The Precision-Based Airman Optimization Increment of Optimization of Human Capital: Re-Envisioning Air Force Recruitment Strategies Through Application of an Adaption of General Systems Performance Theory

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Abstract - Optimization of Human Capital (OHC) is an Air Education Training Command (AETC) Program of Record (PoR) composed of three increments, each of which builds upon the other, culminating in a proposed new approach to evaluating and maintaining airman health and performance. OHC moves beyond the current focus on absence of disease to one that is more mission focused, concentrating on precision care, precision training, and more targeted job placement. The first increment, Precision-based Airman Optimization (PBAO), is underway. The other two increments, Enhanced Medical Screening Techniques for a Fit and Healthy Force, and Prevention, Mitigation, & Worker Hardening Strategies for a High Functioning Force, have not yet commenced, but scientists are already making strides to prepare for their implementation. For PBAO, scientists utilized an adaptation of General Systems Performance Theory (GSPT) as the conceptual basis for measurement and modeling of human performance. In collaboration with subject matter experts, scientists developed a set of basic performance resources (BPRs), individual attributes (such as agility and visual acuity), that could be utilized as measurable indicators of potential performance success within a given career field. By answering the question of how much of a particular ability is truly needed to successfully perform a specific job, the Air Force can make informed concessions in placement to better support mission effectiveness and broaden the population of those considered fit for duty.

Keywords – Precision-based Airman Optimization, Basic Performance Resources, Attributes, General Systems Performance Theory, Audiology, Physiology, Psychology, Vision, Haptics, Proprioception, Vestibular Functioning

1. Introduction

In 2017, the Air Force Surgeon General validated the Optimization of Human Capital (OHC) Research Development Document (RDD) which describes a means to better assess fit between an airman and their job. Analyses conducted during OHC High Performance Team (HPT) events that defined the OHC RDD indicated the potential for significant increases in mission effectiveness and retention over the airman life cycle thus addressing an enduring human capital challenge for the Air Force (AF). The overarching goals of the OHC program are to help inform objective alignment via AFSC-specific, health-informed forecasting efforts and improve precision-based care with greater mission focus. Inherent to achieving these goals is identification of airman traits and attributes that may have a direct impact on achieving mission performance.

During the OHC RDD definition process, three high-level capability gaps were identified and incorporated into three sequential increments to be addressed within the OHC research program. The first, Precision-based Airman Optimization (PBAO), involves evaluating objective alignment from a distinctly health mission performance perspective. Increment 2, Enhanced Screening Techniques, will apply PBAO knowledge and tools to improve precision-based assessment and care delivery. The third increment, Worker Hardening, will utilize PBAO knowledge, tools, and screening techniques to create enhanced, mission-relevant preventive and supportive measures.

A unique aspect of OHC is an overarching philosophy which breaks from the longstanding approach currently in place for recruiting, training, and retaining Air Force personnel. Instead of focusing on the presence or absence of disease, OHC outcomes will invoke a more holistic approach and flip this ideology, looking for presence of capability and how to best maintain that capability over a recruit's career. Figure 1 provides a graphic illustration of the goal of maintaining optimized health and performance from enlistment through separation from service.

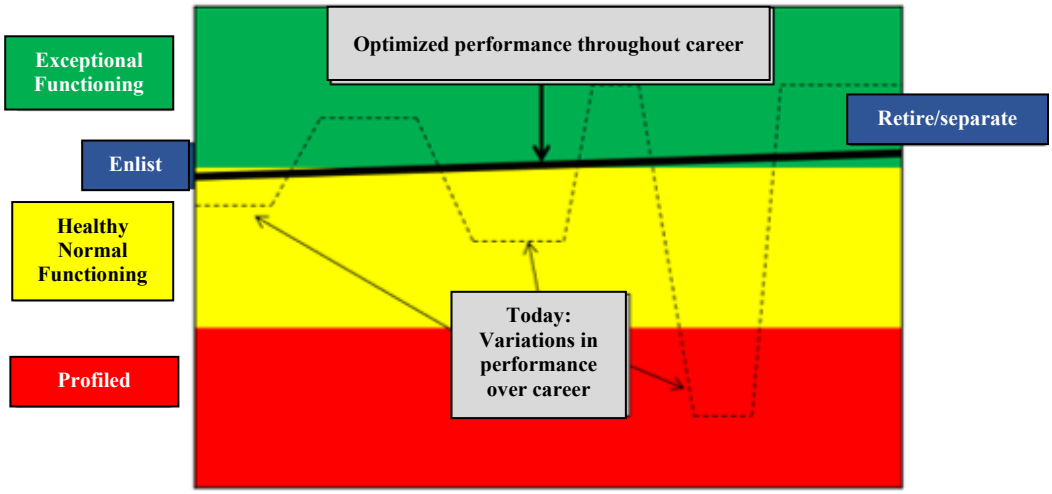

Figure 1. Airman Lifecycle Performance Optimization

Across the Air Force enterprise, leadership ranging from the Surgeon General (SG), to AETC, Air Combat Command (ACC), and career field managers (CFMs) for targeted career fields, have expressed their support for an improved approach to establishing and maintaining airman health and fitness for duty. Change is being driven by a growing realization of the need to prioritize airman health (sensory, psychological, and, physical) and optimize personnel through appropriate career field matching. The OHC PoR stands ready to fulfill these demands through the implementation of an Air Force medical service human performance research and development program evaluating health-informed, AFSC-specific human performance resources to better align, support, and sustain airmen. At its most basic level, OHC is about managing resources (people) in a manner that best benefits not just the Air Force, but also those who choose to serve. Developing a composite list of relevant, measurable attributes, is foundational to achieving the larger goal of PBAO, that of more objectively assessing the *form* of our Airmen to help maximize their *fit* for specific career fields in order to better optimize training and mission *function*.

Efforts thus far in OHC's first increment, PBAO, have resulted in two distinct lists of these measurable attributes, referred to as basic performance resources (BPRs). Beyond being indicators of airman health, measurements resulting from implementation of these proposed BPR inventories can be used as elements of functional profiles, providing a sort of readiness forecast relative to specific AFSCs. When paired with results of a higher-level task (such as performance in a simulated environment), the BPRs can be used to develop a model of resources needed for performance success.[1] The resulting envelope spotlights those BPRs most relevant to predicting airman success in a given job. Figure 2 provides an example of mapping BPRs and performance, as suggested by General Systems Performance Theory (GSPT).

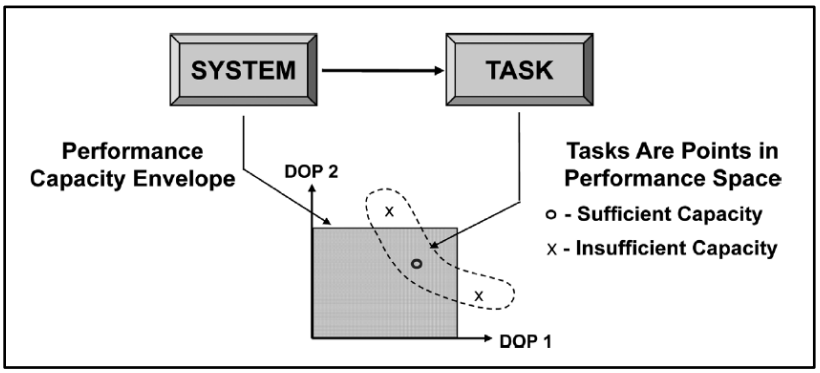

Figure 2. A simple characterization of task and BPR interaction[1]

In Figure 2, resources that fall within the shaded area of the graph represent those with sufficient capacity to support a given higher-level task; those outside the shaded area (denoted by an "x") represent resources with insufficient capacity that either have no bearing on the performance of the higher level task or act as limiting, potentially leading to an individual's inability to function in a specific role.[1]

As referenced, this portion of OHC is underway, with scientists leveraging the concepts of GSPT to develop inventories of characteristics, referred to as BPRs and attributes. These performance indicators can be leveraged to develop profiles, optimizing the fit between workers (airmen) and the jobs they will perform. Such profiles will support the move from a simple focus on absence of disease, to one that also incorporates the basic elements needed to develop high functioning personnel.

In the first inventory (referred to herein as Inventory 1.0) domains of focus were audiology, physiology, psychology, and vision.[2] The second (referenced herein as Inventory 2.0), focused on haptics, proprioception, and vestibular functioning, with haptics defined as touch, proprioception as position and movement, and vestibular functioning equated with balance.[3]

Extensive literature reviews and collaboration with subject matter experts (SMEs) were primary drivers in inventory development. Since they were originally conceived of as targeted efforts focused on specific AFSCs such as 1U0X1, remotely piloted aircraft (RPA) sensor operators (SOs) and 1B4X1, cyber warfare operations, extensive research in those areas was also utilized to help refine included items. However, as research progressed and it became apparent that many aspects of some AFSCs are protected by security classification, the inventories evolved into ones with more generalized applicability and utility across most, if not all, Air Force jobs.

The two inventories resulted in the identification of 272 BPRs and attributes that could be measured as indicators of performance, with 101 elements in Inventory 1.0[2] and 171 in Inventory 2.0.[3] While readiness forecasts are only as good as the data supporting them (e.g., number of attributes measured), there is also the consideration of practicality. As such, both inventories were reviewed to determine how to best combine them into one functional list. Since Inventory 1.0 has already been approved for testing, it was considered complete. Therefore, the task of combining the two inventories entailed more of a review of Inventory 2.0, considering which elements better informed airman selection by adding unique measures that stand on their own merit as well as better inform those already included in the initial list. Following a structured approach to consolidation, a new BPR and attribute list emerged that includes 138 BPRs and attributes in the areas of audiology (9), haptics (30), physiology (37), proprioception and vestibular functioning (7), psychology (44), and vision (11). Of note, 1 BPR in the domain of audiology and 10 BPRs in physiology are viewed as multi-purpose because, in addition to informing their original domains, they also provide data in the areas of both proprioception and vestibular functioning without requiring modification to the current protocol; these overlapping measures provide depth to outcomes without adding time to data collection. Table 1 provides a small sample of BPRs and attributes proposed for inclusion in the consolidated inventory.

Table 1. Examples of Proposed BPRs and Attributes

Name	Definition	Domain of Focus
Auditory threshold	Sound level below which a person is unable to detect any sound.	Audiology
Sound localization	Ability to determine the location of a sound's source, sometimes as a function of level or duration.	Audiology
Tactile spatial sensitivity of digits on the left and right hand	Distance at which one can discern the presence of one versus two points of touch	Haptic
Touch sensitivity of digits on the left and right hand	Level at which an individual identifies perception of skin contact	Haptic
Dynamic balance/Dynamic postural control – right and left leg	The ability to maintain balance while in motion or when switching between positions.	Proprioception and Vestibular functioning

Name	Definition	Domain of Focus
Whole Body Agility	The amount of time taken to traverse a 5-10-5-yard shuttle with three changes in direction.	Physiology, Proprioception, and Vestibular functioning
Upper Extremity Coordination	The capacity to toss a tennis ball against the wall with one hand in an underarm action and catch the ball with the opposite hand in a rapid and accurate manner over one minute.	Physiology, Proprioception, and Vestibular functioning
Impulsiveness	Tendency to be unable to control cravings and urges; desires are perceived as too strong to resist.	Psychology
Arithmetic Reasoning	Ability to solve numerical problems. Reflects reasoning and problem-solving abilities.	Psychology
Depth perception – static - near	Judge which of several objects is closer or farther away from you, or judge the distance between you and an object.	Vision
Useful field of view	See objects or movement of objects to one's side when the eyes are looking ahead.	Vision

2.0 Scientific Rationale

Emanating from GSPT, BPRs represent a universal construct to describe aspects of performance of any system, including humans, across multiple hierarchical levels.[1] In this view, systems possess desirable quantities of materials (e.g., performance resources) that characterize how well that system executes its function.[1] BPRs reflect desirable attributes/performance resources such that having more is understood to convey a greater performance capacity (e.g., rate of response rather than response time).[1] It is also specified that BPRs be measurable on interval or ratio scales (e.g., discrete or continuous quantitative values) where outcome measures are meaningful.[1] As such, attributes resulting in qualitative measures, like those with binary/nominal responses such as "yes" or "no" translated to ratings of (for example) "0" or "1", or those measured along an ordinal scale (e.g., Likert scale) where intervals have no clearly defined numerical value, cannot be translated to BPRs.

GSPT uses resource economics as a basis for describing task interference. The theory proposes that as tasks impart performance resource demands on a system (e.g., human), performance resource availability must exceed task resource demand for all required resources to result in successful task performance.[1] Performance resources are described as being limiting up to a task-determined threshold value.[1] Resource availability that exceeds task threshold requirements will not necessarily improve performance; however, insufficient quantities of a specific resource (such as strength) may hinder success leading to the identification of such resources as limiting.[1]

The Elemental Resource Model (ERM) for human performance results when GSPT is applied to the human system.[1,4] The ERM describes BPRs at the basic element level as well as higher hierarchical levels (e.g., intermediate level BPRs).[4] Those at the basic element level are referred to as basic elements of performance (BEPs).[1] To identify a BPR at any hierarchical level, one must specify a functional unit (i.e., a system) and one dimension of performance.[1]

When taken together, GSPT and the ERM provide a foundational view of the human as a system. The theory (GSPT) helps us better discuss its complexity, providing a common way of talking about the human system and how it performs. The associated model (ERM) manages the engineering aspect, providing a way to manage the system's complexity through the creation of an operational hierarchy. Figure 3 provides a schematic focusing on key aspects of the ERM as it relates to the human as a system.

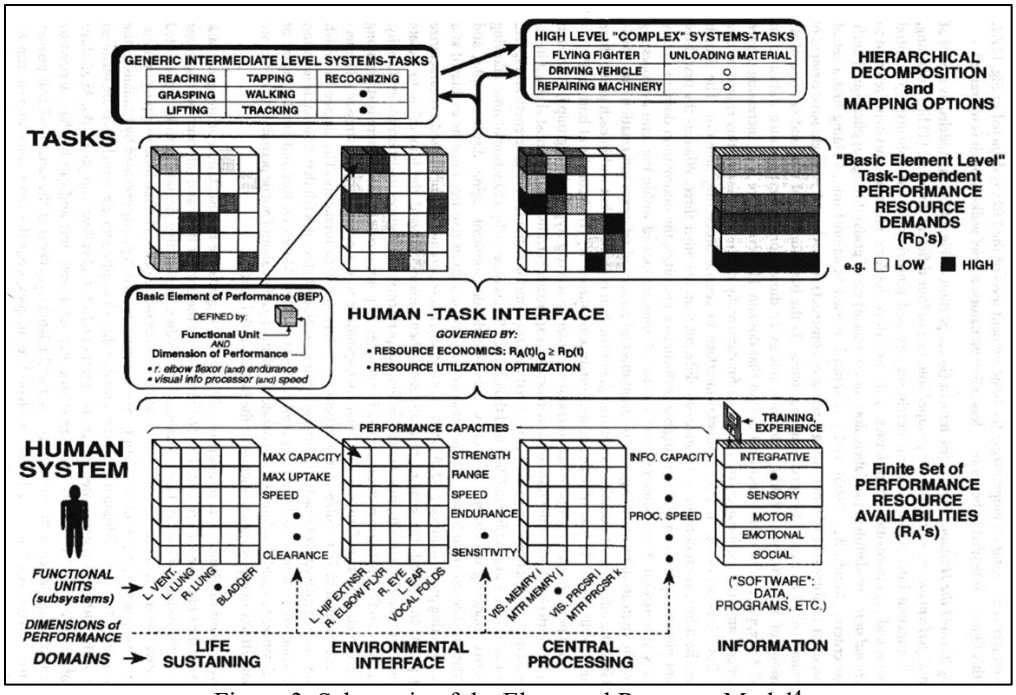

Figure 3. Schematic of the Elemental Resource Model[4]

3.0 PBAO and BPRs

As discussed, the focus of PBAO is identifying and defining BPRs utilizing GSPT as a foundational theory. Rather than adopting GSPT, scientists and SMEs agreed that an adaption of the theory was better suited, leading to inventories composed of both BPRs and attributes, measures that do not fit squarely within the GSPT definition of a performance resource. The rationale was that some requested domains of focus (i.e., haptics, proprioception, and vestibular functioning) do not always result in scalable outcomes; however, they nonetheless represent important measures of performance worthy of consideration when assessing the fitness of airmen.

While well-defined, no formal methodology for the development of BPRs exists, which led PBAO scientists to create a systematic approach to identifying these elements of performance, relying on subject matter expertise, literature reviews, and, in some instances, career-field workshops, to inform the development of BPR and attribute lists.[2,3] The ultimate product of their efforts was two inventories of BPRs and attributes, with associated definitions as well as measurement techniques, that are proposed for consideration as methods of assessing airman performance capabilities.[2,3]

The first developmental effort focused on the areas of audiology, physiology, psychology, and vision, concentrating on specific career fields.[2] The result was BPR and attribute Inventory 1.0, composed of 9 audiology BPRs, 37 physiology BPRs, 44 psychology BPRs, and 11 BPRs in the domain of vision.[2] Resulting outcomes will determine whether BPRs included in the inventory can be successfully utilized as performance indicators within the career fields of interest. Further, the list was developed such that included elements have utility beyond specific career fields, with measurements having broad applicability across Air Force job functions. A data collection plan has received IRB approval and is currently underway, with volunteers from the USAF 1U0X1 community serving as participants. In addition to utilizing BPR Inventory 1.0 to measure their performance abilities, these individuals are also taking part in a Higher Level Task (HLT) comprised of a sophisticated simulation of RPA missions wherein SO and RPA pilot teams play through realistic scenarios, the outcomes of which will be reviewed by SMEs, providing another level of SO performance assessment.

The second PBAO BPR list, Inventory 2.0, focused on somatosensory domains that are less-obviously tied to specific job skills but nonetheless essential for individual success and functional health.[3] Utilizing the same methodology as that employed in the development of the initial BPR inventory, this study resulted in the

identification of 171 items for inclusion, with 161 related to haptic functioning and 19 related to proprioceptive and vestibular functioning.[3] It is important to note that content of this second inventory differs significantly from that of the first from the standpoint of the inclusion of items referred to as attributes in addition to BPRs. This was the result of an adaptation of GSPT rather than a pure adoption of its approach, a decision made due to the nature of the domains of focus.[3] Whereas outcomes in the initial inventory were composed of items with scalable measured outcomes, some in the second inventory were binary in nature and therefore not translatable to BPRs. For clarity, elements that comply with BPR definition criteria (i.e., measured on a quantitative scale such that more of a resource is deemed better) were identified as such; those that did not were included as attributes because they remain important indicators of airman health and performance.[3]

Unlike the initial BPR inventory which is intended to be utilized as "blanket" testing for all airmen, the second inventory is proposed to be more appropriate as a supplemental assessment, targeting airmen suspected of having very specific deficits. The rationale behind this approach is the fact that anyone with a significant deficit in any of the domains targeted in Inventory 2.0 would likely not be selected for service; however, once enlisted, if an airman were to have an injury (e.g., concussive event causing symptoms such as vertigo), this secondary inventory could be an initial step in assessing the extent of the injury's impact on somatosensory functions, thus making it a useful tool for airman retention.

3.1 Consolidation of BPR and attribute inventories

When taken together, Inventories 1.0 and 2.0 propose the utilization of as many as 272 BPRs and attributes in the evaluation of airman health and fitness. Obviously, this is not a reasonable number of measures to utilize on large-scale assessments thus leading to a need for refinement of the inventories. The result is a consolidated list of measurements with the highest likelihood of successfully predicting performance. Measures in Inventory 1.0 have received acceptance for inclusion in testing; as such, this process involved a closer review of Inventory 2.0 to determine which outcomes to include in the primary BPR and attribute inventory.

3.1.1. Decision Framework for Inclusion of BPRs and Attributes. While many researchers would agree that more data is better, it is logical to assume there is a point of diminishing returns, where too much information, such as measuring too many BPRs, potentially hinders the process. In any study, the goal should be one of concern with quality of data, not just quantity; such an approach will yield more reliable results. With that in mind, inclusion criteria for the PBAO BPRs and attributes was developed to support creation of a combined inventory with meaningful outcomes supporting informed recruit evaluation and placement. Examples of inclusion criteria include:

- Time: How much time does it take to perform the assessment?
- Equipment: How much equipment is involved? Is it expensive or complex?
- Training: How much training would an evaluator require to accurately measure the proposed BPR or attribute?
- Information: Is the information gleaned from the measure generalizable, or is it so specialized that it only applies to a small segment of the Air Force community? Will items from Inventory 2.0 better inform those already included in Inventory 1.0?

The first step in this process involved a simple comparison of the two inventories, with items common to both being logical choices for inclusion. Identified duplicate measures in auditory and physiological capabilities become more meaningful predictors of performance because each adds multiple points of information to the equation, providing data not only on those two domains, but also serving as indicators of healthy proprioceptive and vestibular functioning. Further, these BPRs meet the criteria of timeliness as well as utilization of equipment that is economical and easy to use, requiring little training to ensure validity of outcomes.

The next criterion for deciding whether to include Inventory 2.0 measures in the consolidated inventory is their AFSC-specific utility. Since Inventory 1.0 was developed with strong consideration of specific AFSCs and their associated qualifications for success, it is reasonable to assume that Inventory 2.0 elements that further support AFSC-specific capabilities should be considered for inclusion. A review of Inventory 1.0 reveals measures that demonstrate both physical and mental endurance as well as presence of optimal function (an indicator of health). Keeping these factors in mind, BRPs such as Static and Dynamic Balance as well as Walking Functional Mobility and Postural Control should be considered for inclusion in the consolidated list. These measures are ones indicative

of healthy performance in the areas of both proprioception and vestibular functioning which are essential for maintenance of balance and thus, through association, contribute to one's ability to perform essential functions, particularly some of those already included in Inventory 1.0 (such as steadiness and coordinated movement). These measures of postural control, balance, and functional mobility all provide valuable outcomes indicative of an individual's basic body control and coordination.

Finally, due to its extensive nature, separate consideration was given to Inventory 2.0's list of haptic traits, none of which are replicated in Inventory 1.0. The vast majority of items included for assessing haptic functioning seem better suited for supplemental assessment. There are, however, three areas that may be of value as primary assessments, including touch sensitivity, tactile spatial sensitivity, and tactile localization. For purposes of large-scale evaluations, it is suggested that these assessments be limited to the hands, with their outcomes providing a gross indicator of sensitivity that may help better explain performance in upper limb dexterity and coordination tasks (i.e., Tennis Ball Test/Alternate Hand Wall Toss Test and 9-hole Peg Test). For example, if someone is discovered to have performance capabilities that far exceed those of the average person in those evaluations and they also exhibit similar extremes in haptic sensitivity testing, there is a chance the two are interconnected; conversely, there could also be a correlation between low dexterity and coordination test scores and correspondingly poor haptic outcomes.

3.1.2 Modified BPR and attribute table. Upon review, a new BPR and attribute table has emerged, combining elements of Inventory 2.0 with the entire list included in Inventory 1.0; in total, 37 measures from Inventory 2.0 are proposed for inclusion. The resulting list, referenced as Inventory 3.0, adds significant information without adding excessive time to overall evaluations. In addition to potentially better informing outcomes in the original Inventory 1.0, the measures proposed for inclusion add unique information, providing a more complete picture of airman capabilities through assessment of their performance resources in multiple areas.

4.0 BPRs and Their Potential Roles in Future OHC Increments

As previously described, the OHC program is incremental, with each phase building on the next. With its initial increment, PBAO, in the preliminary stages of data collection, it is now time to begin the process of envisioning subsequent phases and the roles that BPRs and attributes may play in their processes and outcomes.

Increment 2, Enhanced Medical Screening Techniques for a Fit and Healthy Force, presents a natural progression in the BPR process, where such measures could be utilized as part of an improved comprehensive plan to assess airmen's health. An initial step could involve a small-scale implementation of the screening methodologies developed in PBAO in a real-world setting. Assuming BPRs are found to be successful indicators of airman readiness to perform, it is suggested that they be rolled out and utilized in an environment outside the laboratory space, determining if they can be successfully implemented by individuals other than trained scientists. Through duplication of high-level task mapping against BPR measures, it can be determined if the process is manageable in a real word setting. Further, the haptic BPRs and attributes set aside as supplemental assessment measures may be useful during this phase, helping ensure airmen remain in the green zone (see Figure 1.0) by providing more specific measures of innate functionality.

As indicated by its name, Increment 3, Prevention, Mitigation, & Worker Hardening Strategies for a High Functioning Force, represents the culmination of OHC efforts, with program outcomes showing their value through a return on investment; that of informing objective alignment, increasing training efficiency, supporting retention of high performing airmen, and enhancing precision-based care. While there are many potential strategies for maintaining a high functioning force, proposed BPR measurements may prove to be a meaningful element to consider. While all BPRs will be important throughout the airman's lifecycle, it is suggested that this portion of OHC may be the best for utilization of the haptic, proprioceptive, and vestibular BPRs as they are thought to be more in line with retention, supporting airmen's continuation in the green zone of functioning (see Figure 1.0) through their utilization in therapies and training to prevent or mitigate performance deficiencies. Following injury and throughout rehabilitation, these BPRs have potential to serve as indicators of success in an airman's recuperative process. Further, periodic reassessment of individuals without injury who seem to be falling off in their performance metrics may point to the appearance of deficits in what were once high-functioning areas, allowing for targeted retraining or, if warranted, further health assessments to rule out the presence of injury or a disease process. Beyond the literal physical functioning of an airman, it is also possible that BPRs may serve to spotlight training

deficits, leading to the need for re-evaluation of certain training strategies resulting in improved training that supports a higher functioning force.

5.0 Conclusion

With no formalized methodology in place, the roadmap for identifying BPRs and attributes included in the inventories under consideration in this paper was developed by research scientists in conjunction with subject matter experts. Successful creation and implementation of an inventory of basic performance resources requires thorough investigation during the BPR selection process as well as consideration of fiscal, temporal, and manpower constraints. It should also be understood that there is opportunity for susceptibility to bias in measures included due to fluctuating information as well as inherent uncertainty in the information available during their selection. New literature is constantly being published with findings from studies that may or may not support initial conclusions, and many AFSCs operate under security classifications such that only limited information about the job and what it entails is available leading to a sort of "educated guessing" strategy about its associated inventory. As such, it is of utmost importance to treat any inventory, whether generalized or AFSC-specific, as a living document requiring periodic updates to maintain its relevance and accuracy. As the USAF evolves, so too should any methodologies that are associated with maintenance of airmen's medical readiness for mission performance. With this in mind, it is believed that OHC is on a successful strategic research trajectory toward achieving the AFMS vision of supporting a military population whose members are the healthiest and highest performing segment in the United States.

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