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## The relationship between psychological factors and the gait analysis of a total knee arthroplasty patient: A case study

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Running Head: PSYCHOLOGICAL FACTORS AND GAIT ANALYSIS OF A TKA PATIENT

THE RELATIONSHIP BETWEEN PSYCHOLOGICAL FACTORS AND THE GAIT  
ANALYSIS OF A TOTAL KNEE ARTHROPLASTY PATIENT: A CASE STUDY

A Thesis Submitted  
in Partial Fulfillment  
of the Requirements for the Designation  
University Honors

Tyler S. Rogers  
University of Northern Iowa  
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# PSYCHOLOGICAL FACTORS AND GAIT ANALYSIS OF A TKA PATIENT

This study by: Tyler Rogers

Entitled: The Relationship Between Psychological Factors and the Gait Analysis of a Total Knee  
Arthroplasty Patient: A Case Study

Has been approved as meeting the thesis or project requirements for the Designation University  
Honors

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Date

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Dr. Jennifer Waldron, Honors Thesis Advisor

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Date

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### **Purpose**

Rehabilitation through the use of physical therapy for the total knee arthroplasty (TKA), or knee replacement, procedure can be an arduous process. The purpose of this study is to identify any relationships between various psychological factors and angular variables observed during the functional activity of gait for TKA patients. Application of these results may be utilized by physical therapists to maximize the quality of personal patient care provided while allowing patients the opportunity to successfully return to the functional activity of walking. Psychological factors that were examined included those noted in the self-determination theory studied by Ryan & Patrick (2009): motivation, autonomy, competence, and relatedness. The participant's perceptions of the rehabilitation process were acquired by survey analysis, and the relationship between these perceptions and the patient's angular gait variables was determined.

### **Literature Review**

In order to fully understand the nature of the rehabilitation process a patient may face after undergoing the total knee arthroplasty procedure, one must understand its multiple components. First, the total knee arthroplasty procedure as a whole must be dissected, including the anatomical and physiological principles of the knee joint, demographics and symptoms of those receiving the procedure, the surgical procedure itself, as well as subsequent rehabilitation and functional outcomes. Next, the functional activity of gait must be discussed. This includes both parameters of normal gait and the establishment of kinematic gait analysis as an effective means to evaluate an individual's gait. Finally, psychological aspects of physical activity must be considered. These factors include motivation, autonomy, competence, and relatedness. These factors are relevant to the rehabilitation process that is physical therapy since this specific piece of ancillary health care regularly involves physical activity performed by patients. A complete understanding of these topics will allow a more meaningful evaluation of this research process.

#### **Total Knee Arthroplasty Procedure**

##### **Anatomy and physiology of the knee joint.**

John Hopkins Medicine (2018) described the functional anatomy of the knee joint. The knee joint consists of two long leg bones, the femur of the thigh and the tibia of the lower leg. The patella, commonly known as the kneecap bone, covers the joint. These bones are supported and held together with muscle and connective tissue, including a medial and lateral meniscus, cartilage, and various ligaments. Ligaments of the knee joint include the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), and lateral collateral ligament (LCL). The joint is further lined by a synovial membrane which

secretes synovial joint fluid in order to lubricate the joint and absorb shock to allow for smoother musculoskeletal movement.

The muscles affecting the knee joint allow it to bend and straighten, clinically referred to as flexion and extension, respectively. There are three main muscle groups that allow the knee to flex and extend throughout its range of motion: the quadriceps, hamstrings, and calf muscles. The quadriceps femoris of the anterior thigh consist of the rectus femoris, vastus intermedius, vastus medialis, and vastus lateralis, and allow the knee to extend. The hamstrings of the posterior thigh consist of the biceps femoris, semitendinosus, and semimembranosus, and allow the knee to flex. Also allowing the knee to flex is the calf muscle, or gastrocnemius, of the posterior lower leg (John Hopkins Medicine, 2018). It is important to have a sufficient understanding of the anatomy and physiology of the knee joint before considering the total knee arthroplasty procedure.

#### **Considering the arthroplasty procedure.**

Various demographics across the United States elect to undergo the total knee arthroplasty procedure. Kremers *et al.* (2015) has researched the prevalence of the total knee arthroplasty (TKA) procedure in the country. It is estimated that about 4.7 million Americans have had the procedure done at least once, a number that is expected to rise to 7.4 million by 2030 (Kremers *et al.*, 2015, paragraph 16). This means that it is only slightly less common for an American to have received a knee replacement than to experience a stroke, heart attack, or heart failure. Nearly all patients are fifty years of age or older, and about 5% of people in this demographic have had this procedure. It is significantly more likely for women to receive the treatment, a fact that may be attributed to an increased rate of fractures in women due to higher rates of osteoporosis. Aging baby boomers have also had a profound impact on the prevalence rates; people in their seventies

have a 7.29% prevalence rate of having had at least one knee replacement (Kremers *et al.*, 2015). One study also estimated that about 60% of TKA patients suffer from obesity as indicated by high body mass index (BMI) scores (Dejong *et al.*, 2011). Though many demographics have completed the TKA procedure, the underlying reasons for patient consideration are often the same.

Mayo Clinic Staff (2017) and John Hopkins Medicine (2018) explained why patients may consider the TKA, or knee replacement, procedure. The TKA is an elective procedure in which much of the bone and cartilage of the femur, tibia, and patella is replaced with artificial materials. The reasons a person may consider undergoing the TKA procedure varies from case to case. The procedure is designed to relieve chronic pain and restore function associated with damage or abnormalities within at least part of the knee. Common culprits of chronic knee pain include history of a severe injury, osteoarthritis, and rheumatoid arthritis. Osteoarthritis causes damage to the cartilage and bone within a joint as adults reach middle-age and is characterized by normal or excessive use while rheumatoid arthritis may cause stiffness by inflaming the synovial membrane lining the surfaces of a joint (John Hopkins Medicine, 2018). Many patients, still, may endure this pain and not consider the replacement until it interferes with daily activities. Patients usually state that the pain has impacted daily functional activities like sitting, standing, walking, and climbing stairs. When a patient decides they are ready to undergo the TKA procedure, a conversation with an orthopedic surgeon is necessary in order to explain the procedure in detail and outline postoperative expectations. The orthopedic surgeon will also assess the patient's range of motion, stability, and strength within the knee as well as order diagnostic testing like x-rays to gain a full visual of the joint (Mayo Clinic Staff, 2017; John Hopkins Medicine, 2018).

Mayo Clinic Staff (2017) and John Hopkins Medicine (2018) explained the total knee arthroplasty procedure. The total knee arthroplasty surgical procedure begins with a vertical incision six to ten inches long over the midline of the patella. After the orthopedic surgeon moves the patella aside, he/she removes the damaged parts of the three bones (femur, tibia, and patella) of the joint. Next, a series of prostheses is attached to each of the bones. The prostheses are made of metal alloys, high-grade plastics, and polymers. The prostheses may be cemented or uncemented; a cemented prosthesis is connected to the bones of the joint with surgical cement, while an uncemented prosthesis is connected to the bone via a porous surface which allows the bone to grow and mold itself to it over time. Variations to the procedure are made at the surgeon's discretion depending on patient factors including age, weight, overall health and knee size and shape. Following the completion of the surgical procedure, the incision is typically closed with staples and bandages or dressings are applied to the wound site (Mayo Clinic Staff, 2017; John Hopkins Medicine, 2018). Following surgery, a patient's rehabilitation process officially begins.

#### **Postoperative patient experience.**

Mayo Clinic Staff (2017) described the general postoperative inpatient experience of the total knee arthroplasty. After the total knee arthroplasty procedure is completed, the patient is closely monitored for any signs of obvious infection or dysfunction. Potential postoperative complications include blood clots, infections, nerve damage, and artificial joint failure due to factors like overuse and excessive patient weight. Symptoms of these complications include fever, chills, drainage from the surgical site as well as an unusual amount of swelling and pain around the knee. In severe instances, a patient may require an additional surgery to remove the artificial parts until recovery, at which time the patient would undergo a second TKA procedure.



In order to prevent these complications, patients are encouraged to do ankle pumps to keep blood flowing and reduce swelling. Compression boots or hose may also be worn to induce these same results. Barring the existence of complications, it can be expected that the new knee will last over fifteen years. An order is then sent for inpatient physical therapy to work with the patient. A physical therapist will meet and evaluate the patient, educate them on postoperative movement expectations, and may complete a series of exercises as well as give a short home exercise program. The patient is also encouraged to ambulate using an assistive device such as a wheeled walker or crutches. It is expected that the patient gradually increases levels of physical activity to prevent joint stiffness associated with inactivity and scar tissue formation.

As noted by Mayo Clinic Staff (2017) and John Hopkins Medicine (2018), the patient is usually discharged a few short days after completion of the total knee arthroplasty procedure. The patient may be considered as a candidate for admission into a rehabilitation facility if largely insufficient progress has been made towards goals for physical therapy or in a case of special individual circumstances. However, the majority of patients are typically discharged home with the understanding that wound care, diet, and exercise protocols must be followed. Considerations for new home arrangements may be recommended to ensure safety and efficiency following surgery. An orthopedic surgeon or physical therapist may recommend moving all essential objects to the ground floor, installing safety bars or shower chairs into the bathroom, removing loose rugs and cords, and arranging for someone to assist with activities of daily living like laundry, bathing, and meal preparation. Additionally, a patient may be given a dressing stick, sock aid, or shoe horn to assist with dressing if bending is too painful. Walking is recommended, but a patient should wait for approval from a physical therapist before engaging in other activities (Mayo Clinic Staff, 2017; John Hopkins Medicine, 2018). Physical therapists are

movement professionals capable of appropriately progressing patients based on their safety while engaging in potential activities.

Cleveland Clinic Staff (2016) and Greengard and Carey (2017) gave common protocol for physical therapy treatment following a successful TKA procedure. Assuming discharge home, patients will soon begin an outpatient physical therapy rehabilitation program. Physical therapist goals for TKA patients generally include increasing range of motion and strength for flexion and extension, decreasing swelling and stiffness, managing pain, returning to activities of daily living, ascending and descending stairs, and if applicable per patient, ambulate without the use of an assistive device. After initial evaluation, physical therapists and physical therapist assistants spend time putting a patient through stretches, manual therapy, exercises, and gait and balance training. Commonly prescribed therapeutic exercises include quad sets, short and long arc quads, straight leg raises, seated hamstring curls, ankle pumps, heel slides, and lying hip abduction (Cleveland Clinic Staff, 2015). These may be done with or without resistance by weights or bands. As the patient progresses, more advanced therapeutic exercises including heel raises, mini squats, standing hip abduction, and bicycling on a stationary bike may be prescribed. Once physical therapy goals are completed, a patient is discharged from treatment (Cleveland Clinic Staff, 2015; Greengard & Carey, 2017). High-impact activities like jumping and running are not recommended even after discharge in an effort to preserve the integrity of the joint's prostheses (Mayo Clinic Staff, 2017). One way to measure the success of the arthroplasty procedure and subsequent physical therapy is by performing tests of functional outcomes.

#### **Successful functional outcomes.**

Research conducted by Dejong *et al.* (2011) studied the rehabilitation process of the TKA procedure and the relationship between time spent in various activities during physical therapy

treatment and successful functional outcomes. The study used Functional Independence Measure (FIM) tests at initial examination and discharge as a means to measure function and draw conclusions. FIM tests are used to assess the amount of assistance a patient requires doing activities of daily living.

It was observed that about 12.5% of time spent with a patient involved assessment/evaluation. Assessment/evaluation was defined as “the process of obtaining a history, performing relevant system reviews, selecting and administering specific tests and measures, and making clinical judgments based on data gathered during the process” (Dejong *et al.*, 2011, p. 1830). This activity is very common during initial examination but is used throughout subsequent treatments as well. There was a negative association between assessment time and patient FIM scores upon discharge. It was also observed that 48.5% of time spent with a patient consisted of therapeutic exercise. Therapeutic exercise was defined as “exercises designed by a physical therapist to work on patient physiological body exertion, to improve body function, or to improve or restore strength, endurance, flexibility, range of motion, or coordination” (Dejong *et al.*, 2011, p. 1830). Finally, the researchers observed that 25% of time spent with a patient included gait training.

Physical therapists are trained clinicians capable of evaluating and correcting gait discrepancies. Gait exercises were defined as “training of skills needed for ambulation over level surfaces and stairs and of high-level locomotor skills such as increasing speed, quick direction changes, walking over different surface texture, negotiating around and over obstacles, tandem walking, jumping, hopping, and jogging” (Dejong *et al.*, 2011, p. 1830). Although the purpose of this study was to examine physical therapy activities in patients with stroke, TKA, and traumatic brain injury, the results did indicate that gait training was positively associated with FIM scores

upon discharge (Dejong *et al.*, 2011). This research has shed light on the specific activities and their frequency during physical therapy that may improve a patient's overall function during activities of daily living, including gait.

### **Gait**

Gait, or walking, is the foundation of many other functional activities; therefore, comprehension of the gait cycle is essential to understanding functional outcomes of TKA patients. Dr. Arun Pal Singh (2018), an orthopedic surgeon, has explained the gait cycle as “the time interval between the exact same repetitive events of walking that generally begin when one foot contacts the ground” (Singh, 2018, paragraph 3). Ashok and Sanjay (2015) have obtained variables via kinematic analysis for normal gait at specific times throughout the gait cycle. The first 60% of the gait cycle is referred to as the “stance phase,” while the last 40% is referred to as the “swing phase.” The stance phase occurs when the observed leg is in contact with the ground and begins with an initial contact of heel strike at 0%. The ankle at heel strike is relatively neutral. At this point a loading response occurs in which the hip and knee of the observed leg support body weight. The knee and hip begin to extend from a flexed state, with a knee angle reaching about 165 degrees and the hip angle reaching a neutral state. At about 25% of the gait cycle, the terminal stance of stance phase occurs, and the opposite leg passes forward. The knee reaches full extension of about 180 degrees and the hip hyperextends as preparation for toe-off begins. At 60% of the gait cycle, toe-off occurs as the leg removes contact with the ground. The hip and knee joints flex in order for the foot to clear the ground through the entirety of swing phase. The hip angle typically reaches a peak via flexion of approximately 150 degrees flexion at around 90% of the gait cycle, just before heel strike. The knee angle reaches a peak via flexion of

approximately 125 degrees at around 70% of the gait cycle. At heel strike (0/100%), the cycle begins again (Ashok & Sanjay, 2015; Singh, 2018).

Gait analysis had traditionally only been done by clinicians using manual resources or the naked eye. Ashok and Sanjay (2015) presented the legitimacy of an alternative resource: kinematic analysis. The accuracy of this tool was suggested by comparing data drawn from it to that of clinical gait analysis reports. In fact, this data may even be used to identify and correct gait abnormalities. Kinematic analysis uses a camera to film a subject walking through the gait cycle. This film may then be analyzed using a computer to determine specific gait variables. Linear and angular variables using joint centers may be quantified by the use of coordinates within the video (Ashok & Sanjay, 2015). This tool allows more accurate evaluation to be completed over time of a subject's gait by variable quantification than does that of the naked eye.

### **Self-Determination Theory and Physical Activity**

Though physical activity may seem to only pertain to physiological events occurring within the body, there is clearly a psycho-social component in play as well. Ryan and Patrick (2009) examined the relationship between the self-determination theory (SDT) and physical activity from a psycho-social perspective. This relationship may be applied to all aspects of physical activity – exercise, play, sport – and by extension, physical therapy. In regard to physical activity, Ryan and Patrick (2009) state, “In the view of self-determination theory, physical activity can be an inherently rewarding activity that contributes to both happiness and subjective vitality. When active, people feel more energy and they satisfy deep psychological needs that contribute to an overall sense of wellness” (Ryan & Patrick, 2009, p. 108). In order to fully grasp the role of the self-determination theory in physical activity, one must understand human motivation and basic psychological needs.

Ryan and Patrick (2009) went on to detail motivation in regard to physical activity. Humans may be intrinsically or extrinsically motivated in regard to physical activity. Additionally, amotivation, or the absence of motivation may be experienced. Intrinsic motivation is defined as “engagement in an activity because of the inherent pleasures and satisfactions it provides” (Ryan & Patrick, 2009, p. 109). People with intrinsic motivation engage in an activity because they find it enjoyable, interesting, challenging, and possess the skills to complete them. The Cognitive Evaluation Theory, a sub-theory within SDT, details potential influences on intrinsic motivation: “Understanding of intrinsic motivation must consider how the characteristics of an activity are experienced and engaged by the individual and how these experiences are affected by situational and contextual factors and supports” (Ryan & Patrick, 2009, p. 110).

Another component of motivation is extrinsic motivation. Extrinsic motivation occurs when an individual completes an activity with some sort of external goal in mind. These goals may be tangible, avoidance of a punishment, or recognition and approval. Whereas sport is generally intrinsically motivated, other forms of exercise are usually extrinsically motivated; individuals often look to accomplish aesthetic and/or health benefits. These researchers discussed another sub-theory of SDT as well: Organismic Integration Theory. Organismic Integration Theory describes forms of external motivation and their effect on internalization of behavior regulation. The two forms of external motivation may be broken into external regulation and introjected regulation. External regulation is defined as, “a person’s actions are compelled or driven by externally controlled rewards or punishments” (Ryan & Patrick, 2009, p. 112). When this is the case, the individual is not likely to become introspective about the actions, and thus, there will be no lasting effect when the rewards or punishments are no longer present. In

introjected regulation, “an individual engages in behaviors to feel better about self-worth or to avoid self-esteem blows or self-disapproval” (Ryan & Patrick, 2009, p. 112). When behavior is internalized with this type of regulation, it may be due to increased feelings of autonomy, or self-endorsement. In turn, an individual will likely persevere as obstacles that could potentially derail the behavior arise (Ryan & Patrick, 2009).

The same study conducted by Ryan and Patrick (2009) also discusses influences on motivation as described in the Basic Psychological Needs Theory. The theory holds that when the basic psychological needs are experienced, optimal motivation can occur which drives intrinsic motivation and internalization. Thus, enjoyability and perseverance of an activity are dependent upon meeting these needs. The three basic psychological needs are autonomy, competence, and relatedness (Ryan & Patrick, 2009).

Autonomy is defined as occurring when “a person experiences his or her behavior as self-organized and endorsed. One fully assents to engaging in the actions” (Ryan & Patrick, 2009, p. 115). In exercise, it may be greatly affected by the social environment around an individual. If an individual perceives a person in power as being controlling or coercive of their participation, rewards, or punishment, low levels of autonomy are likely. A lack of autonomy leads to feelings of being emotionally and physically drained by participation within an activity. Individuals prefer to feel supported in order to undergo positive reflection (Ryan & Patrick, 2009).

Competence, occasionally referred to as self-efficacy, is the confidence an individual feels to be effective and successful in an activity. It is usually closely linked to the amount of experience, knowledge, or skill in that specific activity. Similar to autonomy, it may be affected by the social environment an individual finds oneself in. Meaningful feedback given by those in a position of power or influence has the ability to enhance self-perceived competence and

increase motivation. Likewise, competence and motivation may be adversely affected when an individual receives negative feedback. When a person in a position of power negatively criticizes a person's ability to successfully complete an activity, it may cause feelings of discouragement (Ryan & Patrick, 2009).

Relatedness is defined as a "sense of connection with others, a sense that includes a feeling of being included and cared for by others within the domain of action" (Ryan & Patrick, 2009, p. 115). When these things occur, an individual is more likely to be introspective about their acquired values and skills and develop an appreciation as a result. This psychological need is characterized by care and involvement that others convey (Ryan & Patrick, 2009).

#### **Patient satisfaction with physical therapy experience.**

Physical therapy is an extension of physical activity, so the self-determination theory is applicable to this treatment by extension. Various studies have been conducted involving patient satisfaction with physical therapy treatment.

Autonomy is a crucial aspect relating to patient satisfaction. One study by Dierckx, Deveugele, Roosen, and Devisch (2013) researched preferred levels of patient involvement in decision-making during treatment. It was suggested that patients generally feel sharing decision-making about their treatment with their physical therapist helps them to feel less anxious while increasing knowledge and confidence. An additional benefit is the lack of potential for conflict down the road revolving around confusing about treatment decisions. Statistics showed that only about 17% of patients prefer to have a physical therapist make treatment-related decisions completely alone. Physical therapists underestimated desired levels of patient involvement by 64% (Dierckx *et al.*, 2013). Furthermore, patient involvement in the decision-making process generally improves a patient's satisfaction with treatment (Hush, Cameron, & Mackey, 2011).



Slujis, Kok, and Van der Zee (1993) and Essery, Geraghty, Kirby and Yardley (2017) studied the relationship between competence and compliance to home-based exercise programs. Compliance to these physical therapist-prescribed programs has been suggested to be an accurate predictor of a patient's functional outcome. These programs are usually intended to be completed daily – allowing for far more time to be spent doing unsupervised exercises than time spent with the physical therapist (Slujis *et al.*, 1993). Therefore, the importance of patient compliance cannot be understated. Increased levels of competence and motivation tend to increase compliance. It is not uncommon for patients to feel unsure of themselves while completing home-based programs; they must rely on their own skills and knowledge without access to the physical therapist's feedback. Additional barriers may arise as well that the patient is not prepared to handle. Time constraints, pain, and the need to adapt the program to possessed resources are all patient-perceived obstacles. For these reasons, many do not feel they can effectively complete the program (Slujis *et al.*, 1993; Essery *et al.*, 2017).

Essery *et al.* (2017) also suggested that relatedness is an accurate predictor of patient compliance to home-based exercise programs. The study found that lack of physical assistance and support often caused lower levels of compliance. Conversely, patients seem to be more likely to comply when the physical therapist spends time clarifying any potential questions and when the physical therapist conveys appreciation for the patient's efforts. A non-clinical support system consisting of family and friends may also be beneficial. Not only can these groups give practical assistance during program completion, they may encourage and motivate the patient (Essery *et al.*, 2017). This information, in combination with research about relatedness presented by Patrick and Ryan (2009) and compliance presented by Slujis *et al.* (1993), seems to suggest by extension a relationship between relatedness and a patient's functional outcome.

Many other patient-preferred characteristics of physical therapy treatment were discovered. Monnin and Perneger (2002) and Hush *et al.* (2011) developed and reviewed credible surveys to measure overall patient satisfaction. Patient satisfaction seems to be an indicator of quality of care. Patients place value on the quality of their interactions with professionals, ability to see the same physical therapist over the course of treatment, treatment duration, and organizational convenience of the clinic in which they were receiving care (Monnin & Perneger, 2002; Hush *et al.*, 2011).

### **Summary**

The TKA procedure is a complex process that includes subsequent rehabilitation. It is an increasingly popular procedure for various demographics in the United States (Kremers *et al.*, 2015). Those electing to receive the procedure may do it for a variety of reasons, most notably to relieve chronic pain associated with injury or arthritis characterized by excessive use (John Hopkins Medicine, 2018). Physical therapy protocol following the procedure generally includes increasing range of motion and strength, pain management, and the return to function activities of daily living (Cleveland Clinic Staff, 2016; Greengard & Casey, 2017). Dejong *et al.* (2011) more specifically dissected physical therapy treatment for the TKA procedure by discovering a positive relationship between gait training, a functional task in and of itself, and Functional Independence Measure scores upon discharge. Ashok and Sanjay (2015) presented the legitimacy of kinematic gait analysis as a means to quantify variables of, and therefore evaluate, an individual's gait throughout the gait cycle. Since physical therapy includes physical activity, Ryan and Patrick (2009) presented research on psycho-social aspects of physical activity that should be applicable to this branch of health care by extension. The psychological factors of motivation, autonomy, competence, and relatedness play a crucial role within Self-Determination

Theory. This theory ultimately allows an individual to experience physical activity as being “an inherently rewarding activity that contributes to both happiness and subjective vitality” (Ryan & Patrick, 2009, p. 108) when the previously noted psychological factors are fulfilled to the individual’s desire. The purpose of this study is to identify any relationships between these psychological factors and angular variables observed during the functional activity of gait for TKA patients.

**Research Question to Be Answered**

1. What is the relationship between patient-perceived psychological factors during physical therapy treatment for the TKA procedure and angular variables observed during gait analysis?

## Methodology

### Participant

It was hoped that a larger population size would be utilized for this study in order to examine relationships, but the study's recruitment process ultimately yielded low interest. Thus, research evolved into a case study of a single participant. The participant was a generally healthy male in his 60's. He was discharged from physical therapy approximately 10 weeks after the date of his TKA procedure and was approximately 14 weeks post-operation at the time of data collection. This was the patient's first TKA procedure. The study was approved by the University's Institutional Review Board and stipulated any participants must be at least 12 weeks past the date of their initial TKA procedure. The IRB also required participants be screened by a 3-item health history checklist. The checklist consisted of the following questions:

1. Are you able to walk 50 feet comfortably without the use of an assistive device or worn orthotic brace?
2. Do you have a history of losing your balance or falling?
3. Do you have a history of abnormal blood pressure, irregular heart rate, fainting, shortness of breath, fatigue, muscle cramps, muscle soreness or joint injury, history of falling, or cardiac events while walking?

### Surveys

These surveys were utilized in reference to the experience in physical therapy treatment.

**Treatment Self-Regulation Questionnaire (TSRQ).** The TSRQ survey consists of 15 items in which the participant answered questions relating to the degree of perceived motivation experienced during physical therapy treatment (Levesque *et al.*, 2007). Sample question: "The reason I would exercise regularly is: Because I feel that I want to take responsibility for my own

health.” The participant was asked to indicate the extent to which each reason is true using a 7-point scale. The participant’s scores were evaluated by averaging the sum of each noted component as may be referenced in Appendix A.

**Motives for Physical Activities Measure – Revised MPAM-R.** The MPAM-R survey consists of 30 items in which the participant will answer questions relating to the degree of various perceived motivational components (interest/enjoyment, competence, appearance, fitness, and social) experienced during physical therapy treatment (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Sample question: “I engage in physical activity because I want to be physically fit.” The participant was asked to indicate the extent to which each motive for physical activity is true using a 7-point scale. The participant’s scores were evaluated by averaging the sum of each noted component as may be referenced in Appendix B.

**The Basic Psychological Needs in Exercise Scale (BPNES).** The BPNES survey consists of 11 items in which the participant will answer questions relating to the degree of perceived autonomy, competence, and relatedness experienced during physical therapy treatment (Vlachopoulos & Michailidou, 2009). Sample question: “I feel I have made a lot of progress in relation to the goal I want to achieve.” The participant was asked to indicate the extent to which he agreed with each of these statements using a 5-point scale. The participant’s scores were evaluated by averaging the sum of each noted component as may be referenced in Appendix C.

**Perceived Competence (Exercising Regularly).** The Perceived Competence (Exercising Regularly) survey consists of 4 items in which the participant will answer questions relating to the degree of perceived competence experienced during physical therapy treatment (Williams & Deci, 1996). Sample question: “I feel confident in my ability to exercise regularly.” The participant was asked to indicate the extent to which each statement was true using a 7-point

scale. The participant's scores were evaluated by averaging the sum of each statement as may be referenced in Appendix D.

### **Procedure**

Recruitment took place at a local outpatient physical therapy clinic and was conducted by the clinic's physical therapists. Though these physical therapists reported that potential participants conveyed interest and a desire to participate, only one participant actually contacted the study's researchers. Research subsequently evolved into a case study as a statistical analysis of the results became inappropriate due to the small population size. The participant was successfully screened by the IRB-required 3-item health history checklist. He traveled to the University of Northern Iowa's Biomechanics Laboratory located within the Wellness & Recreation Center. Upon arrival, the participant signed a consent form, and data collection began.

The participant completed an assortment of surveys. These surveys measured varying degrees of patient-perceived levels of motivation, autonomy, competence, and relatedness. The participant then completed two short walks of approximately 15 feet each while being filmed with a video camera to obtain a side profile. The first walking trial was filmed with the participant walking from left to right while the second trial was filmed with the participant walking from right to left. This allowed for clear video to be obtained of both the affected and unaffected knee through the gait cycle. A JVC (The Japan Victor Company, Yokohoma, Japan) model GC-PX1 video camera mounted on a stationary tripod approximately twenty-five feet away from the center of the participant's walking area was used to complete this portion of data collection. The walking surface and surrounding area was level, clean, and free of any clutter in

order to ensure safety and allow for normal gait to be achieved. The study took place in the University's biomechanics laboratory.

After data collection was completed, the participant's surveys were reviewed and scored to reflect his perceptions of autonomy, competence, relatedness, and motivation during his experiences with physical therapy treatment. Each of the side profiles obtained via filming were then kinematically analyzed for specific gait variables using a computer program. Ashok and Sanjay (2015) conducted a study in which they suggested the legitimacy of kinematic gait analysis as an accurate tool to identify and correct gait abnormalities and determine linear and angular gait variables (Ashok & Sanjay, 2015). Innovision Systems Inc. (Lapeer, Michigan, United States of America) MaxTRAQ was used to analyze the participant's gait and quantify angular variables of the hip, knee, and ankle during 3 phases of the gait cycle: heel strike, toe-off, and the peak of swing phase during which the patella was observed to have the most vertical displacement. Quantified data obtained from the kinematic gait analysis was compared to suggested normative values obtained by Ashok and Sanjay (2015) to determine the degree to which normal gait has been achieved following physical therapy treatment (Ashok & Sanjay, 2015). Relationships were examined between the survey-obtained psychological factors and quantified angular variables of gait existed.



## Results

Since there was low interest in the study during the recruitment period, a case study format was utilized. Therefore, it is not possible to statistically examine the central research question of the relationship between patient-perceived psychological factors during physical therapy treatment for the TKA procedure and angular variables observed during gait analysis. However, after quantification of psychological factors via survey analysis and gait variables via kinematic gait analysis, it is possible to make conclusions, albeit limited, about their interactions.

### Surveys

**Treatment Self-Regulation Questionnaire (TSRQ).** The participant indicated in the TSRQ survey that his motivation to exercise during and following physical therapy treatment was mainly autonomous, scoring 6.50 out of 7.00. Autonomous motivation is synonymous with intrinsic motivation. He scored 3.50 out of 7.00 for controlled motivation, which is synonymous with extrinsic motivation. The participant was not amotivated, as is indicated by his score of 1.33 out of 7.00 in this category.

Treatment Self-Regulation Questionnaire (TSRQ)	
Autonomous Motivation	6.50 out of 7.00
Controlled Motivation	3.50 out of 7.00
Amotivation	1.33 out of 7.00

**Motives for Physical Activity Measure – Revised MPAM-R.** The participant indicated in the MPAM-R survey that there were several specific motives he had to engage in physical activity during and following his experience in physical therapy treatment. His fitness was a very

primary motive to exercise with his score of 6.40 out of 7.00. He also indicated that his competence, interest/enjoyment, and appearance were relevant in his decision to engage in physical activity, scoring 5.29, 5.00, and 4.17 out of 7.00, respectively. Social motives do not influence this decision much, as noted by his score of 2.80 out of 7.00 in this category.

Motives for Physical Activity Measure – Revised MPAM-R	
Interest/Enjoyment	5.00 out of 7.00
Competence	5.29 out of 7.00
Appearance	4.17 out of 7.00
Fitness	6.40 out of 7.00
Social	2.80 out of 7.00

**Basic Psychological Needs in Exercise Scale (BPNES).** The participant indicated in the BPNES survey that he felt extreme autonomy, competence, and relatedness when exercising throughout physical therapy treatment. He scored 5.00 out of 5.00 in each of these components.

Basic Psychological Needs in Exercise Scale (BPNES)	
Autonomy	5.00 out of 5.00
Competence	5.00 out of 5.00
Relatedness	5.00 out of 5.00

**Perceived Competence (Exercising Regularly).** The participant indicated in the Perceived Competence (Exercising Regularly) survey that it was mostly true that his perceived

levels of competence during and following physical therapy were influential in his decision to begin or continue a permanent exercise regimen. His score was 5.75 out of 7.00.

Perceived Competence (Exercising Regularly)	
Competence	5.75 out of 7.00

### **Kinematic Gait Analysis**

#### **Ankle.**

The participant's ankles each remained in extension (plantar flexion) throughout the gait cycle checkpoints. At heel strike, the ankle values were relatively the same between his affected and unaffected legs with a slight difference that may be assumed to be insignificant. Each of these values at heel strike, however, exceeded the suggested value. Each of his ankles remained in extension at heel strike when it is suggested that they should be relatively neutral at 90 degrees. At toe-off, the ankle values were quite dissimilar with a total difference of 11.7 degrees. The suggested value for the ankle angle at toe-off is in the middle of these two values at 110 degrees; neither ankle achieved this. At peak swing phase, each of the participant's ankles were at approximately the same value of extension. These values are each contrary to the fact that the suggested value is actually approximately 15 degrees lower, meaning the ankles should slightly enter a state of flexion.

#### **Knee.**

The participant's knee values were relatively similar to each other during both heel strike and toe-off. At heel strike, each knee appeared to achieve the suggested value. At toe-off, the affected and unaffected knee were 14.4 degrees and 12.0 degrees lower than the suggested value, respectively. At peak swing phase, the largest differences occurred. Each knee was significantly

higher than the suggested angle of 130 during this ground-clearing phase. However, the affected knee was much closer to the suggested value, while the unaffected knee had only barely entered into a state of flexion at that moment.

### **Hip.**

At heel strike, each hip appeared to achieve the suggested value. At toe off, the unaffected leg was slightly closer to the suggested value, but the amount by which the affected leg is greater may be assumed to be insignificant. At peak swing phase, the affected leg was slightly greater than the suggested value, but the difference may be assumed to be statistically insignificant. The unaffected leg's hip was nearly identical to the suggested value.

	Affected Leg Values*	Unaffected Leg Values*	Suggested Normative Values* (Ashok & Sanjay, 2015)
Ankle – Heel Strike	97.8	100.7	90.0
Ankle – Toe-Off	103.4	115.1	110.0
Ankle – Peak Swing Phase	97.8	99.5	85.0
Knee – Heel Strike	172.3	169.4	170.0
Knee – Toe-Off	135.6	138.0	150.0
Knee – Peak Swing Phase	162.9	173.5	130.0
Hip – Heel Strike	149.5	151.5	150.0
Hip – Toe-Off	188.9	180.5	180.0
Hip – Peak Swing Phase	158.7	149.8	150.0

\*all values are in degrees

### **Relationship Between Psychological Factors and Gait Variables**

Since the small participant size dictated the requirement for a case study, it would be inappropriate to examine the statistical relationship between psychological factors and observed gait variables. Based on the quantified results of each component, however, it seems likely that the psychological factors and gait variables do work together. The gait variables of the affected leg achieved relative normalcy in comparison with values presented by Ashok and Sanjay (2015) when considering the participant's demographic. Thus, upon examination of survey scores, it is

possible to identify specific psychological factors which have either a positive or negative relationship, or no relationship, with the participant's successful return to normal gait.

### **Motivation.**

Based on the participant's scores on the Treatment Self-Regulation Questionnaire (TSRQ) survey, a few conclusions may be drawn. A positive relationship may be observed between gait variables of the affected leg and autonomous motivation as evidenced by the participant's high score in this section of the survey. There did not seem to be a relationship with controlled motivation, while there was an inverse relationship with amotivation. The Motives for Physical Activities Measure (Revised MPAM-R) survey asked the participant about specific motivators he may or may not have been engaged with during physical therapy treatment. Based on his scores in each of these individual sections, it seems there is a positive relationship between gait variables of the affected leg and motivation from fitness, competence, and interest/enjoyment. No relationship was observed with motivation from appearance.

### **Basic psychological needs.**

The Basic Psychological Needs in Exercise Scale (BPNES) allowed the participant's perceptions of autonomy, competence, and relatedness during physical therapy to be discovered. The participant's scores in each of these areas were at maximal value, suggesting a positive relationship may be drawn between these psychological needs and the observed gait variables of the affected leg. The scores from the Perceived Competence (Exercising Regularly) survey also supported the positive relationship with competence.

### Discussion

Although the participant's quantified gait variables are not exactly identical to the suggested values of Ashok and Sanjay (2015), a physical therapist must also consider a patient's desired or necessary levels of function when progressing said patient throughout a rehabilitation plan. A patient may have achieved or even surpassed these baseline levels of function while not achieving technically normative values. In the case of gait for a TKA patient specifically, a physical therapist may not consider devoting much treatment time to gait training once the patient appears to be relatively normal to the naked eye and has surpassed status as a potential fall risk. A physical therapist may also place a treatment emphasis on patient-perceived pain; if a patient does not claim to experience pain throughout the gait cycle, other tasks are likely to receive more focus during treatment periods.

Overall, the findings of the kinematic gait analysis indicated relative success in returning to normal gait patterns for the participant's affected leg. This is especially true when considering the participant's age and potential comorbidities including osteoarthritis present in other joints of the leg. John Hopkins Medicine (2018) noted osteoarthritis to be most contributed to from excessive use; it is unlikely that the only joint within the leg to undergo this excessive use would be the knee when the ankle and hip are also simultaneously active during many activities of daily living. Furthermore, this seems to be evidenced by the fact that the categories in which the affected leg is statistically different than the suggested values are also categories in which the unaffected leg are different than the suggested values.

Relative congruency between the two extremities even if they do not match apparent normative values should be considered. A valid example of this concept would be the noted ankle values. For each of the investigated points of the gait cycle, he was constantly in a state of

plantar flexion throughout the gait cycle in both legs. It is therefore unlikely that the affected leg's ankle is experiencing this discrepancy due to the TKA procedure or subsequent physical therapy when the unaffected leg did not experience these events. These gait discrepancies could instead be the result of adaptive gait patterns due to overuse, arthritis, or even lifelong issues with being improperly educated on correct gait patterns through childhood and adolescence.

The largest gait discrepancy found in comparison with the suggested normative values presented by Ashok and Sanjay (2015) was actually in the unaffected knee during peak swing phase. At a time when the suggested value puts the knee at 130 degrees in a state of suspended flexion, the participant's unaffected knee had only barely entered flexion as it was still extended 173.5 degrees. As Singh (2018) noted, the knee is typically flexed throughout this point in the gait cycle in order to assist the foot in clearing the ground during swing phase. Here, it is clear the hip is working comparatively more to combat this ground-clearing issue created by the knee; The unaffected hip is at about 150 degrees flexion while the affected is at 160 degrees with a knee that is more actively flexing. The most obvious suggestion as to why issues may be occurring is that the participant could currently be experiencing its own clinical symptoms. John Hopkins Medicine (2018) presented arthritis and chronic pain to be symptoms likely experienced by those considering a TKA procedure; it is likely both legs have experienced these symptoms unless an acute incident caused the need for the TKA procedure initially. The unaffected leg could also potentially be experiencing these gait discrepancies due to issues of maladaptive gait patterns before the TKA procedure in an effort to alleviate pain that have not yet been corrected.

As evidenced by his high survey scores, the participant was clearly motivated during and following physical therapy treatment. Amotivation, scoring 1.33 out of 7.00 on the TSRQ survey, was virtually nonexistent in his case. Conversely, autonomous motivation, scored quite

well with 6.50 out of 7.00 on the TSRQ survey. Autonomous motivation is most closely associated with intrinsic motivation, defined as “engagement in an activity because of the inherent pleasures and satisfactions it provides (Ryan & Patrick, 2009, p. 109). The participant’s affinity to autonomous (intrinsic) motivation was further demonstrated by his scores on the MPAM-R survey. His top scores on the MPAM-R were fitness, competence, and interest/enjoyment. Ryan & Patrick (2009) concluded that people that engage in an activity because they find it enjoyable, interesting, challenging, and possess the skills to complete them are intrinsically motivated. By this application, each of his noted top scores on the MPAM-R were direct intrinsic motivators. As fitness was the participant’s highest scored section of the MPAM-R, it could suggest that following that he was most focused and motivated by rehabilitating his levels of function during physical therapy. The relative success of his affected leg as seen during the kinematic gait analysis may be seen as support to this hypothesis as gait itself is a baseline functional activity. Therefore, it is quite plausible that intrinsic motivation had a role in the achievement of relatively normal gait following the TKA procedure and subsequent physical therapy treatment.

The participant’s consistency between the TSRQ and MPAM-R surveys also existed in the category of controlled motivation. In discussion of external regulation as a subunit of extrinsic motivation, Ryan and Patrick (2009) defined the term as “a person’s actions are compelled or driven by externally controlled rewards or punishments (Ryan & Patrick, 2009, p. 112). Therefore, controlled motivation is most closely associated with extrinsic motivation. but only with autonomous (intrinsic) motivation. The participant scored lowest on the social and appearance sections, respectively, of the MPAM-R. Each of these are external motivators.



The participant achieved maximal scores in the areas of autonomy, competence and relatedness on the BPNES survey. He scored highly on competence on the Perceived Competence (Exercising Regularly) survey as well. In light of the Self-Determination Theory, it should be emphasized that these results indicate he experienced each of these basic psychological needs a sufficient amount in comparison to his own personal desire to receive each of them (Ryan & Patrick, 2009). This ultimately suggests that each of these components were likely to have had a role in the achievement of relatively normal gait in the affected leg following the TKA procedure and subsequent procedure and subsequent physical therapy treatment.

### **Limitations**

The limitations of this study were characterized by a lack of participants and time. Though the participant in this case study was an excellent candidate and met all criteria, the results of this study would likely be more meaningful if a larger population of recent TKA patients had been included. It is possible that the results found in this study may be exclusive to the participant; likewise, it is possible that these results may be applicable to a much larger population. There are several reasons the study could have ended with these specific results. It is possible that the participant was simply an extremely good candidate for both the TKA procedure and rehabilitation – factors including the number and extent of existing comorbidities may influence this. It is possible that the clinic at which the participant received physical therapy employs a particularly competent cohort of physical therapists or that these professionals may have happened to mesh well personally with the participant, resulting in the high scores in the BPNES survey. If this study would have been afforded more time, the data could have been made more meaningful if conducted through a longitudinal process. For example, a kinematic gait analysis could have been conducted before the TKA procedure in order to better see changes

achieved by the procedure and physical therapy. Similarly, the participant could have answered survey questions before physical therapy in order to learn more about his specific expectations from a psychological perspective at that point in time as well.

### **Practical Application**

The findings of this case study could have a variety of practical applications for physical therapists treating TKA procedure patients. As is seen by the frequent use of various Functional Independence Measure tests required by clinics and insurance alike, one of the top concerns physical therapists have for their patients is their return to function. Gait training may be used as a therapeutic exercise to improve strength and pain management skills, but it is also the basis of many activities of daily living (Dejong *et al.*, 2011). A few of these activities include housework like making the bed and vacuuming as well as yardwork like mowing, gardening, and shoveling snow. Therefore, all psychological factors that may influence this functional task should be considered as much as obvious physiological factors.

Although whether or not a patient is motivated or amotivated is ultimately in the hands of each individual patient, physical therapists may find ways to motivate a patient throughout treatment. Upon initial evaluation, physical therapists could ask each patient why he/she chose to undergo the TKA procedure in the first place. It may be that the patient wishes to get back to work as quickly as possible, participate in activities with friends and family members, are just wants to be released from the holds of chronic pain. Regardless, a physical therapist could then use this information to provide reminders of the goal they are working towards any time the rehabilitation process seems particularly challenging or the patient seems to be disinterested. This group of clinicians may also be able to learn much more about the role of the Self-Determination Theory and Basic Psychological Needs Theory (Ryan & Patrick, 2009). By

understanding patients' desires and perceptions of the needs of autonomy, competence, and relatedness, physical therapists may be able to better tailor interaction and provided treatment.

Monnin and Perneger (2002) suggested that patient satisfaction is an indicator of quality care. Though it is likely that all of the basic psychological needs seem to be related to patient satisfaction, research has hypothesized that autonomy in the form of patient involvement in the decision-making process generally improves a patient's satisfaction with treatment (Hush *et al.*, 2011). It has been suggested that physical therapists underestimate the desired level of patient involvement in the decision-making process by an astonishing 64% according to research conducted by Dierckx *et al.* (2013). This may be because physical therapists do not feel patients are generally not educated enough in the health care field to make logical decisions. However, the data presented in this study suggests physical therapists could share the decision-making process for more often than they do. A simple conversation with the patient about this topic may be useful in providing more personal and effective patient care.

Health care in general obviously includes times when patient involvement in this decision-making process is inappropriate; it is possible that circumstances may call for quick decisions to be made, and it is always of the utmost importance to trust the professional's education and experience in the field. However, physical therapy is unique in its often-lengthy treatment span from initial evaluation to discharge. Intimate clinician-patient relationships may be built over this time period during which the desired levels of these psychological needs could be learned. Also unique is its inclusion of physical activity and exercise as a component of treatment. Exercise is capable of being flexible to cater to the autonomous desires of a patient. For example, if a patient does not like to exercise with ankle weights, it is possible that an accommodation could be made to utilize resistance bands during treatment. Similarly, a patient

may not like long arc quads as an exercise. If appropriate in the rehabilitation timeline, the physical therapist could ask the patient if he/she would prefer to perform straight leg raises instead to exercise the same muscle group.

Though more research is necessary to widely validate the findings of this study, the participant's survey results do seem to indicate that autonomy, competence, and relatedness are likely to have a positive relationship with achieving relative normal gait following the TKA procedure and subsequent physical therapy. Each of these components of the Basic Psychological Needs Theory are at least partially capable of being influenced by the physical therapist. Their suggested connection to gait implies that maximizing the potential for each component could not only improve a patient's satisfaction with treatment, but a patient's function and quality of life by extension as well. Creating the most positive atmosphere possible for patients as they embark on often difficult rehabilitation processes is essential to continue to improve the quality of physical therapy as a whole. Putting patient interests first may help patients feel more socially supported and motivated, become more compliant to exercise plans, and enjoy physical therapy more as a whole.

### Literature Cited

- Ashok, T.S., & Sanjay, D.P. (2015). Angular kinematics of knee and ankle joint movement study using video gait analysis 1. *International Journal of Advanced Computing and Electronics Technology*, 2(2), 2394-3408.
- Cleveland Clinic Staff. (2016, July 15). Total Knee Replacement Post-Op Exercises Procedure Details. Retrieved October 26, 2018, from <https://my.clevelandclinic.org/health/treatments/15406-total-knee-replacement-post-op-exercises/procedure-details>
- DeJong, G., Hsieh, C. H., Putman, K., Smout, R. J., Horn, S. D., & Tian, W. (2011). Physical therapy activities in stroke, knee arthroplasty, and traumatic brain injury rehabilitation: their variation, similarities, and association with functional outcomes. *Physical Therapy*, 91(12), 1826-1837.
- Dierckx, K., Deveugele, M., Roosen, P., & Devisch, I. (2013). Implementation of shared decision making in physical therapy: Observed level of involvement and patient preference. *Physical Therapy*, 93(10), 1321-1330.
- Essery, R., Geraghty, A. W., Kirby, S., & Yardley, L. (2017). Predictors of adherence to home-based physical therapies: A systematic review. *Disability and Rehabilitation*, 39(6), 519-534.
- Greengard, S., & Carey, E. (2017, May 26). Recovery timeline for TKR: Rehabilitation stages and physical therapy. Retrieved October 26, 2018, from <https://www.healthline.com/health/total-knee-replacement-surgery/rehabilitation-timeline>
- Hush, J. M., Cameron, K., & Mackey, M. (2011). Patient satisfaction with musculoskeletal physical therapy care: A systematic review. *Physical Therapy*, 91(1), 25-36.

John Hopkins Medicine. (2018). Knee replacement surgery procedure. Retrieved October 26, 2018, from

[https://www.hopkinsmedicine.org/healthlibrary/test\\_procedures/orthopaedic/knee\\_replacement\\_surgery\\_92,p07673](https://www.hopkinsmedicine.org/healthlibrary/test_procedures/orthopaedic/knee_replacement_surgery_92,p07673)

Kremers, H. M., Larson, D. R., Crowson, C. S., Kremers, W. K., Washington, R. E., Steiner, C. A., ... & Berry, D. J. (2015). Prevalence of total hip and knee replacement in the United States. *The Journal of Bone and Joint Surgery. American Volume*, 97(17), 1386-1397.

Levesque, C.S., Williams, G.C., Elliot D., Pickering, M.A., Bodenhamer, B., & Finley, P.J. (2007). Validating the theoretical structure of the treatment self-regulation questionnaire (TSRQ) across three different health behaviors. *Health Education Research*, 21, 691-702.

Mayo Clinic Staff. (2017, December 29). Knee replacement. Retrieved October 26, 2018, from <https://www.mayoclinic.org/tests-procedures/knee-replacement/about/pac-20385276?p=1>

Monnin, D., & Perneger, T. V. (2002). Scale to measure patient satisfaction with physical therapy. *Physical Therapy*, 82(7), 682-691.

Ryan, R.M., Frederick, C.M., Lepes, D., Rubio, N., & Sheldon, K.M. (1997). Intrinsic motivation and exercise adherence. *International Journal of Sport Psychology*, 28, 335-354.

Ryan, R. M., & Patrick, H. (2009). Self-determination theory and physical activity: The dynamics of motivation in development and wellness. *Hellenic Journal of Psychology*, 6, 107-124.

Singh, A. P. (2018, September 27). Normal Gait Cycle. Retrieved October 26, 2018, from <https://boneandspine.com/normal-gait-cycle/>

Sluijs, E. M., Kok, G. J., & Van der Zee, J. (1993). Correlates of exercise compliance in physical therapy. *Physical Therapy, 73*(11), 771-782.

Vlachopoulos, S. P., & Michailidou, S. (2009). Development and initial validation of a measure of autonomy, competence and relatedness in exercise: The basic psychological needs in exercise scale. *Measurement in Physical Education and Exercise Science, 10*(3), 179-201.

Williams, G. C., & Deci, E. L. (1996). Internalization of biopsychosocial values by medical students: A test of self-determination theory. *Journal of Personality and Social Psychology, 70*, 767-779.

**Appendix A:** Treatment Self-Regulation Questionnaire (TSRQ) (Levesque *et al.*, 2007).

Instructions. The following question relates to the reasons why you would either start to exercise regularly through physical therapy or continue to do so. Different people have different reasons for doing that, and we want to know how true each of the following reasons is for you. Your responses will be kept confidential, so none of your practitioners will know about your responses. Please be honest and candid. All 15 responses are to the one bolded question below.

Please indicate the extent to which each reason is true for you, using the following 7-point scale:

1	2	3	4	5	6	7
not at all true			somewhat true			very true

**The reason I would exercise regularly is:**

1. Because I feel that I want to take responsibility for my own health.
2. Because I would feel guilty or ashamed of myself if I did not exercise regularly.
3. Because I personally believe it is the best thing for my health.
4. Because others would be upset with me if I did not.
5. I really don't think about it.
6. Because I have carefully thought about it and believe it is very important for many aspects of my life.
7. Because I would feel bad about myself if I did not exercise regularly.
8. Because it is an important choice I really want to make.
9. Because I feel pressure from others to do so.
10. Because it is easier to do what I am told than think about it.
11. Because it is consistent with my life goals.
12. Because I want others to approve of me.
13. Because it is very important for being as healthy as possible.
14. Because I want others to see I can do it.
15. I don't really know why.

*Scale:*

Autonomous motivation: items 1, 3, 6, 8, 11, 13

Controlled motivation: items 2, 4, 7, 9, 12

Amotivation: items 5, 10, 15.



Appendix B: Motives for Physical Activities Measure – Revised MPAM-R ((Ryan, Frederick, Lepas, Rubio, & Sheldon, 1997).

Instructions. The following is a list of reasons why people engage in physical activities, sports and exercise. Keeping in mind your experience in physical therapy, respond to each question (using the scale given), on the basis of how true that response is for you. Your responses will be kept confidential, so none of your practitioners will know about your responses. Please be honest and candid.

- | 1                                                                           | 2 | 3 | 4 | 5 | 6 | 7                   |
|-----------------------------------------------------------------------------|---|---|---|---|---|---------------------|
| not at all<br>true for me                                                   |   |   |   |   |   | very true<br>for me |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 1. Because I want to be physically fit.                                     |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 2. Because it's fun.                                                        |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 3. Because I like engaging in activities which physically challenge me.     |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 4. Because I want to obtain new skills.                                     |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 5. Because I want to look or maintain weight so I look better.              |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 6. Because I want to be with my friends.                                    |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 7. Because I like to do this activity.                                      |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 8. Because I want to improve existing skills.                               |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 9. Because I like the challenge.                                            |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 10. Because I want to define my muscles so I look better.                   |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 11. Because it makes me happy.                                              |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 12. Because I want to keep up my current skill level.                       |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 13. Because I want to have more energy                                      |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 14. Because I like activities which are physically challenging.             |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 15. Because I like to be with others who are interested in this activity.   |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 16. Because I want to improve my cardiovascular fitness.                    |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 17. Because I want to improve my appearance.                                |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 18. Because I think it's interesting.                                       |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 19. Because I want to maintain my physical strength to live a healthy life. |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 20. Because I want to be attractive to others.                              |   |   |   |   |   |                     |
| <input type="checkbox"/>                                                    |   |   |   |   |   |                     |
| 21. Because I want to meet new people.                                      |   |   |   |   |   |                     |

- \_\_\_ 22. Because I enjoy this activity.
- \_\_\_ 23. Because I want to maintain my physical health and well-being.
- \_\_\_ 24. Because I want to improve my body shape.
- \_\_\_ 25. Because I want to get better at my activity.
- \_\_\_ 26. Because I find this activity stimulating.
- \_\_\_ 27. Because I will feel physically unattractive if I don't.
- \_\_\_ 28. Because my friends want me to.
- \_\_\_ 29. Because I like the excitement of participation.
- \_\_\_ 30. Because I enjoy spending time with others doing this activity.

*Scale:*

Interest/Enjoyment: items 2, 7, 11, 18, 22, 26, 29

Competence: items 3, 4, 8, 9, 12, 14, 25

Appearance: items 5, 10, 17, 20, 24, 27

Fitness: items 1, 13, 16, 19, 23

Social: items 6, 15, 21, 28, 30

Appendix C: The Basic Psychological Needs in Exercise Scale (BPNES) (Vlachopoulos & Michailidou, 2009).

Instructions. The following sentences refer to your overall experiences in exercise in physical therapy as opposed to any other particular situation. Your responses will be kept confidential, so none of your practitioners will know about your responses. Please be honest and candid. Using the 1-5 scale below, please indicate the extent to which you agree with these statements by circling one number for each statement.

	I don't agree at all	I agree a little bit	I somewhat agree	I agree a lot	I completely agree
1. I feel I have made a lot of progress in relation to the goal I want to achieve.	1	2	3	4	5
2. The way I exercise is in agreement with my choices and interests.	1	2	3	4	5
3. I feel I perform successfully the activities of my exercise program.	1	2	3	4	5
4. My relationships with the people I exercise with are very friendly.	1	2	3	4	5
5. I feel that the way I exercise is the way I want to.	1	2	3	4	5
6. I feel exercise is an activity which I do very well.	1	2	3	4	5
7. I feel I have excellent communication with the people I exercise with.	1	2	3	4	5
8. I feel that the way I exercise is a true expression of who I am.	1	2	3	4	5
9. I am able to meet the requirements of my exercise program.	1	2	3	4	5
10. My relationships with the people I exercise with are close.	1	2	3	4	5
11. I feel that I have the opportunity to make choices with regard to the way I exercise.	1	2	3	4	5

*Scale:*

Autonomy: items 2, 5, 8, 11

Competence: items 1, 3, 6, 9

Relatedness: items 4, 7, 10

Appendix D: Perceived Competence (Exercising Regularly) (Williams & Deci, 1996).

Instructions. Please indicate the extent to which each statement is true for you, assuming that you were intending either to begin now a permanent regimen of exercising regularly or to permanently maintain your regular exercise regimen. Your responses will be kept confidential, so none of your practitioners will know about your responses. Please be honest and candid. Use the following scale:

1	2	3	4	5	6	7
not at all true			somewhat true			very true

1. I feel confident in my ability to exercise regularly.
2. I now feel capable of exercising regularly.
3. I am able to exercise regularly over the long term.
4. I am able to meet the challenge of exercising regularly.

*Scale:* An individual's score is simply the average of his or her response on the 4 items.