

# PSYCHOLOGICAL DISTRESS AND WELL-BEING IN PROSTHETIC USERS

## THE ROLE OF REALISM IN BELOW-KNEE PROSTHESES

### Abstract

The needs of below-knee amputees, in terms of the aesthetics of the prostheses, receive little or no attention. Failure to address this issue could create dissatisfaction with the body image of amputees. This paper seeks to explore different aspects of the psychological issues and well-being of users by focusing on the hypothesis that the level of realism in prostheses is linked to multiple factors, i.e. the time occurred since amputation and acceptance of limb loss. Specifically, we highlight the positive role of using artificial-looking devices for promoting the self-confidence of wearers during the second phase post-amputation, and the use of cosmetic devices in the first phase. The data derives from a closed ended questionnaire, email exchanges with users and an in-depth literature review. The paper constitutes a contribution to research on the “aesthetics of prosthetic devices” by taking into account the dynamics behind the psychological distress and well-being of prosthetic users.

**Keywords:** *prosthetic devices, aesthetics, well-being, body image, lower limb amputees*

### Introduction

This paper explores the role of realism in prostheses as a way of meeting the expectations of prosthetic users at two stages post-amputation, and how wearing the “right” design (according to the perception of the amputee observer) can positively affect body image and self-esteem. Specifically, we argue for the positive role played by non-realistic prostheses in enhancing psychological well-being.

“Prosthetic” is a term that refers to devices designed to replace a missing part of the body. This definition applies to devices that replace a limb segment rather than externally-applied devices which are referred to as “orthotics”. For example, we can classify an artificial arm, leg, or finger as a “prosthesis”, whereas external entities such as a dental brace, insoles or a pair of glasses are “orthotics”. Specifically, our field of research currently focuses on below-knee prosthetic devices. In this paper we will refer to any device resembling the appearance of a human leg with the term “cosmetic” (Figures 1a and 1b), while “non-cosmetic”, “non-realistic” or “artificial looking” will identify devices with an interface dissimilar to a human leg (Figures 1c and 1d).

The subjects of our research are amputees [or rather people who have had a limb amputated (Pearsall, 1999)] who are prosthetics users or future users. For the specific purposes of this paper we refer to below-knee amputees, even though it does include a few examples of upper limb wearers.

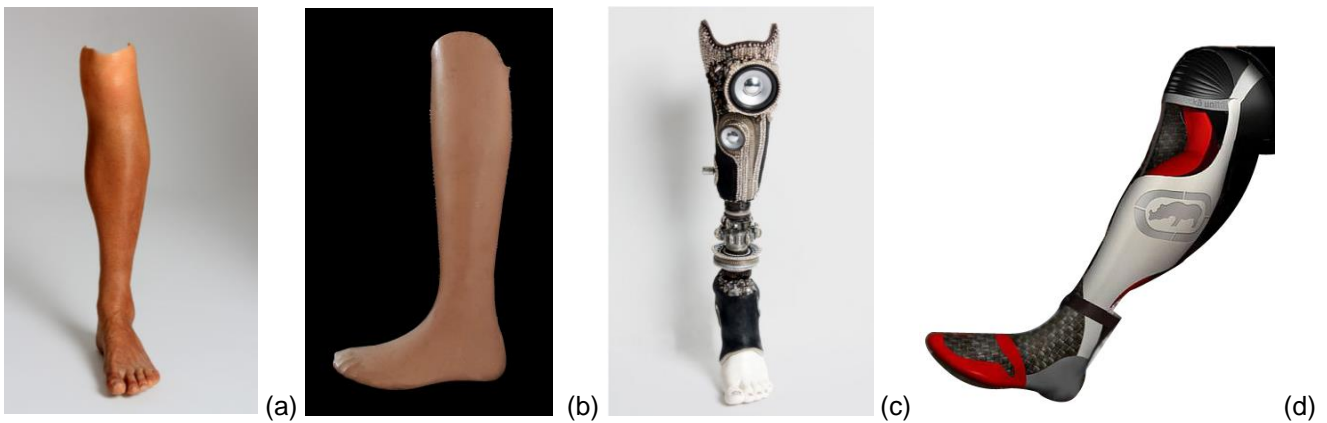


Figure 1: cosmetic devices with high (a) and medium (b) level of human resemblance (sources: (a) The Alternative Limb Project, photographer: Rosemary Williams - [www.thealternativelimbproject.com](http://www.thealternativelimbproject.com) - (b) photo from personal archive), and “non-cosmetic” or “artificial looking” devices (c and d) (sources (c) The Alternative Limb Project, photographer: Rosemary Williams - [www.thealternativelimbproject.com](http://www.thealternativelimbproject.com) - (d) “Ecko Unltd. Prosthetic Leg” of Jordan Diatlo - <http://www.jordandiatlo.com>)

The limited literature on the aesthetics of prosthetic devices demonstrates that this field is still in its infancy. A review of current prosthetic design literature shows that extended work to date has been largely focused on the technical improvement of the devices (Cheetham, Suter, & Jäncke, 2011; Hahl, Taya, & Saito, 2000; Klute, Kallfelz, & Czerniecki, 2001; Mak, Zhang, & Boone, 2001) in spite of the research around aesthetics. Our search found few academic studies discussing realistic-appearance aesthetic devices - and that the literature that does exist focuses mainly on upper limb designs (Davies, Douglas, & Small, 1977; Ferrone, 2001). This contrasts with a considerable number of companies (e.g. “Procosil”, “Touch Bionics”, “The alternative Limb project”, “Ottobock”) and associations (i.e. “Amputee Coalition”, “Amputee prosthetics”, “Westcoast brace and limbs”) that deal with the production and/or advertisement of high-level realistic-looking limbs. Similarly, we found little literature investigating the aesthetics of non-realistic devices (Capestany & Esparza, 2011; Hilhorst, 2004; Plettenburg, 2005), but wider attention on the part of companies (e.g. “The alternative Limb project”, “Bespoke innovations”) and designers (i.e. Sophie de Oliveira Barata, Scott Summit).

## Method

The main data-sources used to prepare this paper consist of responses to a questionnaire, personal e-mails from below-knee prosthetic users and a comprehensive literature review.

Regarding the internet survey, the study consisted of an online questionnaire (that took approximately 25 minutes to complete). It was based on a set of closed ended questions structured using the Likert scale rating system. A quantitative method was adopted because of the necessity of collecting a large amount of data. There were one hundred and fourteen participants in the study who may be classified as follows:

- Amputation: Amputees 24 (21.1%) and Non-amputees 90 (78.9%)
- Gender: 40.4% Male and 59.6% Female

Amputee participants were sub-classified into: lower limb amputees 22 (92%) and upper limb amputees 2 (8%).

The International Personality Item Pool (IPIP) template was chosen for testing personality aspects (L. R. Goldberg et al., 2006). This system provides a list of questions for investigating the personality traits of participants. Each question offered participants the opportunity to rate the statement, choosing one of the five

points on the Likert scale between “very inaccurate” and “very accurate”. The scoring had to be evaluated as “positive” or “negative” according to the statement proposed. The issues investigated were: level of physical activity, extroversion and assertiveness, sociability, calmness, courage, kindness, and generosity. Each of these traits was tested by posing an average of 10 questions.

Regarding the e-mail based data collection, the information was gained through informal conversations engaged in with prosthetic users between 2012 and 2013.

## **Psychological aspects of prosthetic users**

The amputation of a limb can generate unpleasant psychological consequences (R. T. Goldberg, 1984; Horgan & MacLachlan, 2004; Price & Fisher, 2007; Rybarczyk, Nyenhuis, Nicholas, Cash, & Kaiser, 1995; Shukla, Sahu, Tripathi, & Gupta, 1982; Whyte & Niven, 2001) in addition to profound effects on body image (Maguire & Parkes, 1998). Specifically, the literature shows how dealing with the new bodily dissatisfaction can generate symptoms such as stress and depression (Breakey, 1997; Cansever, Uzun, Yildiz, Ates, & Atesalp, 2003; Williamson, Schulz, Bridges, & Behan, 1994), difficulty in accepting an amputation (Sjödahl, Gard, & Jarnlo, 2004) and difficulties in establishing romantic and sexual relationships (C. Murray, 2009). In some cases it has been shown that an amputee experiences extreme denial. English (1989) records the example of a woman amputee who “had even left instructions in her will that she should be buried in her artificial leg so that even beyond the grave her secret would be preserved”.

Breakey (1997) argues that, despite the existence of psychological issues influencing psychological well-being and life satisfaction in amputees, the rehabilitation process pays little attention to these problems in patients. Additionally, Asano et al. (2008) state that, according to their scale, lower limb amputees record a lower level of quality of life than upper limb amputees.

The literature shows that the physical trauma of amputation can have negative psychological repercussions in amputees, and we argue that accounting for this is important for better understanding prosthetic users.

Surprisingly, in addition to the previous examples showing the negative issues correlated with amputation, it has also been shown that positive post-amputation experiences exist. Experts in the field and medical staff tend to conceive amputation as a “mutilating” procedure, when other researchers see the issue in a positive light, as a process of reconstruction (Bowker, 1981; Bradway, Malone, Racy, Leal, & Poole, 1984). Stress is one of the main consequences of limb amputation. However it has been argued that when this aspect is overcome, it can have a positive outcome as the self-esteem of the amputee can be “strengthened and grown” [(Ickovics & Park, 1998), in (Oaksford, Frude, & Cuddihy, 2005a)]. Similarly, Bonanno (2004) describes the experience of coping with an adversity (i.e. amputation) as an opportunity to thrive and change. In accordance with this belief, Gallagher and MacLachlan (2001) report an interview with an amputee, where she states she’s feeling “great” because she managed to “get on with her life” by dealing successfully with the trauma and now feels like “a better person”.

Tedeschi et al. (1996) state that the experience of thriving after a traumatic experience is named “posttraumatic growth” and that this process is obtained by a change in how people view themselves (Tedeschi & Calhoun, 1996, 2004), cited in Phelps et al. (2008), when others highlight the importance of “meaning-making” for successfully overcoming the post-traumatic experience (Taylor, 1983). Phelps et al. (2008) argue that the core process of thriving positively with amputation consists in engaging a set of cognitive coping strategies such as

revising life goals and priorities if the traumatic experience is to be overcome. An amputee mentioned in Gallagher and Maclachlan (2001) stated that the acceptance of amputation is an important issue in the process of getting over the experience [the psychological dissatisfaction]: “it is like when somebody you know dies, it takes a while to get over it, but gradually you do”.

In accordance with the literature, our questionnaire shows that amputees (compared with non-amputee participants) recorded a significantly higher “positive level of traits” showing a “positive attitude towards life” such as: physical activity, extroversion (or assertiveness), sociability, bravery (or courage), and generosity. Our understanding of the psychological process post-amputation is that amputees, after facing the natural process of negative psychological reactions, can respond to psychological distress and reach a positive life-facing attitude, even gaining higher levels than non-amputees. We claim that both negative and positive psychological feelings in amputees are part of their normal process of “growth” and that these can be directly related to prosthetic design choices, and therefore that gaining a clear comprehension of these dynamics is essential for understanding the role of the aesthetics of devices for the wearers. This belief will be further explored in the following sections.

### **The grieving process post-amputation**

In “psychological adaption to amputation”, Bradway et al. (1984) state the existence of one stage pre-amputation (a stage that may not occur in certain cases) and three post-amputation stages, something that everyone universally experiences. The stages are a) grief b) realization that the limb is no longer present c) denial and d) return home. The authors state that denial is the stage where people tend to show negative psychological symptoms (depression, insecurity, preoccupation etc.) (Friedmann, 1978; Parkes, 1975), and that the phase of returning home can generate either a successful adaption to disability or, sadly, a “fall” back to the previous stage.

The prosthetic web site “Hanger” describes the experience of amputation as a life-changing experience that may be emotionally devastating. “Everyone deals with these feelings in different ways. Allow yourself to grieve and to feel your loss. [...]. Ultimately, you will reach a stage of acceptance. How long this may take varies from person to person but one thing is certain: when you are able to accept your new body image you'll be able to lead a happier life.”

“The Five Stages of the Grieving Process” have been identified as a set of psychological stages that people go through when experiencing amputation: denial, anger, bargaining, depression, acceptance and hope (Kubler-Ross, 2009). This process is discussed by the amputee researcher Saul Morris (in “Amputee Coalition”) and is described as “essential” because anyone who has ever experienced an amputation goes through the same cycle, though the duration of each stage varies according to the individual (“some people will do it in a short time, while others will take several months”).

Rybarczyk et al. (1995), show that depression in amputees can be classified both in the long term (17 years after amputation) and in the short term (4 years after amputation). This finding suggests that the grieving process may not necessarily end with “acceptance and hope” and therefore the stages may not hold true for everyone, or that “acceptance and hope” may take even longer than 17 years after amputation.

### **The role of prosthetic devices in the psychological well-being of prosthetic users**

*“No-one comes out unscathed by an amputation and a prosthesis may act as a security, a guarantee or a mechanism for requiring the integrity of one's physical appearance, which validates one's psychological integrity.” (Pillet & Didierjean-Pillet, 2001)*

Interest concerning the enhancement of the self-body image and psychological well-being of amputees has been under consideration for some time. Singh, Hunter and Philip (2007) emphasize the benefit of learning new skills and improving the mobility of the amputee in order to overcome unpleasant psychological feelings. In a similar way Dunn (1996) focuses on 1) finding positive meaning in being an amputee, 2) adopting an optimistic attitude and 3) perceiving control over disability. In the context of dealing with phantom limb pain (an issue that negatively affects the physical and psychological well-being of amputees), it has been argued that factors such as, for example, the individual patient's medical history, phantom sensations, daily activities, social support received and the influence of an amputation has to be taken into account when analyzing improvements in an amputee's well-being (Bosmans et al., 2007).

A functional prosthesis can undoubtedly be considered an important contribution to achieving well-being. For example, it has been argued that the use of a prosthesis helps the user to regain mobility (Pohjolainen, Alaranta, & Kärkäinen, 1990) and to return to performing social activities (C. D. Murray, 2005). However, by going beyond the functional role of the prosthesis, the literature shows how the aesthetics of the device influence the psychological concerns of amputees. It has been stated that if users are to accept a prosthesis they must be comfortable, functional and have a pleasant appearance (Millstein, Heger, & Hunter, 1986). Similarly, Bhuvaneshwar et al. (2007) report that “cosmetic appearance appears to play as great a role in psychological sequel of amputation as does the return of physical function”. Similarly, Murray (2005) reports the case of a prosthetic user who refuses to wear his prosthesis on a daily basis providing as an explanation the judgment that the device is “clumsy and unattractive” rather than a specific complaint regarding functionality. Similarly, Nguyen (2013), and Rybarczyk and Behel (2008) address the fact that adjustment difficulties in amputees have to be reconnected to the aesthetics of the limb by highlighting the importance of this kind of aesthetic dissatisfaction for females.

From a design perspective, Cairns, Murray et al. (2013) argue that the appearance of the prosthesis affects acceptance of the device and that there is a link between the perception of its negative aesthetics and a negative self-body image. In the context of lower limb cosmetic devices, it is stated that the improvement of the aesthetics of the prosthesis can consequently help to improve the self-body image and psychological wellbeing of the wearer. Accordingly, it is our belief that the aesthetics of prosthetics can influence the psychological well-being of lower-limb amputees and we argue that this principle should be accounted for in prosthetic design.

Considering the role of hand prostheses, Pillet and Didierjean-Pillet (2001) argue that the device can be the “answer” to overcoming the issues encountered when taking part in social activities. The authors also highlight the fact that all amputees have special personal requirements and that “nowadays, function is not sought at any cost, especially not at the cost of sacrificing the appearance of the hand”. Regarding the use of digital cosmetic prostheses (i.e. devices with a high level of limb-like realism – Figure 1a), Carrol and Fyfe (2004) state that in contrast to PVC prostheses (i.e. devices with a lower level of limb-like realism – Figure 1b), they can reduce the level of anxiety and depression in the wearer. Their conclusion is that the “improvement” of the realistic appearance of devices can enhance the well-being of the users. We find ourselves discordant with the positive effect of the level of realism in prostheses, but we agree with these authors concerning the importance of pleasant aesthetics in helping resolve psychological distress in amputees.

The limitation that we found in the works cited up till now is that they take into account only the aesthetic role of cosmetic prostheses. Few academic papers have focused on the non-cosmetic aesthetics of prosthetic design when it comes to improving the experiences of the wearers, suggesting that this research gap is relatively new and unexplored. An example of literature which does briefly touch upon the subject is provided by authors such as Capestany and Esparza (2011) who describe a case study of an amputee who required a personalized golf-prosthesis. In a similar manner, Plettenburg (2005) designed a prosthetic prehensor (a design similar to a wrench) for children, by using a combination of solid design and an appealing colorful style. Similarly, Hilhorst (2004) described his non-conformist-styled design applied to prostheses for children, personalizing them for each individual's unique "identity". These three examples are significant in terms of exploring the role of non-cosmetic looking devices intended to enhance the well-being of individuals. Our research differs in that it examines both cosmetic and non-cosmetic designs and that it focuses on lower limb devices rather than upper limbs.

Regarding upper limb amputees, Pillet (2001) proposes the question "can a patient who abandons his/her prostheses be considered healed?". According to our point of view, in upper limb prosthetic users this stage of acceptance of the new body could be verified if the amputee chooses to use a non-cosmetic device or to abandon the use of prosthetics altogether. As a matter of fact, the difference between upper and lower limb amputees is that the use of a prosthetic leg may be required if mobility is to be regained, or the individual is to be able to take part in social activities; in these cases arm/hand prostheses mainly represent an aesthetic "security" (Pillet, 1984). However, considering that this paper focuses on lower limb prosthetic users, we will not go into this issue in greater depth here.

## **Levels of realism in prostheses reflecting the acceptance of amputation**

Our opinion is that the achievement of well-being for amputees is not a simple goal but is linked to internal dynamics and external events correlated to the trauma of the amputation. Additionally, all individuals have a personal story and the track for achieving well-being may vary from case to case. However, it is our belief that a set of general dynamics may potentially be present in all subjects. In addition to the important role of issues such as the rehabilitation process, medical treatment, social support, etc., the role played by the aesthetics of prosthetics can make a valid contribution that enhances well-being in amputees by improving their self-body image.

In this section we introduce our hypothesis regarding the role of realism in the aesthetics of prostheses in enhancing acceptance during the post-amputation stages, with an additional focus on other factors involved (i.e. time and coping strategies).

First, we propose a simplistic division of the post-amputation period into two stages: the first characterized by strong unpleasant psychological feelings ("Phase one") correlated with the fact that the limb loss is not accepted yet, and the second stage where a positive attitude towards life emerges as a consequence of a greater acceptance of amputation ("Phase two"). Second, we aim to correlate an overview of the aesthetic needs of prosthetic users for a desirable level of realism in the prostheses (Figure 2).

We understand the psychological process during the post-amputation period to be far more complex and that it may normally include more than two phases. However, in order to meet the specific requirements of this research, we decided to simplify the post-amputation stage and to focus only on the factors of non-acceptance

[i.e. grouping the first four phases of the “grieving process”: denial, anger, bargaining, and depression (Kubler-Ross, 2009)] and acceptance [i.e. the last phase of the “grieving process”: acceptance and hope (Kubler-Ross, 2009)].

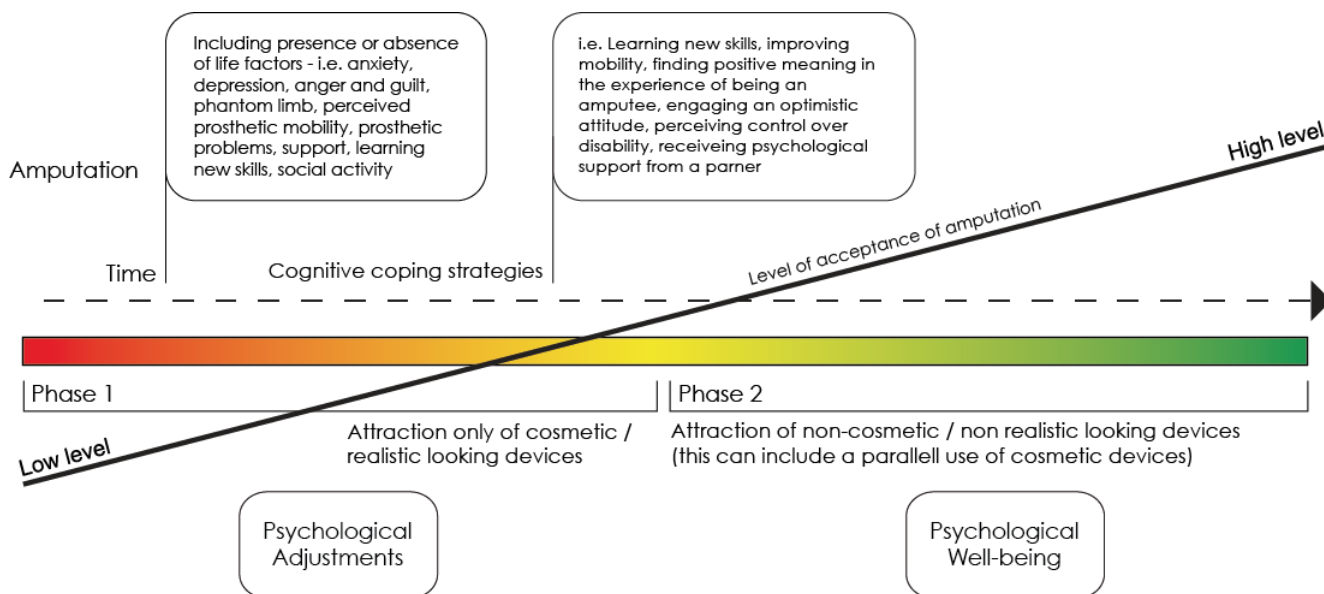


Figure 2. Graph showing the two phases experienced by prosthetic users for the desirable level of realism in the prostheses related to influencing factors - Phase 1: the amputated body is not accepted and the preference is for cosmetic devices, Phase 2: positive acceptance of amputation and attraction of non-cosmetic devices

The main factors affecting the phases of the graph are Time, Level of Acceptance of Amputation, and Personal Characteristics (gender, age, self-consciousness). The first and second factors (Time and Level of Acceptance) will be described first, after which we will deal with Personal Characteristics.

## Time

Sprangers and Schwartz (1999) suggest that the internal standards of amputees are re-defined over time, and that psychological adaptation occurs in a parallel process (Gallagher & MacLachlan, 2001; Livneh, Antonak, & Gerhardt, 1999; Pezzin, Dillingham, & MacKenzie, 2000). Additionally, it has been stated that coping strategies change over time simultaneously with the changing demands of adjustment [(Lazarus, 2006) cited in (Oaksford et al., 2005a)]. In a similar manner, Desmond & MacLachlan (2006) state that a short time elapsed since amputation is correlated with high levels of post trauma distress and symptoms of anxiety - a belief shared also by Oaksford et al. (2005a), according to whom a long time since amputation leads to a more favorable adjustment to limitation. This statement is supported by a study suggesting that depression is marked immediately after amputation and gradually resolves over time (Frank et al., 1984). Phelps et al. (2008) argue that, when high levels of depressive disorders are found in the first two years after amputation (25-35%), they subsequently tend to show a significant decline (mean: 8%).

The passage of time post-amputation causes the user to face negative and positive factors such as: anxiety, depression, anger and guilt, perceived prosthetic mobility, social support, partner support, learning new skills, comorbidity, prosthetic problems, social activity (Asano et al., 2008; Bhojak & Nathawat, 1988; Buffery & Gray, 1972; Burger & Marincek, 1997; C. Murray, 2009).

The factors listed do not necessarily appear universally and the lapse of time necessary for people to re-define their own standard varies from case to case. It is proposed that the presence or absence of a given factor can influence the length of time necessary for a person to move from Phase 1 to Phase 2.

### Level of Acceptance of Amputation

The “Level of Acceptance of Amputation” is affected by the degree to which factors occurring during the post-amputation period are dealt with positively or negatively (see previous point), and, according to our point of view, is positively achieved when cognitive coping strategies are successfully applied. Examples of coping strategies are: 1) engaging an active and confrontational attitude rather than a passive and maladaptive one, 2) being optimistic instead of pessimistic 3) being social and “externally-orientated” instead of cognitive and internally-orientated (Livneh, Antonak, & Gerhardt, 2000) 4) reversing life goals and priorities 5) accommodating traumatic experience and 6) seeking beneficial aspects (Phelps et al., 2008). As mentioned in the section “psychological aspects of prosthetic users”, it is also important to acknowledge the role of “meaning-making” (Taylor, 1983) if a successful post-traumatic growth is to occur after amputation (Dunn, 1996; Oaksford, Frude, & Cuddihy, 2005b).

Senra et al. (2012) illustrate the emotional changes that occur in lower limb amputees prior to obtaining a new self-identity (Figure 3). The process described by the authors is directly relevant to our work as it proposes, within the process of self-identity change following amputation, the role of the prostheses and the embodiment of amputation as final factors in obtaining a new self-identity. Additionally, their research shows that a set of psychological changes occurs prior to the identity change (i.e. changes in self-in-the present, self-biography, self-projection in the future or self-identification with the impairment). Our research views these factors as a set of “coping strategies”.

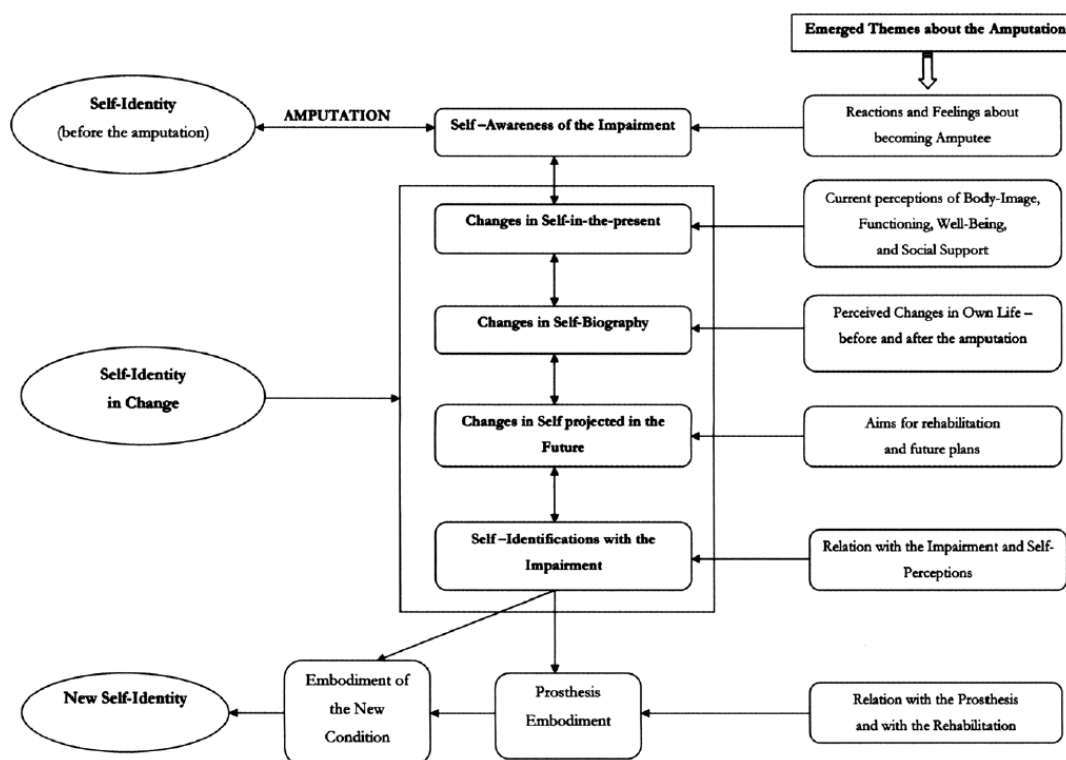


Figure 3 Model for self-identity changes related to lower limb amputation (Senra et al., 2012)



## Two stages post-amputation

In relation to time and to the level of acceptance of amputation, the phases of our graph are described as following:

**Phase 1.** The amputee is subject to unpleasant psychological feelings (Horgan & MacLachlan, 2004; Price & Fisher, 2007; Shukla et al., 1982; Whyte & Niven, 2001) and is attracted to devices resembling the realistic look of a limb (i.e. cosmetic devices) that remind the subject of the lost leg. We believe that people do not accept that they have an amputated body - or at least have no desire to show it to others - as they have not (yet) fully accepted they have an "altered" body. In agreement with Pereira et al. (1996) and Carrol and Fyfe (2004), our belief is that cosmetic prostheses with human-leg resemblance can be considered important in the process of "restoring the person's damaged body image". We claim that at this stage attraction towards realistic-looking devices has to be conceived as a normal phase that needs to be navigated before a full acceptance of the amputated body may be gained. It is to be hoped that this phase will not last long.

**Phase 2.** The amputee gains a better acceptance of their "mutilated" body, the traumatic experience does not generate increased levels of psychological reaction, and the self-body image is more positive. This belief is supported by the fact that our investigation recorded the presence of a percentage of amputees who were attracted to cosmetic devices, in opposition to a smaller number who were attracted to non-cosmetic devices.. Individuals no longer feel like hiding the amputation as they did before, and do not fear using a device with non-human characteristics that clearly "shows" the limb loss. Cairns (2013) recorded that 49/59% of patients rating satisfaction for cosmetic prostheses were neutral or dissatisfied with the color/shape/touch and feel of the devices and stated that a higher level of realism did not generate further aesthetic attraction. When prosthetic users overcome the normal process of psychological distress and regain confidence they will also be ready to go "beyond" the use of a realistic prosthetic. By wearing a non-cosmetic device they find attractive they will, in return, reach higher levels of confidence in their own bodies.

Our hypothesis is that the attraction towards robotic devices (an attraction that does not exclude a parallel favorable attitude towards cosmetic devices) represents an evolution/improvement in the self-body vision of the amputee. We argue that when amputees "accept" the new body shape, they are psychologically more confident and consequently do not see their disability as a visual limitation they need to "hide" using a realistic silicone cosmetic device. The point of view of John (screen-name), a male amputee, is that:

*"Although I think that there are so many reasons that you might want a limb that looks lifelike, so many of us acknowledge our loss of a limb and feel that if it is no longer there, why pretend? If it is obviously false then why not make more of this possible advantage?"*

Additionally, we report the words of a male amputee (screen-name: Albert) at an advanced stage of amputation (his amputation having occurred many years ago):

*"I have chosen not to hide what I have irreversibly lost. I do not care about this issue (the loss), but it does not occur to me to falsify something that is not reproducible with "silicone"[...]. I could not tolerate the surprise of the people when, as will obviously happen, they discover the deception. No. I prefer to show immediately what has been lost and that it has been replaced by something that does not create feelings of pity but, I hope, aesthetic attraction."*

Albert is not afraid of showing his disability and feels the desire to wear a device representing aesthetic needs that involved a big step beyond the attraction of cosmesis. He is ready to use a prosthesis that does not merely resemble the old limb, or else a device designed to represent an important meaning for the wearer such as “strength”, “speed”, “gracefulness”, “playfulness”. He also hopes the device will generate aesthetic appreciation in external observers as well.

In agreement with this statement, we report the evidence of John:

*“I lost my leg – below the knee - when I was 16 [he is currently 45] and until recently I have 'made do' with what was out there, usually something that looked like it had been taken from a shop mannequin. [...] A couple of years back I came across a robotic-looking leg. This style is so appealing that now I shorts in the gym when I'm wearing it. It looks 'cool'! It suggests I am healthy, active, sporty: everything my mannequin leg doesn't!”*

In “Design meets Disability” Pullin (2009) states that prostheses should not become simply replacements of the human limb, as its design helps determine and communicate simply what they are instead. Additionally, by mentioning the work of an artistic upper limb design, he reports the point of view of the sculptor Jaques Monestier: “I wanted to transmute what might be considered a disfigurement into something marvelous and exotic. I wanted to create a hand that would no longer cause shame and repulsion. I wanted the amputee to be proud to have it and look at it. And for the people around them, I wanted the prosthetic hand to be an object of healthy curiosity, a work of art”.

Our belief, which match the points of view reported above, is that the use of a non-cosmetic device may help wearers to see their own bodies as something that is more than an “illusion” of what existed before and is now lost forever. Amputees have the “power” to choose a pleasant looking product of design and to show external observers that they are not disabled, but super-abled individuals who are proud of their bodies.

As we mentioned above, attraction and the use of non-cosmetic devices does not imply that all the users should deny the use of cosmetic devices for good. We wish only to specify that they should be seen as one option (e.g. for combining with a dress, or for a formal occasion) in addition to the confidence gained by wearing non-cosmetic devices on other occasions. The top fashion model Aimee Mullins, a double amputee, states: “I don't have any issue wearing legs that aren't human-like, but I want the option to have human-looking legs” [“Two legs good 24 legs better” (Vainshtein, 2012)]. Aimee is the perfect example of a person who has coped well with limb loss and reached a high level of confidence with her body image. We would consider her to be living in Phase 2.

## **Future work**

In order to test our hypothesis on the attraction of realism in devices, we have initiated an interview-based experiment based on a revised version of the RGT technique (a method taken from Personal Construct Psychology). The experiment shows the amputee participants a set of non-cosmetic and cosmetic devices and records their level of attraction towards the different levels of realism. The non-cosmetic devices include a set of our own designs that embody a set of principles and elements, as well as meanings (i.e. “stability”, “energy”, “gracefulness”, “lightness” etc.). The aim of the experiment is to compare the level of attraction towards realistic prosthetics among participants with different characteristics such as 1) length of time since amputation 2) gender 3) age 4) personal characteristics / background. Our hope is that the investigation will confirm the statements made in this study.

## Conclusion

Our belief is that prostheses that are perceived as attractive by prosthetic wearers can improve their body image and psychological well-being. Additionally, the development of acceptance for the new body can influence the attraction felt towards realistic or non-realistic-looking designs. We argue that prosthetic devices with non-human characteristics can better promote the acceptance of limb loss and provide well-being to the user during a second, post-amputation, phase. Furthermore we argue that cosmetic devices can help wearers to deal with the psychological adjustments associated with limb loss only during the first phase. The hypothesis has been conceived in general terms because, for instance, the length of time needed to arrive at Phase 2 may vary from person to person according to the personal history of the amputee, and there are likely to be many people who might be considered “exceptions”.

This work aims to contribute to academic research on the aesthetics of prosthetic devices and to relate this concept to the promotion of the psychological well-being of prosthetic users. We have advanced a different perspective regarding the aesthetic needs of amputees, relating this issue to their post-amputation psychological processes. Additionally, we showed why the aesthetics of prosthetic devices should receive more attention in the post-amputation rehabilitation process, in order to promote a better body image among amputees.

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