To begin, one of the most salient social factors within the literature, autonomous supportive coaching, will be addresses.

Autonomous Supportive Coaching

Many studies referenced within this dissertation (Adie et al., 2008; Adie & Jowett, 2010; Alcaraz et al., 2015; Banack et al., 2011; Gillet et al., 2010; Jõesaar et al., 2012; Trigueros et al., 2019) point toward the myriad benefits of autonomous supportive coaching. This coaching style is defined by coaches facilitating social and contextual conditions conducive to BPNS and self-motivation. Autonomous supportive coaching practices include inviting athlete participation in decision making processes, acknwledging athlete emotions, providing choices, and taking

personal interest in coaches' athletes (De Francisco, Arce et al., 2018). See Table 1 for more examples of need supportive and need thwarting communication styles.

Results of the afformentioned studies unanimously point toward the benefits of providing autonomy supportive coaching, including increased athlete perceptions of autonomy and relatedness (Banack et al., 2011), prediction of athletes' intrinsic motivation (Jõesaar et al., 2012), facilitating self-determinded motivaiton and performance (Gillet et al., 2010), adaptation of mastery-approach goals (Adie & Jowett, 2010), and increased psychological needs satisfaction and resiliance (Trigueros et al., 2019). Given the inherently high stakes, high pressure (Gelinas & Munroe-Chandler, 2006; Goldman, 2015; Goldman & Valley, 2014; 2016; 2021; Monnich, 2021; USA Hockey Goaltending, 2021; Vehviläinen, 2012) and reactive (Clark & Luongo, 2010; Monnich, 2021) nature of goaltending, facilitating opportunities for goalies to regain perceived control appears to be a reasonable goal for goaltenders, parents, and coaches alike, especially given the impact goaltenders have on team success (Chan et al., 2012).

While team coaches have a responsibility to develop every athlete on the team, many coaches feel ill-equipped to assist their goaltender (USA Hockey Goaltending, 2021). As stated by USA Hockey's Goaltending (2021) Manager, Steve Thompson, "You don't have to be a goalie scientist to be a great goalie coach. Showing interest in a goalie's development, being consistent, available for support, asking questions, getting feedback is often what these young players need" (para. 24). Such recommendations align well with the tenants of autonomous supportive coaching. While the aforementioned ideas are helpful in theory, how to operationalize them may be challenging. One such medium, especially for coaches who do not possess goaltending or goalie-specific coaching experience, may be the utilization of goalie-centric learning analytics in which goalies are provided opportunities to produce their own goalie-

specific data and self-reflective feedback for themselves, their coach, and their team. The next section elaborates on these learning analytic possibilities.

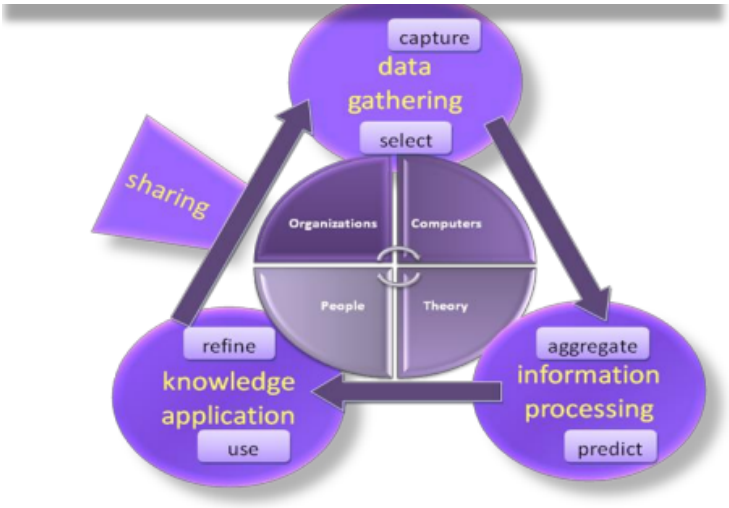
Applying Learning Analytics to Goaltending

Sclater (2017) cites myriad studies on the benefits – and potential liabilities – of learning analytics as applied in the education domain. It seems reasonable that learning analytics theory and techniques could be applied to the physical education and sports contexts as well. Sclater (2017) posits that reflective and real-time use of learning analytics is often superior in motivating and empowering end-users compared to interventions enacted on students by a middle person. Learning analytics software that has users reflect on their own performance, experiences, and even emotions makes space for greater metacognition, self-regulation, and therefore student or athelete success (Corin et al., 2005; Kruse & Pongsajapn, 2012). Furthermore, wearable technologies, fitness trackers, and phone applications have made way for "the quantified self" (Sclater, 2017, p. 127), in which one is able to set goals, self-monitor, self-adjust, and choose whether to utilize social aspects of self-tracking programs. In this way, one could argue that such adaptive learning (Siemens & Long, 2011) could support individuals' BPNs of competence, relatedness, and autonomy and more optimal levels of self-determined motivation (Ryan & Deci, 2017; Standage & Ryan, 2019). The use of such self-produced and self-tracked data aligns well with the tenants of autonomous supportive coaching. This utilization of self-tracked, self-produced, and athelete-facing analytics provides an opportunity to bolster a currently lacking hockey analytics culture while supporting the BPNs, motivation, and rights of players. Additionally, these efforts could support pleas for hockey management's better use of data (Mason & Foster, 2007; Naples et al., 2018; Nandakumar & Jenson, 2019; Porreca & Rocco, 2016), an approach that Siemens & Long (2011) claim has enabled other organizations like

higher education to better "help leaders to make data-lead decisions, increase organizational effectiveness using live-time information, identify value produced by leadership, and produce learner-facing analytics" (p. 36). Elias's (2011) model for learning analytics (see Figure 22) appears to align most closely with the issue of sports performance and analytics. This model emphasizes that data analytics, at its highest level, is not only bytes of information but can be used to inform, predict, use, and ultimately to share with others in a reflective, self-regulating, and motivating way.

Figure 22

Learning Analytics Continuous Improvement Cycle



Note: From "Learning Analytics: Definitions, Processes and Potential," by T. Elias, 2011, (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.456.7092&rep=rep1&type=pdf). CC By-NC.

Data and information produced by humans or programs are necessary, but knowledge and wisdom are often applied in the contexts of people, teams, and organizations. In this way, the quantified self and other empowering user-facing analytics may serve as a viable medium by which Elias's (2011) model for learning analytics may be operationalized.

Importantly, data can be collected in myriad ways, ranging from paper and pencil to paid-for software utilizing artificial intelligence to gather data and report results. To again align with the tenants of autonomous supportive coaching, the enhancement of self-motivation by way of autonomy, competence, and relatedness is key. For example, a goaltender might record performance and/or psychological data around objective measures such as shot number, location, and/or type. Additionally, goalies could collect data on the degree to which they maintained concentration, controlled emotions, recovered after getting scored on, stayed present, or maintained confidence (Monnich, 2021). The benefit of a more digital approach is that visualizations for individual games and/or longitudinal reports can be more readily produced and reflected upon. See Figures 24 - 31 below for examples of these reports across various digital platforms and Appendix G for the codebook used to produce visualization in Figures 23 and 24.

Figure 23

Goalrobber Hockey Schools Post-Game Reflection Mobile Application

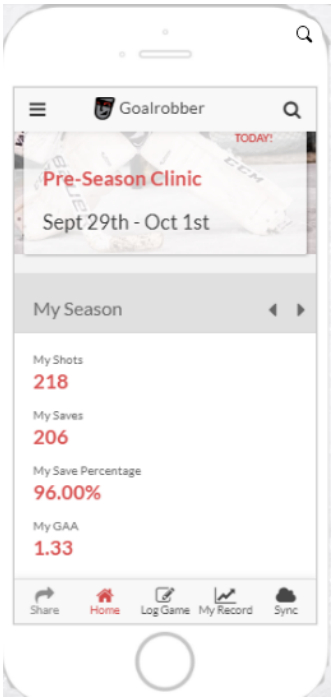
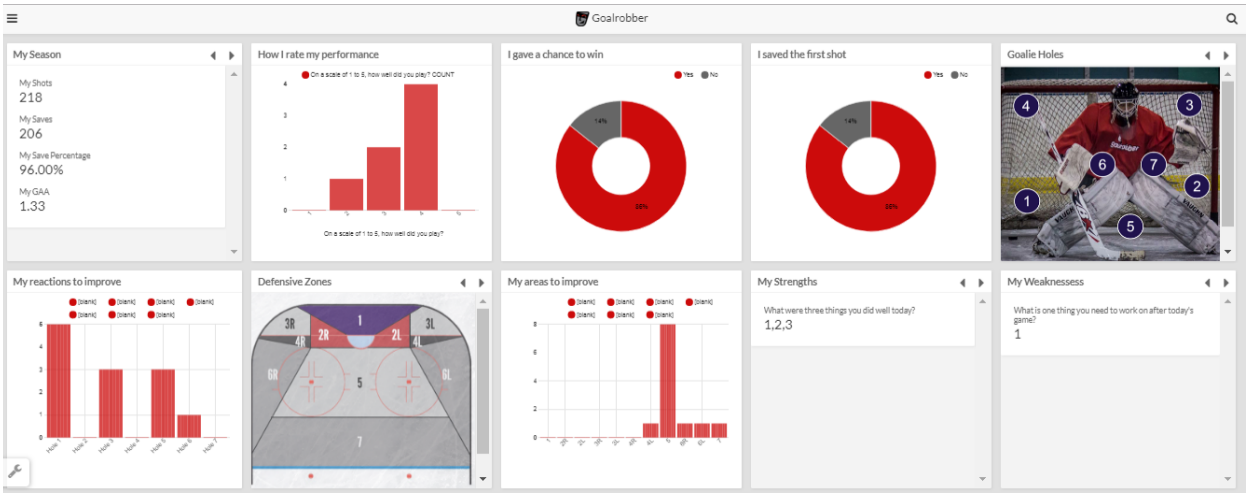


Figure 24

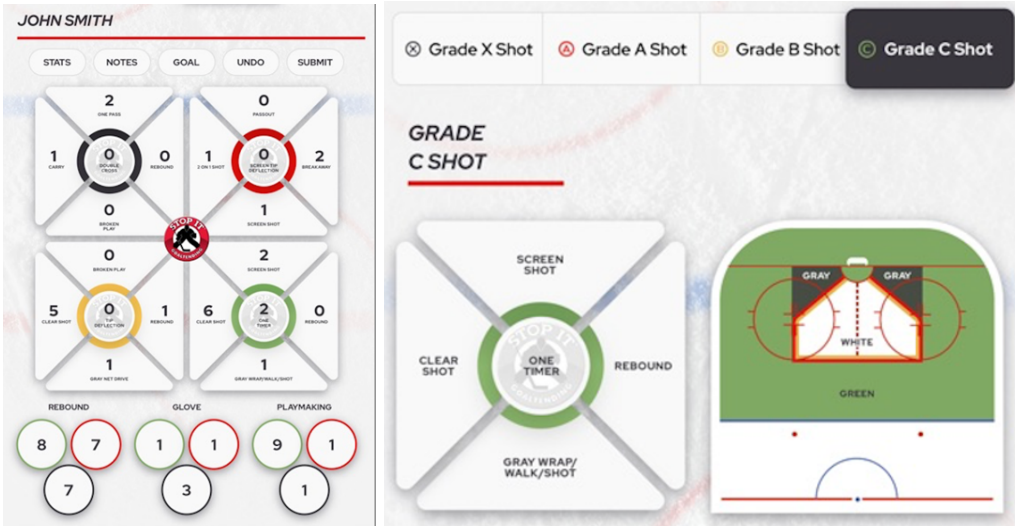
Goalrobber Hockey Schools Live-Time Performance Visualizations



Other third-party mediums could be used such as USA Hockey's goalie tracker (www.usahockey.com), InStat (www.instat.com), Hudl (https://www.hudl.com), SIG Gameday (www.siggameday.com), or Goaliath goalie app, to name a few. See Figures 25 – 30.

Figure 25

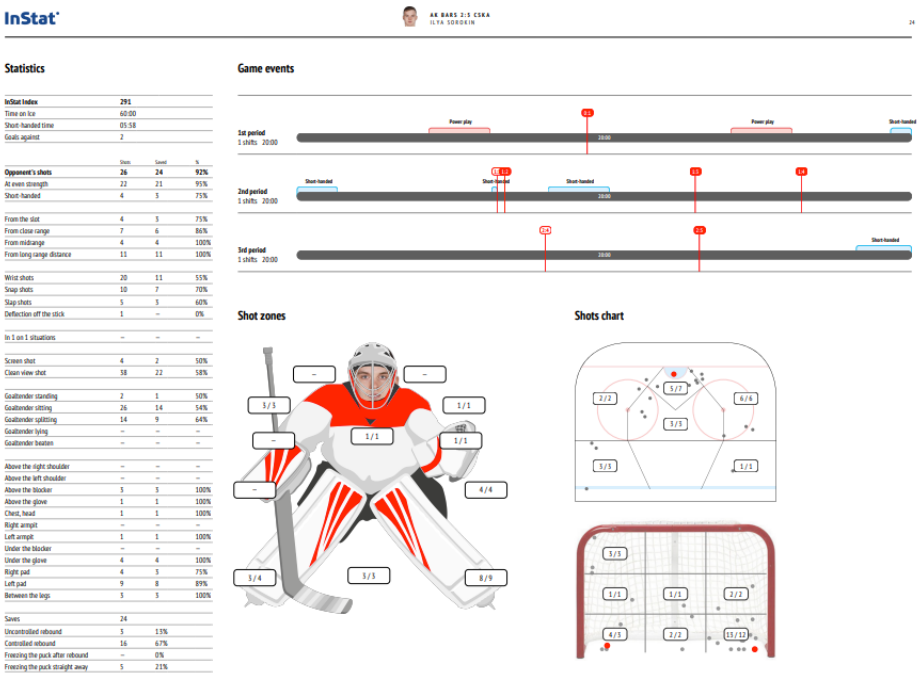
SIG Gameday App Interface with Shot Location, Shot Type, and Playmaking



Note: From https://stopitgoaltending.com/newswire_3/, 2020. Copyright 1010 by Stop It Goaltending.

Figure 26

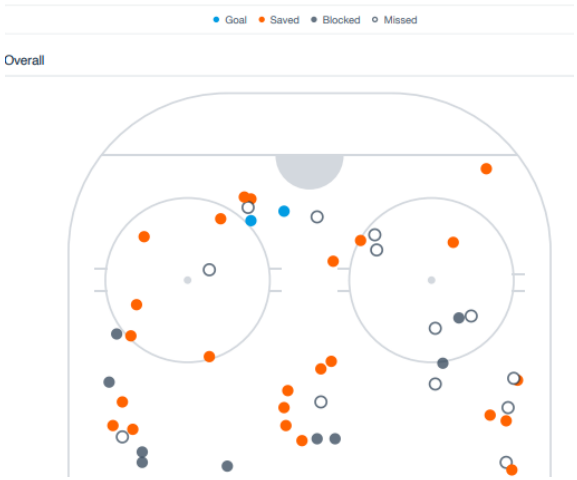
InStat Shots on Goal Report with Rink Location, Goaltender Holes, and Timestamp



Note: Copyright © InStat Sport Global Group of companies 2022

Figure 27

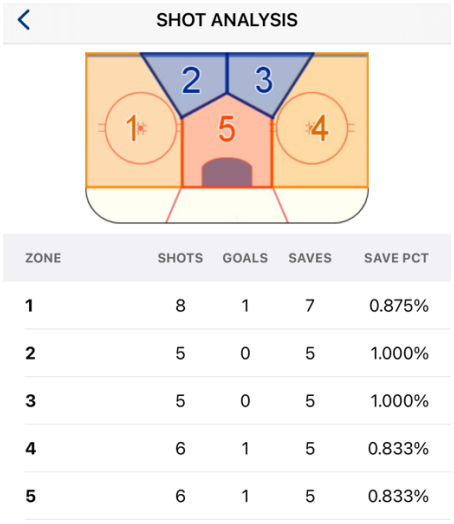
Hudl Shot Chart Report with Shot Attempts, Blocked Shots, Saves, and Goals



Note: From https://www.hudl.com/support/hudl/v3/breakdown-stats-and-reports/stat-reports/shot-chart-report-ice-hockey. Copyright 2022 by Agile Sports Technologies, Inc.

Figure 28

USA Hockey's Shot Analytics Phone Application Interface with Zones



ZONE	SHOTS	GOALS	SAVES	SAVE PCT
1	8	1	7	0.875%
2	5	0	5	1.000%
3	5	0	5	1.000%
4	6	1	5	0.833%
5	6	1	5	0.833%

Note: From https://www.usahockey.com/mobilecoach. Copyright 2022 by SportsEngine, Inc.

Figure 29

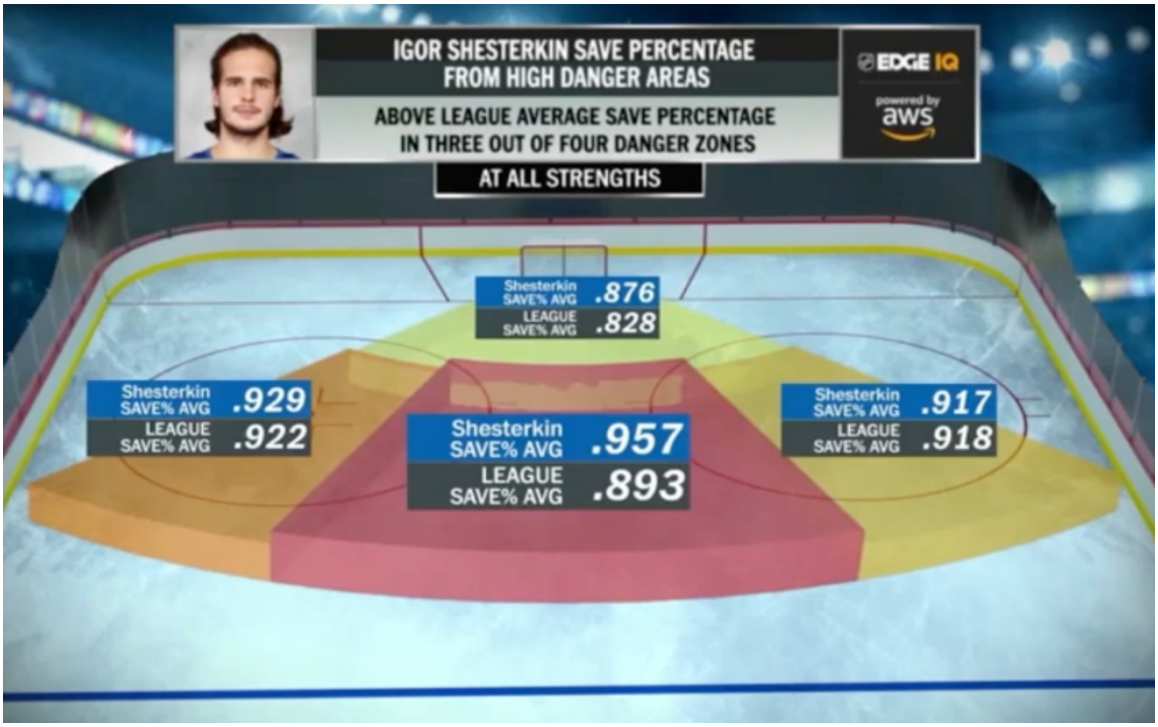
Goaliath Goaltender Shot Tracking App Screenshot

Note: From https://goaliath.xyz/. Copyright 2021 by Jeff Marlow.

Although not self-produced, the NHL has recently utilized artificial intelligence (AI) powered by Amazon to track shot location (https://aws.amazon.com/sports/nhl/). See Figure 31.

Figure 30

NHL and Amazon Edge IQ Sample Goaltender League Average vs. Goaltender Save Percentage by Danger Zones



Note: From https://www.nhl.com/bruins/video/nhl-edge-iq-save-percentage/t-277774708/c-10738435. Copyright 2020 by Boston Professional Hockey Association, Inc and National Hockey League.

The above stat trackers are but a sampling of viable options; however, all approaches possess potential psychological and logistical barriers, which will be addressed following section.

Barriers and Roadblocks to Goaltender Learning Analytics

In addition to the current data analytics challenges that exist within hockey culture (Mason & Foster, 2007; Naples et al., 2018; Porreca & Rocco, 2016; Nandakumar & Jenson,

2019), hockey organizations – like any institution – may not yet be ready to fully implement sports analytics. As Mason and Foster (2007) admitted, within the NHL there are "lots of numbers and statistics but no well-established systems to track them" (p. 208). Another potential barrier for this self-recorded data is the possibility of low player participation. For the data to be self-produced, goaltenders are required to input, upload, or otherwise provide their data. Mason and Foster (2007) cite players' reluctance to wear data-producing devices; similarly, both the participation and reliability of athlete's manually entering performance and perception data could be a challenge. Finally, there is a risk of over-analyzing performance, especially at the youth level. Organizations, coaches, and players should be careful not to "kill passion" (Sclater, 2017, p. 133) within the sport, decrease intrinsic motivation for playing, and even decrease the likelihood of achieving flow state (Csikszentmihalyi, 1990; Schüler & Brandstätter, 2013) by focusing too heavily on the data instead of genuine learning and experience. Care must be taken in finding the balance between the art and science of performance, especially at the youth levels.

Given the position of goaltending is physically, psychologically, and mentally unique, goaltenders and their teams would likely benefit from goalie-specific analytics in addition to other team and position metrics. Utilizing self-produced data via computer or phone application may both help to produce valuable data as well as evoke a culture around the quantified-self, adaptive learning, and autonomous coaching. In this way, hockey – and sports generally – is not only able to produce and mine data but better align its uses with the essence of LA's learner/athlete-centric approach.

Goalie Coaching and Game Management

Findings from the current study reveal associations between the frequency of recent and career goalie coaching and many optimal psychological and performance outcomes. To this end,

one response may be providing goalies more accessibility to goalie-specific coaching and/or educating coaches to become more efficacious at coaching their goaltenders. According to Thompson in USA Hockey Goaltending's (2021) recent article, "A New Approach to Goaltender Development," hockey coaches – even those who did not play the position themselves – can become effective at coaching and developing goaltenders. USA Hockey's (2021b) bronze, silver, and gold goaltender certification program – and others like it – are attempting to provide a nation-wide goalie-coaching education curriculum. In addition to communicating well, providing feedback, and incorporating technical goalie cues in practice, USA Hockey Goaltending (2021) provides age-appropriate game management guidelines that better ensures every goaltender receives optimal playing time. For 8u goalies, quick change goalie equipment is recommended which allows players to rotate into and out of the goalie position multiple times per game. At the 10u level, goalies are encouraged to wear real goalie gear while rotating at the halfway point of the period with another goalie. For 12u, recommendations are for goalies to play a full period before switching, considering each period a 12-minute shift. At 14u, goalies should change at the halfway point of the game. Finally, for 15+ goalies are recommended to play full games but split regular season competitions to prepare for elite level hockey in which goalies have historically played full games unless being pulled. The shorter shift for 14 and under goaltenders provides coaches opportunities to give feedback and relate to goaltenders, much like they do with players in other positions. This focus on providing all goalies with as many games as possible is congruent with the numerous results within this study that demonstrate associations between games played, BPNS, motivation, and perceived success. Although the study's participants were 18 years and older, these may be study implications generalizable to broader goaltender groups, especially second and third-string goaltenders who may play few games.

Mental Skills Training

Another implication revolves around learned mental skills. To review, in his landmark mixed methods study of ice hockey goalies, Monnich (2021) collected survey, interview, focus group, and survey data which identified perceived participant mental challenges such as maintaining focus or concentration, controlling emotions; recovering after getting scored on; performing consistently; controlling thoughts; anxiety, nervousness, or fear; and dealing with negative thoughts as well as other themes such as staying in the present moment, anxiety/doubt; self-awareness, self-improvement; confidence; and competitive attitude. Survey results indicated that goaltenders see mental skills as important; however, interview and focus group data revealed a great disparity between the mental challenges faced by goalies and their ability to effectively utilize the mental skills and techniques necessary to mitigate these challenges. The desired mental skills cited included staying focused; controlling thoughts; arousal regulation; controlling emotions; using self-talk, setting goals; using imagery; and recovering from failure.

Gelinas and Munroe-Chandler (2006) suggest that concentration, arousal control, imagery, and self-talk are among the most central mental skills. To address the psychological needs of Finish goaltenders, Vehviläinen (2012) compiled a mental training guide for ice hockey goaltenders. Within his paper, he suggested 12 mental qualities of which goaltenders and goalie coaches should be aware: self-confidence, imagery, emotion control, stress and anxiety, game preparation, game planning, feedback, flow, and *motivation*.

Although it is beyond the scope of this paper to address each of the mental skills mentioned above, goaltenders and goalie coaches would likely benefit from the acquisition of these and other techniques, especially those fostering perceived control – even of thoughts – posited to be lacking in the goaltending position. As recommended by Monnich (2021), groups

such as USA Hockey, public and private hockey organizations, goalie coaches, and goaltenders themselves may find the creation and implementation of mental skills curriculum beneficial to goaltender well-being and performance. Replication of studies such as Rogerson and Hrycaiko's (2002) in which various mental skills and their association with objective measures will be important in the empirical validation of these techniques.

Other Perceived Control Techniques

Another medium by which goaltenders might regain perceived control is through adopting a *growth mindset*, the belief that intelligence and basic abilities are malleable and can be self-improved through effort (Dweck, 2006). In a review, Ng (2018) posited that growth mindset and intrinsic motivation are interrelated, both undergirded by autonomy and self-regulation. Namely, people embracing a growth mindset have perceived control over their ability, believing it can be changed through their owned actions. The understanding of exact relationships between growth mindset, autonomy, and intrinsic motivation is in its beginning stages (Ng, 2018) and warrants further investigation. One potential avenue for bolstering a goaltender growth mindset and perceived autonomy is through the teaching of learned and empowering technical skills. A sampling of such goaltending techniques comes from Clark and Luongo (2010), in which they encourage specific competence and autonomy-supportive techniques such as developing a puck-collection habit (e.g., containing shots to the chest and covering pucks), depth management, prioritizing angle, improving flexibility, rebound control, communicating with teammates, developing a pre-game routine, and playing the puck, to name a few. There exist myriad goalie training books, programs, and companies; the goal of this short section, however, is to highlight the importance of fostering growth mindset, perceived control,

and intrinsic motivation as well as providing goaltenders with goalie-specific techniques that encourages these and other (e.g., flow) psychological states.

Limitations

The current dissertation delimited goalies to those who were playing competitive hockey during the 2019 – 2020 and/or 2020 – 2021 seasons. Although this study was amongst the largest ice hockey goalie studies to date ($N = 180$), an even larger sample size would have been helpful in producing greater statistical power. The Covid-19 pandemic delayed, interrupted, and/or cancelled many hockey and other sports seasons. Therefore, the timeframe over which goalies reported their psychological experiences and performance may have further compounded issues in goaltender participation and representation. Best efforts were made to account for potential effects of Covid-19; however, it is unlikely that this variable was fully controlled. Furthermore, analyses were not controlled for the average number of games played across various levels, leagues, and countries. As a key performance metric, this total number of games played across teams remained a potentially confounding variable. Similarly, the number of goalies on each team roster was unaccounted, which could have affected testing for differences across goaltender starting status. For example, it is possible that a participant was the only goalie on their team, or that they were one of two goalies on the team which would make being a third string goalie impossible.

As noted in the results chapter, BPNS items did not cleanly load onto their theorized factors. Averaging respective items along with subsequent factor analyses demonstrated sufficiently strong internal consistency for each of the BPNS via Cronbach's Alpha. Yet, the initial loadings as well as strong intercorrelation between BPNS factors remained a liability for the study.

Valid results are dependent on participant honesty and accuracy, which introduces subjectivity and participant bias. Included performance metrics were objective, but there was no way to check the accuracy of these statistics, given the confidential nature of the study. Also inherent to voluntary participation is the possibility certain goaltender characteristics were over-represented. For example, goaltenders who experienced more success may have had an increased likelihood of participating. Furthermore, perhaps those who were more motivated demonstrated a higher rate of survey completion. The dissemination of this study's survey was done primarily through the researcher's coaching and goaltending network; the exact survey distribution was unknown due to the use of social media, email, various professional networks, as well as those networks' reach. Although this network spans across many leagues, states, and even countries, certain regions and/or demographics could be over or underrepresented.

Another limitation was the lack of empirical research on ice hockey goaltending, specifically goalie psychology and motivation. While this realization provided opportunity to make a genuine contribution to the literature, the exploratory in nature of some analyses within this study posed risks of inflated type 1 error. Therefore, transparency was and will continue be key as will replication in the form of hopeful complimentary research.

Finally, this study was not longitudinal, and no treatment was applied for experimental or quasi-experimental design. Inferential and predictive statistics were utilized to establish a better understanding of the current goaltender psychological experience and performance realities as well as their relationships with one another. These analyses do not have the power to imply causation.

Recommendations for Future Research

This study added to the currently sparse empirical goaltending body of research. However, results as well as limitations evoke additional research questions of which this dissertation might inform. First, research building on the work of Monnich's (2021) goaltender mental skills mix-methods study could quantitatively assess the degree to which goaltenders can control negative thoughts and the association such thought control has on goaltender well-being and performance. Measuring the effects of social influencers such as autonomous supportive coaching, parenting, and team dynamics on goaltender BPNS, motivation, and performance would seem like a productive next step in better understanding the goaltender psychosocial experience as well. Conducting a single study on goaltenders of all ages – both amateur and elite – which utilizes the same variables and survey items would provide the ability to assess common measures across a broader demographic range. Additionally, gathering greater and more quality goalie-specific analytics such as shot location, shot type, shot attempts, minutes played, goalies on the team, and coach evaluations may help in more accurately assessing goaltender performance. Finally, replication of SDT studies within the domain of goaltending, hockey, and/or other sport domains could test the generalizability of these motivation and performance results. Structural equation modeling appears to be an effective and commonly used statistical analyses method which could more succinctly evaluate relationships between complex phenomenon like those of SDT's psychosocial model.

Conclusion

Ice hockey goaltending is a unique and challenging position in the world of sports (Druzin, 2013; Fry, 2017; Vehviläinen, 2012; Sipponnen, 2018; Gelinas & Munroe-Chandler, 2006; Monnich, 2021). A goaltender's job is high stakes and most impactful on team success

outcomes (Chan et al., 2012). They serve as the last line of defense and their playing time is both highly competitive and potentially volatile. As a result, goaltenders are subject to exceptional levels of pressure, stress, and anxiety (Goldman, 2015; Goldman & Valley, 2014; 2016; 2021; Monnich, 2021; USA Hockey, 2020). Additionally, goalies and goalie coaches express challenges in goaltenders' abilities to control their thoughts and emotions while lacking the mental skills to overcome such mental obstacles (Monnich, 2021). Despite many books and interviews written about goaltending (Druzin, 2013; Fry, 2017; Goldman, 2015; Goldman & Valley, 2014; 2016; 2021), goalie mental training guides (Gelinas & Munroe-Chandler, 2006; Sipponnen, 2018; Vehviläinen, 2012), and recent goalie coach education initiatives (USA Hockeya, 2021), relatively little empirical work has been conducted on hockey goaltender psychology and almost none on motivation. The purpose of this study was to better understand the psychosocial aspects of goaltending by measuring goaltenders' BPNS, related self-determined motivation, and assess how these factors relate to goaltender goaltender's perceived success and performance. A self-determination theory framework was utilized.

This study added to the sparse body of goaltending research. Results indicate that, while goaltenders demonstrated relatively high levels of BPNS and autonomous motivation, they also showed moderately high levels of controlled motivation and amotivation. These BPNS and motivation results appeared less optimal for non-professional and non-starter goaltenders. Additionally, social influences such as number of goalie's parents who had played hockey negatively associated with higher quality constructs while, conversely, frequency of goalie coaching associated positively. Congruent with SDT, autonomy and relatedness predicted autonomous motivation, and competence predicted amotivation. Surprisingly, however, autonomy predicted (nearing significance) an increase in controlled motivation and amotivation

within their respective models. Finally, regarding performance, social variables, BPNS, and motivation types predicted performance as measured by games played and recent game performance but not by goals against average or save percentage. Autonomous supportive coaching provides a viable framework for applying the tenants of SDT to sports and, more specifically, ice hockey goaltending. This player-centered approach to coaching aligns with USA Hockey (2021a) Goaltending's recent goalie coach education initiatives in which coaches are provided both technical and coaching technique training to better support their goaltenders. These teachings serve as an important starting point. However, goalie coaching best practices and curriculum could be significantly bolstered with empirically-based research such as this study and hopefully many more to come.

APPENDICES

Appendix A

Pilot Survey

This survey concerns your thoughts and experiences as a hockey goaltender. There are no right or wrong answers – we are trying to find out how you think and feel about various aspects of your goaltending experience. Please be as honest as possible in your responses."

QUESTIONNAIRE SUMMARY:

Scale/measure	Items
Participant Characteristics	8
Social Factors	3
Objective Performance	2
Basic Psychological Needs	12
Motivation	20
Perceived Success	5
TOTAL	48

PARTICIPANT CHARACTERISTICS

ID	Random number identifying each participant.
Gender	What is your gender? (1) Male (2) Female
Age	What is your age, in years? [text box]
Race	What is your race? (1) White (2) Asian or Asian American (3) Black or African American (4) Native American/American Indian, Indigenous, or Alaska Native (5) Native Hawaiian or Other Pacific Islander (6) Other
Goalie_Last	Did you play goalie last year? (1) Yes (2) No
Goalie_This Year	Do you plan to play goalie last year? (1) Yes (2) No (3) Maybe
State/Province	What state or province do you play hockey in? (1) North Dakota

	(2) South Dakota (3) Minnesota (4) Montana (5) Other [text box]
Level	What is your current level of play? (1) Peewee/12U (2) Bantam/16U (3) High School/19U (4) AAA hockey (5) Other [text box]
Experience	How long have you been a hockey goalie, in years? [example: 3]

SOCIAL FACTORS

Coaching	On average, how often do you receive goalie coaching? (1) Never (2) A few times a year (3) Once a month (4) Once a week (5) More than once a week
Parent players	Did either of your parents play hockey? (1) Yes (2) No (3) I don't know
Parent goalies	Did either of your parents play goalie? (1) Yes (2) No (3) I don't know

OJBECTIVE PERFORMANCE

Save Percentage	What was your save percentage this past season? [example: 91.4] *If you do not know, please leave blank.
GAA	What was your goals against average this past season? [example: 2.45] * If you do not know, please leave blank.

BNSS – BASIC NEEDS SATISAFCTION SPORTS (Autonomy, Competence, & Relatedness)

The following set of items refer to your OVERALL experience as a goalie. Please read each item carefully. Respond to it as honestly as you can.

Autonomy

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
autonomy1	As a goalie, I get opportunities to make my own choices.
autonomy2	Being a goalie is what I want to be doing.
autonomy3	I play goalie the way I want.
autonomy4	As a goalie, I am pursuing objectives that are my own.

Competence

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
comp1	I am good at being a goalie.
comp2	I can overcome challenges as a goalie.
comp3	I am a skilled goaltender.
comp4	I have the ability to perform well as a goalie.

Relatedness

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
relate1	I have close relationships with people in hockey.
relate2	There are people in hockey who care about me.
relate3	I show concern for others in hockey.
relate4	In hockey, there are people who I can trust.

Note: Adapted from "Preliminary empirical validation of the "Basic Needs Satisfaction in Sport Scale" with a sample of Spanish athletes," by C. De Francisco, F.J. Parra, C. Arce, and M.D. Vílchez, 2018, *Frontiers in psychology*, *9*, 1057. (https://doi.org/10.3389/fpsyg.2018.01057). Copyright 2018 by De Francisco, Parra, Arce and Vilchez. CC BY.

BRSQ, BASIC REGULATION IN SPORTS QUESTIONS – MOTIVATION

Rate your level of agreement with the following statements about the reasons WHY you play goalie. Answer as honestly as you can.

Stem: "I am a goalie…

Intrinsic/Integrated Regulation

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
intrinsic1	… because I enjoy it.
intrinsic2	… because it's an opportunity to just be who I am.
intrinsic3	… because it's fun.
intrinsic4	… because it allows me to be true to myself.

Identified Regulation

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
identify1	… because I learn things that are useful to me in other areas of my life.
identify2	… because it makes me a more well-rounded person.
identify3	… because I value the skills that come from being a goalie.
identify4	… because it is one of the best ways to spend time with my friends.

Introjected Regulation

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
introject1	… because I would feel bad if I quit.
introject2	… because I would feel like a failure if I stopped playing.
introject3	… because I must play to feel good about myself.
introject4	… because if I quit, I would feel guilty.

External Regulation

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
external1	… because if I don't play others will be unhappy with me.
external2	… because I feel pressure from other people to play.
external3	… because people push me to play.
external4	… because other people think being a goalie is cool.

Amotivation

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	**Items**
amotiv1	…, but I question why I continue.
amotiv2	…, but I wonder "what's the point?"
amotiv3	…, but the reasons why are not clear to me anymore.
amotiv4	…, but I question why I am putting myself through this.

Note: Adapted from "The Behavioral Regulation in Sport Questionnaire (BRSQ): Instrument development and initial validity evidence," by C. Lonsdale, K. Hodge, and E. A. Rose, 2008, *Journal of sport and exercise psychology*, 30(3), 323-355 (https://doi.org/10.1123/jsep.30.3.323). Copyright 2008 by Human Kinetics, Inc.

PERCEIVED GOALTENDER SUCCESS

The following set of items refer to your OVERALL experience as a goalie. Please read each item carefully and respond to it as honestly as you can.

Stem: "Since you began playing goalie, how SUCCESSFUL do you feel…

(1 = *Very unsuccessful*, 5 = *Very successful*)

	Stem: Since you began playing goalie, how SUCCESSFUL do you feel…
Name	**Items**
success1	… you are as a goalie overall?
success2	… about your performance in games?
success3	… in achieving the objectives you've set for yourself?
success4	… in the progress you've made over time?
success5	… in gaining new knowledge and understanding about goaltending?

Note: Adapted from "Achievement goals in sport: The development and validation of the Perception of Success Questionnaire," by G.C. Roberts, D.C. Treasure, and G. Balague, 1998, *Journal of Sports Sciences*, *16*(4), 337-347 (https://doi.org/10.1080/02640419808559362)

Appendix B

Dissertation Survey

This survey concerns your thoughts and experiences as a hockey goaltender. There are no right or wrong answers – the purpose is to find out how you think and feel about various aspects of *your most recent season* as a competitive goaltender. Please be as honest as possible in your responses. Thank you.

QUESTIONNAIRE SUMMARY:

Scale/measure	**Items**
Participant Characteristics	14
Social Factors	4
Objective Performance	7
Basic Psychological Needs	15
Motivation	20
Perceived Success	6
TOTAL	66

PARTICIPANT CHARACTERISTICS

ID	Random number identifying each participant.
Gender	What is your gender? (1) Male (2) Female
Age	What is your age, in years? [text box]
Height	How tall are you, in inches or cm? [example: 61 in or 155 cm] [text box]
Weight	How much do you weight in lbs or kgs? [example: 200 lbs or 91 kgs] [text box]
Country	What country are you from? (1) Austria (2) Canada (3) Czech Republic (4) Finland (5) German (6) Russia (7) Slovak Republic (8) United States (9) Other [text box]
Race	What is your race? (1) White (2) Asian or Asian American

	(3) Black or African American (4) Native American/American Indian, Indigenous, or Alaska Native (5) Native Hawaiian or Other Pacific Islander (6) Other [text box]
State/Province	If from the US or Canada, what state or province are you from? (1) Other [text box] (2) I'm not from the US or Canada
Hockey Experience	At what age did you begin playing hockey? [example: 7] [text box]
Goalie Experience	At what age did you begin playing goalie full time? [example: 10] [text box]
Catch	Do you catch right or left? (1) Right (2) Left
Play	Are you currently playing competitive hockey? (1) Yes (2) No
Level	What is/was your most recent level of competitive play? (1) HS/Midget/19U (2) Juniors or Major Juniors (3) College Club/ACHA (4) College D3 (5) College D1 (6) Minor League Professional (7) Major League Professional (6) Other [text box]
Starter	What status best describes your goaltending role on your most recent team? (1) Starter (2) Second string (3) Third string (4) Other [text box]
Injury	What percent of the season did you experience injury that significantly affected your ability to play? [example: 10%] [text box]

SOCIAL FACTORS

Parent players	Did your parents play hockey? (1) Yes, both played. (2) Yes, one of my parents played. (3) No, neither of my parents played.
Parent goalies	Did either of your parents play goalie? (1) Yes, both played. (2) Yes, one of my parents played. (3) No, neither of my parents played.

Goalie Coaching Season	On average, how often have you received goalie-specific coaching during your most recent season? (1) Never (2) Rarely (3) Sometimes (4) Often (5) Very Often
Goalie Coaching Career	On average, how often have you received goalie-specific coaching through your career? (1) Never (2) Rarely (3) Sometimes (4) Often (5) Very Often

PERFORMANCE MEASURES

Games played	How many games did/have you played in your most recent season? [example: 12]
Game percent	Approximately what percentage of total games have/did you play over the season? [example: 60] [text box]
Last_Game_ Play	Did you receive playing time in your team's most recent game? (1) Yes (2) No
Last_Game_ Performance	How would you rate your performance in the last game you played? (1) Poor (2) Below Average (3) Average (4) Above Average (5) Excellent
Last_Game_ Outcome	What was the outcome of the last game you played? (1) Win (2) Loss (3) Tie
Save Percentage	What is/was your cumulative save percentage in your most recent season? [example: 91.4] [text box]
GAA	What is/was your cumulative goals against average in your most recent season? [example: 2.45] [text box]

BNSSS – BASIC NEEDS SATISAFCTION SPORTS (Autonomy, Competence, & Relatedness)

The following set of items refer to your OVERALL experience as a goalie. Please read each item carefully. Respond to it as honestly as you can.

Autonomy

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	**Items**
autonomy1	As a goalie, I get opportunities to make my own decisions.
autonomy2	Being a goalie is genuinely what I want to be doing right now.
autonomy3	I play goalie the way I want.
autonomy4	As a goalie, I am pursuing objectives that are my own.
autonomy5	As a goalie, I feel in control.

Competence

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	**Items**
comp1	I am a capable goalie.
comp2	As a goalie, I can overcome challenges.
comp3	I am a skilled goaltender.
comp4	I have the ability to perform well as a goalie.
comp5	As a goalie, I feel competent to achieve my objectives.

Relatedness

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	**Items**
relate1	I have close relationships with people in hockey.
relate2	There are people in hockey who care about me.
relate3	I care about others in hockey.
relate4	In hockey, there are people who I can trust.
relate5	In hockey, I feel included.

Note: Adapted from "Preliminary empirical validation of the "Basic Needs Satisfaction in Sport Scale" with a sample of Spanish athletes," by C. De Francisco, F.J. Parra, C. Arce, and M.D. Vílchez, 2018, *Frontiers in psychology*, *9*, 1057. (https://doi.org/10.3389/fpsyg.2018.01057).

BRSQ, BASIC REGULATION IN SPORTS QUESTIONS - MOTIVATION

Rate your level of agreement with the following statements about the reasons WHY you play goalie. Answer as honestly as you can.

Stem: "I am a goalie…

Autonomous (Intrinsic/Integrated and Identified Regulation)

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
intrinsic1	… because I enjoy it.
intrinsic2	… because it's an opportunity to just be who I am.
intrinsic3	… because it's fun.
intrinsic4	… because it allows me to be true to myself.
identify1	… because it helps me learn things that are useful in other areas of my life.
identify2	… because it makes me a more well-rounded person.
identify3	… because I value the skills that come from being a goalie.
identify4	… because it is one of the best ways to spend time with my friends.

Controlled (Introjected and External Regulation)

(1 = *Strongly Disagree*, 5 = *Strongly Agree*)

Name	Items
introject1	… because I would feel bad if I quit.
introject2	… because I would feel like a failure if I stopped playing.
introject3	… because I must play to feel good about myself.
introject4	… because if I quit, I would feel guilty.
external1	… because if I don't play others will be unhappy with me.
external2	… because I feel outside pressure to play.
external3	… because people push me to play.
external4	… because other people think being a goalie is admirable.

Amotivation

(1 = *Strongly Disagree*, 5 = *Strongly Agree)*

Name	**Items**
amotiv1	…, but I question why I continue.
amotiv2	…, but I wonder "what's the point?"
amotiv3	…, but the reasons why are not clear to me anymore.
amotiv4	…, but I question why I am putting myself through this.

Note: Adapted from "The Behavioral Regulation in Sport Questionnaire (BRSQ): Instrument development and initial validity evidence," by C. Lonsdale, K. Hodge, and E. A. Rose, 2008, *Journal of sport and exercise psychology*, 30(3), 323-355 (https://doi.org/10.1123/jsep.30.3.323). Copyright 2008 by Human Kinetics, Inc.

PERCEIVED GOALTENDER SUCCESS

The following set of items refer to your most recent season as a goalie. Please read each item carefully and respond to it as honestly as you can.

Stem: "As a goalie, how SUCCESSFUL do you feel…

(1 = *Very unsuccessful*, 5 = *Very successful*)

	Stem: Since you began playing goalie, how SUCCESSFUL do you feel…
Name	**Items**
success1	… you are as a goalie overall?
success2	… about your performance in games?
success3	… in achieving the objectives you've set for yourself?
success4	… in the recent progress you've made?
success5	… in achieving desirable outcomes?
success6	… about your recent goaltending accomplishments?

Note: Adapted from "Achievement goals in sport: The development and validation of the Perception of Success Questionnaire," by G.C. Roberts, D.C. Treasure, and G. Balague, 1998, *Journal of Sports Sciences*, *16*(4), 337-347 (https://doi.org/10.1080/02640419808559362)

Appendix C

Social Media and Email Survey Recruitment Infographic

Appendix D

Social Media Script

Calling all 18+ goalies who are or have played competitively within the last year to participate in a study on goaltender motivation and performance! Here's what you need to know:

.

The digital survey will take approximately 10 minutes

.

It is completely voluntary and anonymous

.

Upon survey completion, each participant will be given an opportunity to enter their name in a *drawing for 1 of 3 $50 Amazon gift cards*

.

Results are anticipated to build goaltender self-awareness and inform the hockey community on how to better support goaltender development

.

Go to link to participate now!

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.

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For more information see the included infographic or contact Nate Speidel at nate.speidel@und.edu. Thank you!

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#hockey #goalies #hockeycoaches #goaliecoaches #goalienation #goalieworld #hockeyschools #goaliecamps #goalietraining #hockeylife #goalielife #puck #51in30 #icehockey #goaliedrills #tendylifestyle #hockey4life #hockeygram #hockeytraining #goalielove

Appendix E

Dissertation Participant Recruitment Email

Dear goaltender,

My name is Nate Speidel, and I am pursuing my Ph.D. in Educational Foundations and Research at the University of North Dakota. As a part of my research, I am studying *Hockey Goaltender Motivation* to better understand goalies' psychological states and how they affect performance. I hope this research will benefit goaltenders and the goaltending communities.

I am looking for goaltenders ages 18+ who are *currently playing competitively or have played competitively within the past year* and are willing to take a short 10-minute survey. The survey will be anonymous, and all results will be presented in aggregate so no individual can be identified.

Also, each participant will be given an opportunity to enter their name in a drawing for 1 of 3 $50 Amazon gift cards upon completion.

If you are willing, please take the electronic survey below on the device of your choice. Feel free to forward this opportunity on to other qualified goaltenders as well - the more goalies that participate, the more likely the research results will be meaningful.

Survey Link (Desktop Version)

Survey Link (Mobile Phone Version)

The survey will be open for approximately two weeks. I have attached an information sheet and infographic with more details about the study. Thank you for your consideration. Please feel free to contact me with any questions.

Best regards,
-Nate Speidel
e: nate.speidel@UND.edu
p: (701).870.1783

Appendix F

IRB Informed Consent Statement

UNIVERSITY OF NORTH DAKOTA
Institutional Review Board
Informed Consent Statement

Title of Project: Ice Hockey Goaltender Performance: Examining the Role of Basic Psychological Needs and Self-Determined Motivation

Principal Investigator: *Nate Speidel, nate.speidel@UND.edu*

Advisor: *Dr. Rob Stupnisky, (701)-777-0744, robert.stupnisky@UND.edu*

Purpose of the Study: The purpose of this study is to measure goaltenders' basic psychological needs satisfaction (BPNS) and related self-determined motivation (autonomous, controlled, and amotivation), and then assess the relationship these factors have with goaltender performance.

Procedures to be followed:
Goalies will be asked to take a 5-10 minute online survey. Goaltenders must be 18+ years of age and either currently playing competitively or have played competitively within the past year.

Risks:
There are no risks in participating in this research beyond those experienced in everyday life. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled.

Benefits:
- You might learn more about yourself by participating in this study.
- You might have a better understanding of your motivation as a goaltender.
- This research might provide a better understanding of how goalies are best motivated and coached.

Duration:
It will take about 5-10 minutes to complete the questions.

Statement of Confidentiality:
The survey does not ask for any information that would identify who the responses belong to. Therefore, your responses are recorded anonymously. If this research is published, no information that would identify you will be included since your name is in no way linked to your responses.

All survey responses that we receive will be treated confidentially and stored on a secure server. However, given that the surveys can be completed from any computer (e.g., personal, work, school), we are unable to guarantee the security of the computer on which you choose to enter your responses. As a participant in our study, we want you to be aware that certain "key logging" software programs exist that can be used to track or capture data that you enter and/or websites that you visit.

Right to Ask Questions:
The researcher conducting this study is Nate Speidel. You may ask any questions you have now. If you later have questions, concerns, or complaints about the research please contact Nate Speidel at nate.speidel@UND.edu and/or Dr. Robert Stupnisky at Robert.stupnisky@UND.edu or (701)-777-0744 during the day.

If you have questions regarding your rights as a research subject, you may contact The University of North Dakota Institutional Review Board at (701) 777-4279 or UND.irb@UND.edu. You may contact the UND IRB with problems, complaints, or concerns about the research. Please contact the UND IRB if you cannot reach research staff, or you wish to talk with someone who is an informed individual who is independent of the research team.

General information about being a research subject can be found on the Institutional Review Board website “Information for Research Participants” http://und.edu/research/resources/human-subjects/research-participants.html

Compensation:
At the end of the survey, participants may opt into entering their email address for a chance to win 1 of 3 $50 Amazon gift cards. Email addresses will not be associated with survey responses in order to protect privacy.

Voluntary Participation:
You do not have to participate in this research. You can stop your participation at any time. You may refuse to participate or choose to discontinue participation at any time without losing any benefits to which you are otherwise entitled.

You do not have to answer any questions you do not want to answer.

Completion and return of the survey imply that you have read the information in this form and consent to participate in the research.

Please keep this form for your records or future reference.

Appendix G

Goalrobber Goalie Self-Reflection Data Codebook

The data described in this codebook is intended to reflect an example self-reflection question set for goalies to complete after their most recent game performance.

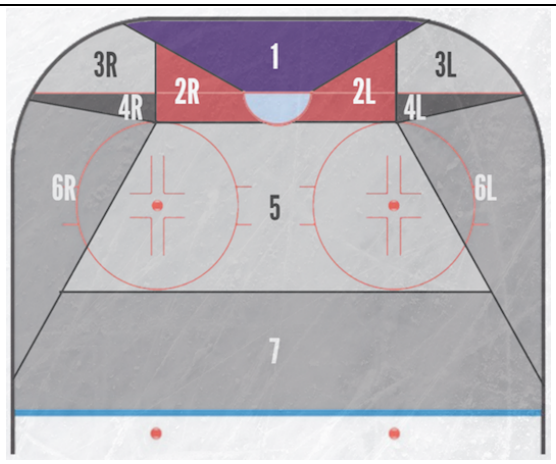
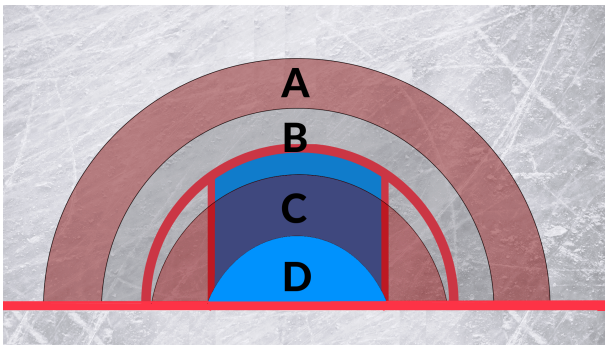
Instructions to participants:

"Within the 24 hours of your most recent game, please complete the following questions."

VARIABLES

Variable Name	Description	Variable Type
Name	What is your name? [text box]	Nominal
Opponent	What team did you play? [text box]	Nominal
Date	On what date did you play the game? [text box]	Ordinal
Month	This represents how many months into the season the game was played.	Ordinal
Season	This represents which season from which the game was played.	Ordinal
Result	What was the result of the game? (1) Win (2) Lost (3) Tie	Nominal
Minutes Played	How many minutes did you play? [text box]	Ratio
Team Score	How many goals did our team score? [text box]	Ratio
Opponent Score	How many goals did the opponent score? [text box]	Ratio
Score Differential	What was the score differential? This is measured by Team Score – Opponent Score. [text box]	Interval
Performance	On a scale of 1 to 5 (1 = Very Poorly, 5 = Very Well), rate how well you feel you played: (1) Very Poorly (2) Poorly (3) Average (4) Well (5) Very Well	Interval
First Shot	Did you stop the first shot of each period? (1) Yes (2) No	Nominal
Chance to Win	Do you feel you gave your team a chance to win the game? (1) Yes (2) No	Nominal

Shots on Goal	How many shots did the opponent have on you? [text box]	Ratio
Saves	How many saves did you make? [text box]	Ratio
Save Percentage	This is calculated by Saves/Shots x 100.	Ratio
Hole_1through7	Tracks which of the 7 possible holes the puck passed the goaltender to result in a goal against. See figure below. (1) Hole 1 (2) Hole 2 (3) Hole 3 (4) Hole 4 (5) Hole 5 (6) Hole 6 (7) Hole 7 	Nominal
Zones_1through7	Tracks from which zone the shooter shot from when scoring a goal. See figure below. (1) Zone 1 (2) Zone 2R (3) Zone 2L (4) Zone 3R (5) Zone 3L (6) Zone 4R (7) Zone 4L (8) Zone 5 (9) Zone 6R (10) Zone 6L (11) Zone 7	Nominal

		
Depth_AthroughD	Tracks where the goaltender was located in his or her crease, which denotes how much depth the goaltender had when the goal against was scored. See figure below. (1) Depth A (2) Depth B (3) Depth C (4) Depth D 	Ordinal
Shot Type	This variable measures what kind of shot was taken to score the goal against. (1) Straight Shot (2) Screen (3) Tip (4) Rebound (5) Lateral Play	Nominal
Strengths	List three concepts you felt you did well today.	Open
Opportunities	List three concepts you felt you could work on after today's game.	Open

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