

Spring 5-14-2021

## Patient Engagement in Cosmetic Designing of Prostheses: Current Practice and Potential Outcome Benefits

Kenneth Repayo

*University of Nevada, Las Vegas*

Cailin Mitchell

*University of Nevada, Las Vegas*

Matthew Tillitt

*University of Nevada, Las Vegas*

Collin Weber

*University of Nevada, Las Vegas*

Follow this and additional works at: <https://digitalscholarship.unlv.edu/thesesdissertations>



Part of the [Physical Therapy Commons](#)

---

### Repository Citation

Repayo, Kenneth; Mitchell, Cailin; Tillitt, Matthew; and Weber, Collin, "Patient Engagement in Cosmetic Designing of Prostheses: Current Practice and Potential Outcome Benefits" (2021). *UNLV Theses, Dissertations, Professional Papers, and Capstones*. 4104.

<https://digitalscholarship.unlv.edu/thesesdissertations/4104>

This Doctoral Project is protected by copyright and/or related rights. It has been brought to you by Digital Scholarship@UNLV with permission from the rights-holder(s). You are free to use this Doctoral Project in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/or on the work itself.

This Doctoral Project has been accepted for inclusion in UNLV Theses, Dissertations, Professional Papers, and Capstones by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact [digitalscholarship@unlv.edu](mailto:digitalscholarship@unlv.edu).

PATIENT ENGAGEMENT IN COSMETIC DESIGNING OF PROSTHESES:  
CURRENT PRACTICE AND POTENTIAL OUTCOME BENEFITS

By

Cailin Mitchell  
Kenneth Repayo  
Matthew Tillitt  
Collin Weber

A doctoral project submitted in partial fulfillment  
of the requirements for the

Doctor of Physical Therapy

Department of Physical Therapy  
School of Allied Health Sciences  
The Graduate College

University of Nevada, Las Vegas  
May 2021

**Copyright 2021 by Cailin Mitchell, Kenneth Repayo, Matthew Tillitt, Collin Weber**

**All Rights Reserved**

**Doctoral Project Approval**

The Graduate College  
The University of Nevada, Las Vegas

May 14, 2021

This doctoral project prepared by

Cailin Mitchell

Kenneth Repayo

Matthew Tillitt

Collin Weber

entitled

Patient Engagement in Cosmetic Designing of Prostheses: Current Practice and Potential Outcome Benefits

is approved in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy  
Department of Physical Therapy

Szu-Ping Lee, Ph.D.  
*Research Project Coordinator*

Kathryn Hausbeck Korgan, Ph.D.  
*Graduate College Interim Dean*

Daniel Young, Ph.D.  
*Research Project Advisor*

Merrill Landers, Ph.D.  
*Chair, Department of Physical Therapy*

## **ABSTRACT**

### Purpose:

Making a prosthesis for an individual with limb loss is a highly personalized process. A currently unexplored area is whether there are tangible benefits in greater patient engagement during the making of their prostheses. We examined the current practice of engaging patients in prosthetic cosmetic designing and identified factors associated with patient outcomes.

### Methods:

This cross-sectional study surveyed 104 prosthetists and 25 prostheses users. The questionnaires covered aspects of prosthetic prescription, users' perceived level of engagement, and self-reported outcomes. Regression analyses were used to examine the associations between perceived level of engagement, satisfaction, and other outcomes.

### Results:

Among prosthesis users, 75% reported being offered at least one cosmetic option during the making of their prostheses which corresponded with 82.7% of the prosthetists reporting that they typically engage patients in their practices. Patients who were offered at least one cosmetic design option reported significantly greater satisfaction than those that were not offered the option ( $p=0.027$ ). Patients' level of satisfaction was significantly correlated with a perception that their prostheses empower them in daily activities ( $r=0.415$ ,  $p=0.028$ ).

### Conclusion:

Engaging patients in the cosmetic designing of their prosthesis is a widely accepted practice. Prosthetic practitioners should consider the potential benefits of higher levels engagement for all patients.

### Clinical Relevance:

Limb loss is a complex health condition that impacts patient's physical and psychological functioning and wellbeing. Engaging patients in the prosthetic design process is a ubiquitous practice, however some prosthetists may offer higher levels of cosmetic options only to certain populations. Higher levels of engagement in the prostheses-making process support patients' senses of autonomy and empowerment and is related to greater prosthetic compliance.

## **ACKNOWLEDGEMENTS**

This research study was made possible by the University of Nevada, Las Vegas Physical Therapy Department Grant. The authors would like to thank Szu-Ping Lee, PT, PhD for his excellent guidance as principal investigator of this study.

## TABLE OF CONTENTS

ABSTRACT.....	iii
ACKNOWLEDGEMENTS.....	v
TABLE OF CONTENTS.....	1
INTRODUCTION .....	2
METHODOLOGY .....	4
Prosthetists Survey.....	4
Protheses Users Survey .....	4
DATA ANALYSIS.....	6
RESULTS .....	8
Prosthetists Survey Results.....	8
Protheses Users Survey Results .....	10
DISCUSSION.....	12
Limitations .....	15
CONCLUSION.....	16
APPENDIX 1: PROSTHETISTS SURVEY .....	17
APPENDIX 2: PROTHESES USER SURVEY.....	18
BIBLIOGRAPHY.....	20
CURRICULUM VITAE.....	23



## INTRODUCTION

Amputation is a life-altering, traumatic experience that can affect many facets of an individual's life (Ostler, et al., 2014). It is suggested that the affected aspects of the individual's life include limitations in performing activities professionally, socially, and recreationally (Holzer, et al., 2014). In addition to the loss of a functional limb segment, patients are affected psychologically, which often results in emotional stress and reduction of overall quality of life (Holzer, et al., 2014). In the United States alone, there are currently more than 2 million people living with amputations, with about 185,000 more occurring each year (Owing & Kozak, 1998; Ziegler-Graham, et al., 2008). With this large and ever-growing population, there is an increasing need to understand how to improve patient outcomes after amputation.

One currently unexplored area is whether there are tangible benefits in engaging patients in the decision-making process regarding the cosmetic and functional componentry choices when making their prostheses. All prostheses are tailor-made to fit the patients, however, some prosthetists solicit a higher degree of input from their patients, such as on cosmetic features (i.e. color and artistic/graphical designs), protective/cosmesis covers, and other prosthetic components (Murray, 2013). Higher levels of engagement during this process may support patient's autonomy and improve body image, which have been shown to be decreased in patients with limb amputations (Holzer, et al., 2014; Donovan-Hall, et al., 2002).

Satisfying one's fundamental need for autonomy, even in seemingly incidental choices, has been shown to improve motor performance, learning, and self-efficacy (Wulf, et al., 2014). For example, Wulf et al. (2014) showed that by offering a choice of ball color during a throwing task (i.e. a choice unrelated to task performance), participant's accuracy significantly improved. The observed effect carried over to skill transfer, retention and enhanced self-efficacy, indicating

that such benefits are profound. As applied to prosthetic clinical practice, being given the opportunity to choose the cosmetic design of one's prosthesis could positively impact the various aspects of prosthetic utilization, leading to better outcomes for the prosthesis user. Rejection of a prosthetic limb may occur if the patient could not overcome the problems of body image anxiety, stress, depression, and reduced quality of life commonly associated with limb loss (Ostler, et al., 2014; Zidarov, et al., 2009; Murray & Fox, 2002). Previous studies have shown that perceived satisfaction regarding one's prosthesis and its actual usage are significantly correlated (Murray & Fox, 2002). However, the effects of patient engagement during the design and fabrication processes on prosthetic satisfaction, utilization, and other outcomes remain unknown.

The purpose of this study was to examine: 1) the current practice and factors that influence whether patients with limb loss are given the opportunity to provide input to the cosmetic design of their prostheses, 2) whether being involved in designing the appearance of one's prosthesis is related to more positive patient self-reported outcomes. We hypothesized that greater involvement in the making of one's prosthesis would result in psychological benefits and improved outcomes.

## **METHODOLOGY**

Cross-sectional surveys of prosthetists and amputee patients were conducted between August 2019 and February 2020.

### Prosthetists Survey

The prosthetists survey used in this study was a 12-item questionnaire that queried prosthetists about their current practice of offering prosthetic design options to patients (Appendix 1). Questions included whether and why they typically offer or not offer the cosmetic design options, the types of cosmetic options they typically offer (i.e. color, artistic/graphic design, shell/cover, and other), populations they perceive to be more likely to request or to whom they are more likely to offer the options, and if the prosthetists perceive any differences in patients who received a prosthesis with their chosen design options. An inclusion criterion was that the participant must be a currently practicing prosthetist.

### Protheses Users Survey

The 20-item protheses users survey focused on questions related to the engagement in the process during the fabrication of their protheses and the participant's perceptions regarding their prosthetic device and other outcomes (Appendix 2). Specific outcomes included prosthetic usage (i.e. typically daily and weekly wear time) and perceptions regarding how one's personal prosthesis looks, works, and empowers the user to do what he/she likes to do. The inclusion criteria were patients who are 18 years and older, have had a major lower limb loss (defined as losing at least one major joint) and owned a working prosthesis for at least 6 months. The exclusion criterion were non-prosthetic users and presence of any conditions that can interfere with the participant's ability to understand and answer the survey questions.

Both questionnaires were created and validated by experts in prosthetics, rehabilitation, and clinical behavior psychology, as well as a group of prostheses users. The surveys were administered using an online survey platform (Qualtrics, Provo, UT, USA) advertised via the Orthotics and Prosthetics Listserve, prosthetic companies' websites, a local Amputee Patient Support Group, prosthetic and rehabilitation services in the region, and personal communication.

## DATA ANALYSIS

For the prosthetists survey, the primary variable of interest was whether the cosmetic design options are typically offered (by the prosthetist in question) during the prosthetic making process (Q2, appendix 1). We explored predictors for a positive response to this question using a logistic regression model. Secondary analyses examined the open-ended responses from prosthetists regarding the practice of offering the prosthetic cosmetic options to their patients. For example, prosthetists were asked “*Why do you typically offer cosmetically customized prosthesis to a patient?*”. The responses to this question were grouped into four categories: patient-driven, prosthetist-driven, cost-related, and other reasons. Examples of patient-driven responses included: “*it is the patient’s leg, it should look the way they want it to*”, and “*people get more joy and show off their prosthesis if they are excited about how it looks*”. The prosthetist-driven category contained responses that were related to the prosthetist’s belief; examples of such responses included: “*[prosthetic] covers protect components...*”, and “*it may increase compliance*”. Cost-related responses were grouped if the responses were related to insurance coverage or lower out of pocket costs to the patient. Examples of this included: “*only a few insurance companies deny cosmetic coverage...*” and “*it’s easy and inexpensive*”, Responses in other categories included: “*It is a service we provide to all patients. Standard operating procedure*”. The reasons for not typically offering the cosmetic options to their patients were also analyzed using the same four categories of responses. Example responses included: “*[cosmesis] inhibit component function and are a pain to make*” (prosthetist-driven) and “*usually not paid for by insurance, patients don’t usually want to pay*” (cost-related).

For the prostheses users surveyed in the study, aspects of perceived involvement during the prostheses making process were described using descriptive statistics. To further investigate

potential predictors of patients receiving prosthetic options during fabrication, a regression model was applied to examine its association with gender and time after amputation, as a previous study has shown females were more likely to receive cosmetic covers for their prostheses (Highsmith, et al., 2016). Additional analyses focused on comparing the self-reported outcomes between individuals who were given the options vs. those who weren't (Q11: "*Were you given an option to customize your prosthesis?*"). We examined the correlations between the perceived levels of involvement and satisfaction toward their prostheses and other patient-reported outcomes using bivariate Pearson correlation statistics.

To further examine the effects of specific cosmetic design options on patients' self-reported outcomes, we applied the weighted quantile sum (WQS) regression model to condense the prosthetic options into a mixture variable and to simultaneously evaluate the mixture impact on each self-reported outcome item (Carrico, et al., 2015). The weight of each prosthetic option on the mixture effect reflects the contribution of that prosthetic option to the overall effect. We also constrained the mixture effect to be positive based on preliminary analyses and background knowledge in the optimization function of the weight estimation. A total of 100 bootstrapping steps were carried out to make the estimated coefficient of the mixture effect more robust. A  $\tau$  value from the reciprocal of the number of prosthetic options was used to determine whether a weight of a prosthetic option had a relative contribution greater than a default weight.

SPSS version 26 (IBM SPSS Statistics, International Business Machines Corp., New York, USA) was used to compute descriptive statistics, Pearson correlations, and logistic regression models. RStudio version 1.3.1056 (RStudio, PBC, Massachusetts, USA) was used to perform the WQS regression analysis. The significance level for all analyses was set at 0.05.

## RESULTS

### Prosthetists Survey Results

For the prosthetists survey, a total of 104 complete responses were received. Most prosthetists solicit input from their patients when fabricating the prostheses for them (91.3%, n=95), and 82.7% of the prosthetists confirmed that they typically offer at least one cosmetic design option to their patients. Patient-driven factors were the leading reason to offer those options (64.0%). Within the prosthetists who reported that they do not typically offer cosmetic options (n=18), cost-related (n=6, 33.3%) and prosthetist-driven (n= 7, 38.9%) factors were the leading reasons. Some prosthetists said that they are more likely to offer the cosmetic options to certain populations (Table 1). Of the prosthetists who considered age as a deciding factor (n=23), 69.6% said they were more likely to offer cosmetic options to younger adults versus 30.4% to older adults. The prosthetists who considered sex as a deciding factor (n=15) indicated that they were more likely to offer the option to female patients (73.3%). Other populations that the prosthetists would consider when offering the design options included race and cultural groups (n=5), patients with special needs (n=2), patients with better insurance (n=3), and patients with higher educational levels (n=1). The logistic regression analysis showed that the prosthetist's estimated percentage of their patients who choose to have a cosmetically customized prosthesis (Q7, appendix 1) was the only significant predictor of whether the prosthetist would offer such options to his/her patient (p=0.001).

A high percentage of the surveyed prosthetists (69.2%) reported that they noticed positive differences in patients who own a prosthesis with customized design options. Specifically, the

noted differences included more positive attitude, improved motivation, compliance, and function (table 1).

Table 1: Summary of the Prosthetists Survey Results

<b>Question</b>	<b>N</b>	<b>%</b>
Do you typically offer cosmetically customized prostheses to a patient?		
<b>Yes</b>	86	82.7
<b>No</b>	18	17.3
Why do you typically offer cosmetically customized prostheses to a patient?		
<b>Patient-driven reasons</b>	55	64.0
<b>Prosthetist-driven reasons</b>	35	40.7
<b>Cost-related reasons</b>	6	7.0
<b>Other</b>	10	11.6
Who is the population that you are more likely to offer a cosmetically customized design or a higher level of design option to?		
<b>Age</b>	28	22.1
Pediatric	5	21.7
Younger adult	16	69.6
Older adult (>50 years of age)	7	30.4
<b>Sex</b>	15	14.4
Female	11	73.3
Male	4	26.7
<b>Other populations</b>	13	12.5
Between patients who have and do not have custom-designed prosthesis, do you notice a difference?		
<b>Yes</b>	72	69.2
<b>No</b>	32	30.8
What are the differences you notice between patients who have and do not have a prosthesis with cosmetic design?		
<b>Motivation</b>	22	21.4
<b>Attitude</b>	33	31.7
<b>Compliance</b>	18	17.3
<b>Function</b>	9	8.7
<b>Other</b>	13	12.5



## Prostheses Users Survey Results

A total of 28 current prostheses users participated. On average, the participants were  $8.8 \pm 9.8$  years after their amputation at the time of this study. Most prostheses users (78.6%) said that they felt engaged in the design of their current prostheses, of which 95.5% said that they were given at least one cosmetic design option (color, artistic/graphic designs, cosmesis shell/cover, and other). On average, the prostheses users surveyed rated their level of involvement in the process of making their prostheses  $77.6 \pm 28.8$  on a scale of 0-100. Regarding the question “*how important is the look of your prosthesis?*” they rated it  $76.8 \pm 29.2$  out of 100. The regression analyses were unable to find any prostheses users characteristics that predict whether they received a cosmetic design option. Particularly, our model showed that gender and years after amputation were not significant predictors ( $p=0.462$  and  $0.175$ , respectively).

Comparisons between those who were ( $n=22$ ) and weren't ( $n=6$ ) offered at least one cosmetic design option showed that participants who had the option placed significantly higher importance on the looks of their prostheses (yes option =  $83 \pm 25.1$  vs. no option =  $53.8 \pm 34.0$ ,  $p=0.027$ ). Correlation analyses showed that the level of importance participants place on the looks of their prostheses was significantly correlated with their perceived levels of involvement during fabrication ( $r=0.488$ ,  $p=0.008$ ), and how much the cosmetic aspect of the device determines whether they use their prostheses ( $r=0.597$ ,  $p=0.001$ ). The correlation analyses further showed that a patient's satisfaction regarding the look of his/her prosthesis was significantly correlated with their levels of perception that their prostheses empower them to do things they like to do ( $r=0.415$ ,  $p=0.028$ ). The perceived level of empowerment from their prostheses was also significantly correlated with the number of hours they report they can comfortably wear the prostheses ( $r=0.443$ ,  $p=0.018$ ), the level that they look forward to wear the

prosthesis everyday ( $r=0.564$ ,  $p=0.002$ ), and the overall satisfaction regarding how their prostheses works ( $r=0.859$ ,  $p<0.001$ ).

Weighted Quantile Sum (WQS) analyses showed that giving input to different cosmetic options (i.e. color, graphics, and shell/cover) has variable levels of effect on different outcomes (table 2). In general, giving input to color and cosmesis shell/cover design options exhibited relatively higher weighed effects than graphics design options regarding the selected outcomes.

Table 2. Mixture effects of giving input to different cosmetic options on self-reported outcomes

	Cosmetic options		
	Color	Graphics	Shell/Cover
Motivation to wear the prosthesis everyday	0.24*	<0.01	0.40*
Empowerment by prosthesis	0.27*	0.01	0.24*
Satisfaction on how prosthesis works	0.18*	<0.01	0.37*
Satisfaction on how prosthesis looks	0.27*	0.01	0.24*
Level of involvement during prosthesis making process	0.09	0.02	0.35*

\* Relative weight > 0.17

## **DISCUSSION**

We found that most prosthetists engage their patients in the design process of their prostheses, specifically more than 80% typically offer at least one cosmetic design option to their patients. This was confirmed by that 75% of the surveyed prostheses users stated that they were offered at least one cosmetic design option during the fabrication of their personal prostheses. Consistent with experimental findings that choice promotes positive affect and intrinsic motivation (Patall, et al., 2008; Wulf & Lewthwaite, 2016), almost 70% of the surveyed prosthetists reported that they noticed more positive attitude, improved motivation, compliance, and function in patients who owned a prosthesis with customized cosmetic design options. This also corresponded to our findings from the prostheses users that their level of satisfaction regarding the looks of their prostheses was significantly related to whether they feel the prostheses empower them and their overall satisfaction. The findings from our research helps to elucidate how seemingly decorative prosthetic options can have psychological benefits that translate to potential positive outcomes for prostheses users.

We found that soliciting inputs from patients is an integral part of prosthetic prescription and fabrication. Most if not all prosthetic devices are individually customized to fit the patient's needs including comfort, function, and cosmesis. The results from the prosthetic practitioners surveyed in this study reflected this practice principle that soliciting input from patients during the making of their prostheses is well-accepted, mostly to satisfy the patients' needs and preferences. However, some practitioners were more likely to offer design options to certain patient populations. For example, several prosthetists reported that they are more likely to offer cosmetic design options to patients who are younger or female. These biases corresponded with the findings from Highsmith et al. (2016) that female patients with lower limb loss were more likely to receive a cosmesis cover than males. Prosthetists' implicit bias toward this practice may

result in lost opportunities in gaining the benefits associated with greater engagement and choice (Patall, et al., 2008). Personal values such as gender (e.g. feminine or masculine), professional, cultural, and other attributes should be considered for every prostheses users (Resnik, et al. 2019).

For prosthetists who reported that they do not typically offer prosthetic cosmetic options, cost-related and prosthetist-driven factors were the leading reasons behind this opinion. The cost related factor should be considered in light of insurance coverage; certain payors consider cosmesis to be irrelevant to function and may deter prosthetists from offering such options. For example, Medicare in the United States typically only pays for components that can be justified to offer protection to the prosthesis (i.e. shells or covers), and not purely cosmetic (“Local Coverage Determination – Lower Limb Prostheses,” 2020). The prosthetists-driven reasons involved the prosthetists’ beliefs that adding certain cosmetic components such as the cosmesis cover can disrupt the normal function of a prosthesis. A previous study by Cairns et al. (2014) revealed that up to 64% of the prostheses users expressed less than satisfied opinions regarding their cosmesis cover. Specifically, 43% of them were less than satisfied by how their prosthesis covers influenced prosthetic joint movement for those with an above-the-knee amputation. This corroborates with comments from the prosthetists in our study that adjustment difficulty, disruption of component function, and durability were their main concerns regarding cosmesis foam covers. While efforts were made to improve the look and function of cosmesis covers (Cairns, et al., 2018), this cosmetic option is likely one of the less offered in current prosthetic clinical practice.

In the current literature, the importance of prosthetic cosmesis to a patient and whether the look of a prosthesis affects patient outcome are inconclusive. For instance, a systematic

review conducted by Richie et al. showed that users of upper limb prostheses often view function as more important than cosmesis (Ritchie, et al., 2011). Nevertheless, the look of one's prosthesis was unlikely to be completely unimportant to the user, as satisfying prostheses users' needs in cosmesis have long been the guiding principle in prosthetic prescription and fabrication. We found that most prosthetists offer cosmetic options to satisfy their patient's preferences. Many prosthetists mentioned "*fun*", "*personal expression*", and "*acceptance*" when asked why they typically offer cosmetic options to their patients. This ubiquitous practice adopted by most prosthetists may implicitly provide support to their patients' autonomy.

The benefits of autonomy support have been demonstrated in several recent studies. For example, Lewthwaite et al. showed that giving participants choices unrelated to the task, i.e. choice of a painting to hang on the wall just prior to the participant performing a balance task, can lead to improved performance and motivation (Lewthwaite, et al., 2015). The leading theory behind this effect is that supporting an individual's sense of autonomy can improve self-efficacy, positive affect, and motivation (Wulf & Lewthwaite, 2016). Autonomy support can be viewed as the practice of fostering an environment that emphasizes an individual's ability to make their own choices, which under the context of prosthetics can be easily achieved by engaging patients in the design process of their prostheses. Our findings supported this premise given that participants' perceived level of satisfaction regarding the look of their prostheses was significantly correlated with their perception on how their prostheses empower them during daily activities. Furthermore, the perceived level of empowerment from their prostheses was significantly correlated with their actual prosthetic usage time, motivation to wear the prosthesis, and the overall satisfaction on how their prostheses works. If patients with limb loss are more motivated to wear their prosthesis, it is reasonable to believe that such behavior can lead to better

functional and health outcomes in the long run, as they would be more inclined to be physically active and participate in higher levels of activities necessary to their social roles.

The current behavior science literature indicates that there are tangible benefits of offering small and seemingly incidental choices and instructing with words that encourage active decision-making (Lewthwaite, et al., 2015; Hooyman, et al., 2014). As applied to clinical prosthetic practice, these empowering acts do not have to involve major componentry decisions (i.e. offering more expensive prosthetic components), so seeing the value of supporting patients' autonomy not as a function of cost will mean that clinicians can capitalize on the benefits of autonomy support without needing to charge for it or to incur significant monetary or time costs. Prosthetists should consider opportunities more generally in engaging patients in all facets of their practices.

### Limitations

The number of prosthesis users interviewed for this study was limited (n=28). Although this number is larger than some of the previous studies on this topic (Donovan-Hall, et al., 2002), the survey was conducted regionally and based on a sample of convenience, both of which may limit the generalizability of the study findings. A larger study controlling these potential confounding factors is needed to further explore the effect sizes of different prosthetic cosmetic options on outcomes in individuals with limb loss. While we had a sizable sample of responses from prosthetists, half of them practice in the West and Southwest regions of the United States. Regional differences, specifically the differences in state insurance policies may affect the generalizability of our results.

## **CONCLUSION**

High percentages of prosthetists and persons with limb loss reported offering and receiving design options on prosthetic cosmesis, indicating that this is a widely adopted practice. Offering cosmetic options and supporting patients' autonomy involve little to no risk in clinical prosthetic practice, while showing tangible benefits. This study provides evidence supporting prosthetists to engage their patients during the prosthesis making process, as it has the potential to drive patient empowerment and motivation.

## **APPENDIX 1: PROSTHETISTS SURVEY**

Q1: When making a prosthesis for a patient, do you ask the patient for their input or preference on the following: (components, cosmetic features, other)?

Q2: Do you typically offer cosmetically customized prostheses for a patient? (Yes/No)

Q3: You have chosen yes in Q2. Why do you typically offer cosmetically customized prostheses for a patient? (Fill-in)

Q4: You have chosen no in Q2. Why do you not typically offer cosmetically customized prostheses for a patient? (Fill-In)

Q5: What cosmetic options do you normally offer to a patient? (color, graphic/artistic design, shell/cover, other)

Q6: Which of the cosmetic options cost extra? (color, graphic/artistic design, shell/cover, other)

Q7: Of all your patients, estimate the percentage of people who choose to have a cosmetically custom-designed prosthesis. (Sliding Scale between 0-100%)

Q8: Are there certain populations that you are more likely to offer a cosmetically customized design or a higher level of design option to? (Yes/No)

Q9: You have chosen yes in Q8, who is the population that you are more likely to offer a cosmetically customized design or a higher level of design option to? (age, sex, other demographics)

Q10: Are there certain populations that are more likely to request a cosmetically customized design or a higher level of design option to? (Yes/No)

Q11: You have chosen yes in Q10, who are the certain populations that are more likely to request a cosmetically customized design or a higher level of design option to? (age, sex, other demographics)

Q12: Between patients who have and do not have a prosthesis with cosmetically customized designs, do you notice any differences in: (attitude, motivation, function, compliance, other)?



## **APPENDIX 2: PROSTHESES USERS SURVEY**

Q1: How long ago did you receive your current prosthesis? (Entering years)

Q2: On average, how many days per week do you wear your prosthesis? (Sliding scale of 0-7 days)

Q3: On average, how many hours per day do you wear your prosthesis? (Sliding scale of 0-24 hours)

Q4: On average, how many hours can you comfortably wear your prosthesis every day? (Sliding scale of 0-24 hours)

Q5: On a scale of 0-100, how much do you look forward to wear your prosthesis every day? (Sliding scale of 0-100 from “not at all” to “always”)

Q6: On a scale of 0-100, do you feel your prosthesis empowers you to do things you like to do? (Sliding scale of 0-100 from “not at all” to “always”)

Q8: On a scale of 0-100, how satisfied are you with the way your prosthesis works? (Sliding scale of 0-100 from “not at all” to “completely satisfied”)

Q9: On a scale of 0-100, how satisfied are you with the way your prosthesis looks? (Sliding scale of 0-100 from “not at all” to “completely satisfied”)

Q10: On a scale of 0-100, how involved were you in the process of making your prosthesis? (Sliding scale of 0-100 from “not at all” to “completely involved”)

Q11: Were you given an option to customize the look of your prosthesis? (Yes/No)

Q12: You have chosen yes in Q11, why did you choose to customize the look of your prosthesis? (Fill-in)

Q13: What aspects of your prosthesis did you give input to? (functional features: foot, joints, socket, suspension, and other; cosmetic features: color, graphic/artistic designs, shell/cover, and other)

Q14: If you were given a choice but decided not to customize the look of your prosthesis, why? (Fill-in)

Q17: Would you choose to customize the look of your prosthesis if given the option?

Q18: You have chosen yes in Q17, how would you want your prosthesis customized? (functional features: foot, joints, socket, suspension, and other; cosmetic features: color, graphic/artistic designs, shell/cover, and other)

Q19: From a scale from 0-100, how important is the look of your prosthesis? (Sliding scale of 0-100 from “not at all” to “very much so”)

Q20: From a scale of 0-100, how much do you feel that the cosmetic aspect of your prosthesis determines whether you use it? (Sliding scale 0-100 from “not at all” to “very much so”)

## BIBLIOGRAPHY

- Cairns, N., Corney, J., Murray, K., Moore-Millar, K., Hatcher, G. D., Zahedi, S., Bradbury, R., McCarthy, J. (2018). Rethinking the foam cosmesis for people with lower limb absence. *Prosthetics and orthotics international*, 42(2), 223-227.
- Cairns, N., Murray, K., Corney, J., McFadyen, A. (2014). Satisfaction with cosmesis and priorities for cosmesis design reported by lower limb amputees in the United Kingdom: instrument development and results. *Prosthetics and orthotics international*, 38(6), 467-473.
- Carrico, C., Gennings, C., Wheeler, D. C., Factor-Litvak, P. (2015). Characterization of Weighted Quantile Sum Regression for Highly Correlated Data in a Risk Analysis Setting. *Journal of Agricultural, Biological, and Environmental Statistics*, 20(1), 100-120.
- Centers for Medicare & Medicaid Services. (2020). *Local Coverage Determination - Lower Limb Prostheses 2020*. <https://www.cms.gov/medicare-coverage-database/details/lcd376/details.aspx?LCDId=33787&ver=22&Date=&DocID=L33787&bc=iAAAAAIAAAAA&>
- Donovan-Hall, M. K., Yardley, L., Watts, R. J. (2002). Engagement in activities revealing the body and psychosocial adjustment in adults with a trans-tibial prosthesis. *Prosthetics and orthotics international*, 26(1), 15-22.
- Highsmith, M. J., Kahle, J. T., Knight, M., Olk-Szost, A., Boyd, M., & Miro, R. M. (2016). Delivery of cosmetic covers to persons with transtibial and transfemoral amputations in an outpatient prosthetic practice. *Prosthetics and orthotics international*, 40(3), 343-349.
- Holzer, L. A., Sevelde, F., Fraberger, G., Bluder, O., Kicking, W., & Holzer, G. (2014). Body image and self-esteem in lower-limb amputees. *PLoS One*, 9(3), e92943.

- Hooyman, A., Wulf, & Lewthwaite, R. (2014). Impacts of autonomy-supportive versus controlling instructional language on motor learning. *Human Movement Science, 36*, 190-198.
- Lewthwaite, R., Chiviacosky, S., Drews, R., & Wulf, G. (2015). Choose to move: The motivational impact of autonomy support on motor learning. *Psychonomic Bulletin & Review, 22*(5), 1383-1388.
- Murray, C. D. (2013). 'Don't you talk to your prosthetist?' Communicational problems in the prescription of artificial limbs. *Disability and Rehabilitation, 35*(6), 513-521.
- Murray, C. D., Fox, J. (2002). Body image and prosthesis satisfaction in the lower limb amputee. *Disability and Rehabilitation, 24*(17), 925-931.
- Ostler, C., Ellis-Hill, C., & Donovan-Hall, M. (2014). Expectations of rehabilitation following lower limb amputation: a qualitative study. *Disability and Rehabilitation, 36*(14), 1169-1175.
- Patall, E. A., Cooper, H., Robinson, J. C. (2008). The effects of choice on intrinsic motivation and related outcomes: a meta-analysis of research findings. *Psychological Bulletin, 134*(2), 270-300.
- Randolph, B. J., Nelson, L. M., Highsmith, M. J. (2016). A Review of Unique Considerations for Female Veterans With Amputation. *Military medicine, 181*(S4), 66-68.
- Resnik, L., Klinger, S., Gill, A., Biester, S. E. (2019). Feminine identity and functional benefits are key factors in women's decision making about upper limb prostheses: a case series. *Disability and Rehabilitation: Assistive Technology, 14*(2), 194-208.

- Ritchie, S., Wiggins, S., Sanford, A. (2011) Perceptions of cosmesis and function in adults with upper limb prostheses: a systematic literature review. *Prosthetics and orthotics international*, 35(4), 332-341.
- Wulf, G., Chiviakowsky, S., & Cardozo, P. L. (2014). Additive benefits of autonomy support and enhanced expectancies for motor learning. *Human Movement Science*, 37, 12-20.
- Wulf, G., Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin & Review*, 23(5), 1382-1414.
- Zidarov, D., Swaine, B., Gauthier-Gagnon, C. (2009). Quality of life of persons with lower-limb amputation during rehabilitation and at 3-month follow-up. *Archives of physical medicine and rehabilitation*, 90(4), 634-645.
- Ziegler-Graham, K., MacKenzie, E. J., Ephraim, P. L., Trivison, T. G., & Brookmeyer, R. (2008). Estimating the prevalence of limb loss in the United States: 2005 to 2050. *Archives of Physical Medicine and Rehabilitation*, 89(3), 422-429.

## **CURRICULUM VITAE**

Cailin Mitchell, SPT

Department of Physical Therapy  
University of Nevada, Las Vegas  
Email Address: cailindm@gmail.com

### **Education**

California State University, Fullerton  
B.S., Kinesiology, May 2018

Kenneth Repayo, SPT

Department of Physical Therapy  
University of Nevada, Las Vegas  
Email Address: kennethrepayo@gmail.com

#### Education

University of Nevada, Las Vegas  
B.S., Kinesiology, May 2016

Matthew Tillitt, SPT

Department of Physical Therapy  
University of Nevada, Las Vegas  
Email Address: Matthew.tillitt@yahoo.com

#### Education

University of Colorado, Boulder  
B.A., Political Science, May 2012

University of Nevada, Reno  
B.S., Community Health Science, May 2017



Collin Weber, SPT

Department of Physical Therapy  
University of Nevada, Las Vegas  
Email Address: Cweb888@hotmail.com

#### Education

University of Nevada, Las Vegas  
B.S., Kinesiology, December 2017