

# Systematic approach to the treatment of binocular dysfunction using virtual reality

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## BACKGROUND

Many patients who would benefit from vision therapy (VT) do not receive it. One of several reasons is that binocular vision (BV) is highly complex: VT requires one-on-one testing and treatment by highly skilled clinicians who are in short supply. Here we describe a framework that allows the doctor or vision therapist to off-load some of their patients' treatment, testing, and the more routine parts of decision-making to at-home virtual reality (VR) software. The goal of this project is for specialists to be able to treat more patients at lower cost by increasing the amount of skill-appropriate treatment between office visits.

## PRINCIPLES OF HOME OPERATION

VT addresses specific skills, such as: vergence ranges along with awareness of diplopia; flat fusion; and stereopsis. Manipulating accommodative demand is difficult within currently available consumer-grade VR displays, however, decoupling of vergence and accommodation (as done with Vectograms/graphs in the clinic) is straightforward.

During home training, an artificial intelligence agent, the VT Virtual Assistant (VTVA™):

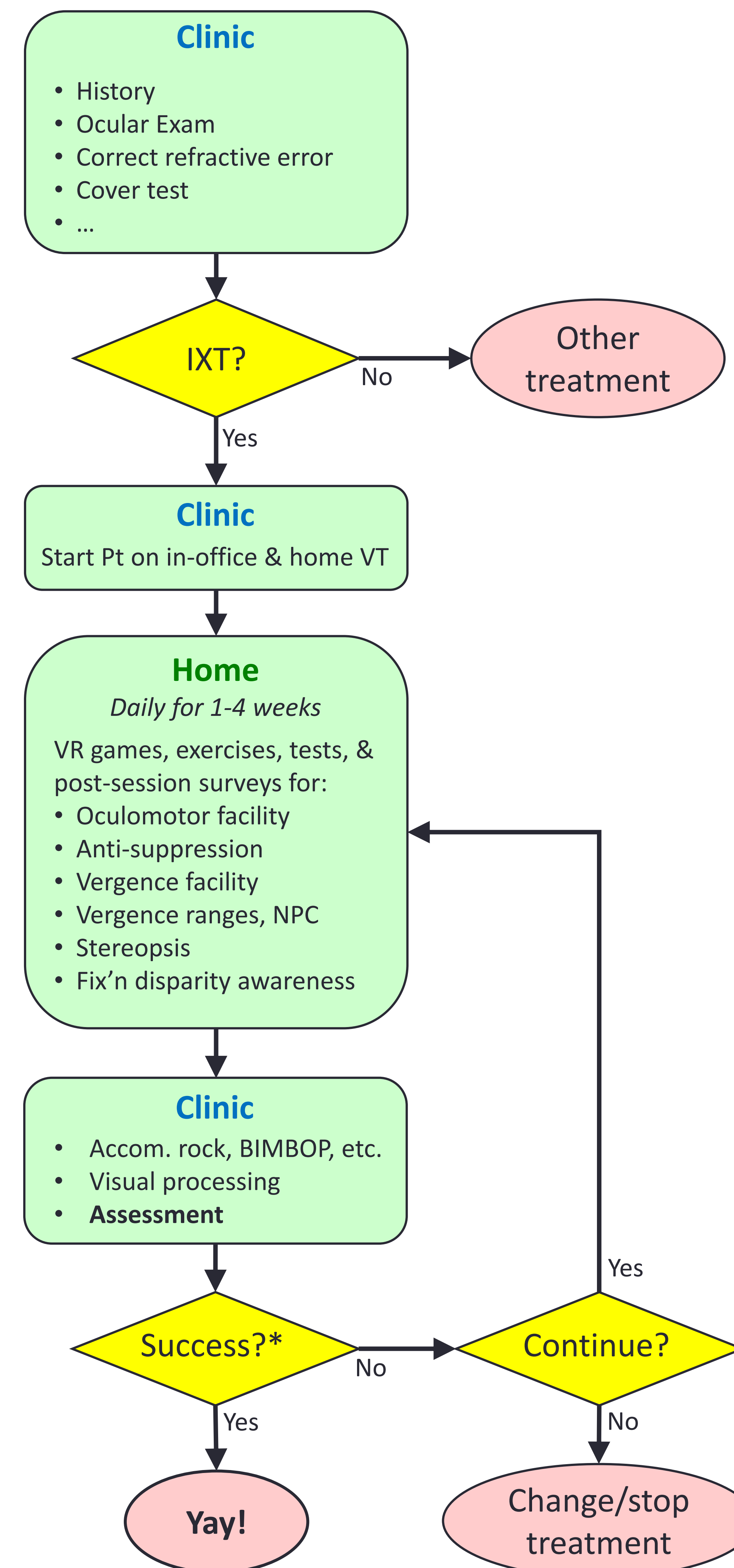
- Controls game difficulty to keep patient engaged in training
- Monitors training variables such as blur, occlusion, vergence demand, and binocular disparity
- Collects, reports, and responds to subjective ratings in questionnaires for comfort, asthenopia, etc.
- Assesses specific skills, including awareness of diplopia, flat fusion, vergence ranges, and stereopsis with results available over the internet to the clinician.

## HOME TREATMENT EQUIPMENT



Virtual reality headset

## EXAMPLE: INTERMITTENT EXOTROPIA

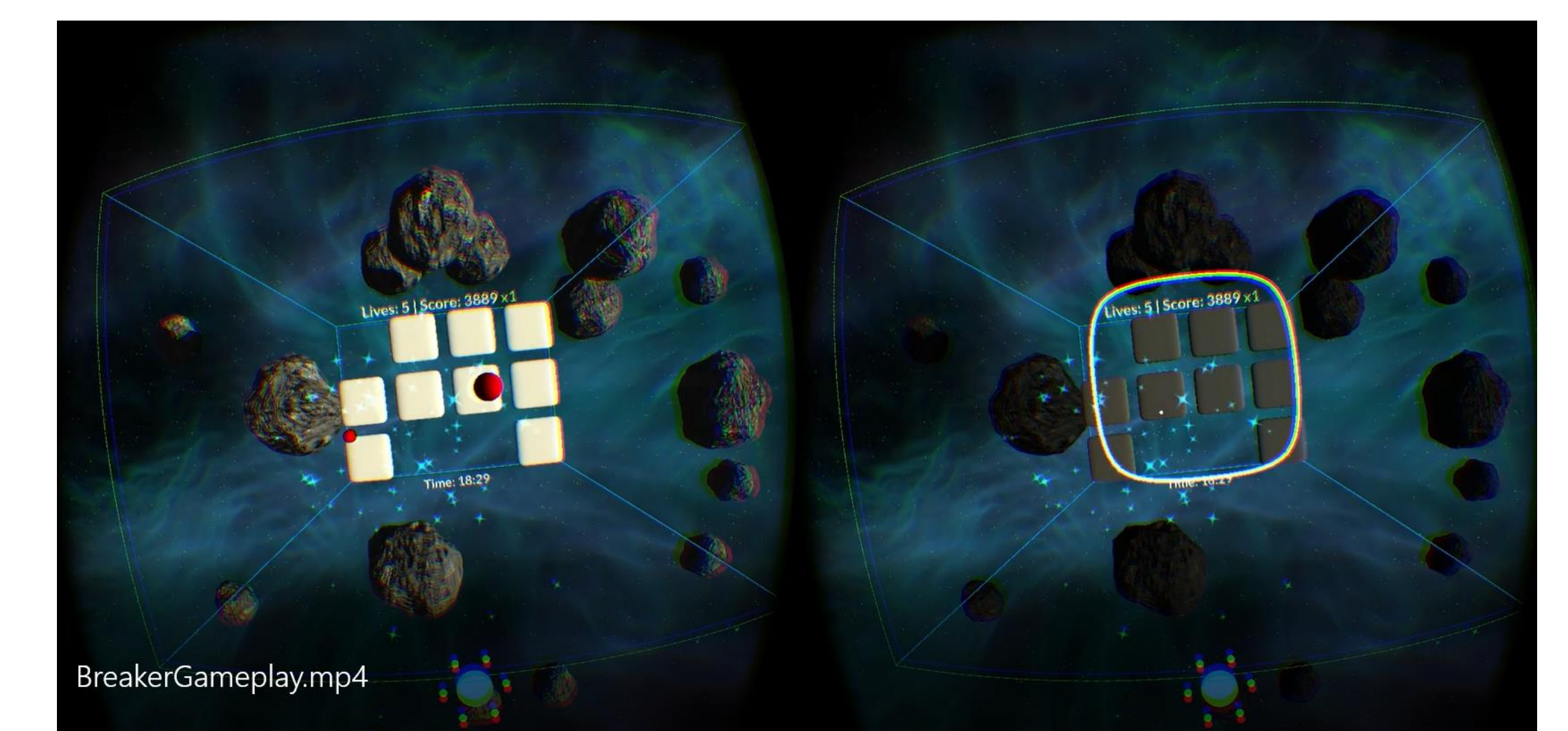


\*Suggested criteria for Success (Flom, 1958):

- Clear, comfortable binocular vision at all distances up to NPC
- Normal NPC
- Stereopsis
- Normal motor fusion ranges
- At most 1% prevalence of tropia, and always with diplopia
- At most 5Δ prism needed in spectacles

## EXAMPLE: SEQUENCING IN "BREAKER" HOME TREATMENT OF SUPPRESSION

SUPPRESSION PROGRESSION PROTOCOL - BREAKER						
Session	Suppression Value	Object Size	Contrast Ratio	Blur	% Balls Hit	Difficulty
Stage 0.1	100%	3	100	50	75%	Easy
Stage 0.2	100%	3	100	50	75%	Easy
Stage 0.3	100%	3	100	50	75%	Easy
Stage 0.4	100%	3	100	50	75%	Easy
Stage 0.5	100%	3	100	50	75%	Easy
<b>BINOCULAR GAME</b>		3	0	0	75%	Easy
Stage 1.1	<= 80%	3	75	0	75%	Easy
Stage 1.2	<= 80%	3	75	0	75%	Easy
Stage 1.3	<= 80%	3	75	0	75%	Easy
Stage 1.4	<= 80%	3	75	0	75%	Easy
Stage 1.5	<= 80%	3	75	0	75%	Easy
Stage 2.1	<= 70%	2.5	60	0	75%	Medium
Stage 2.2	<= 70%	2.5	60	0	75%	Medium
⋮						
Stage 9.3	<= 0-5%	1	5	0	75%	Master
Stage 9.4	<= 0-5%	1	5	0	75%	Master
Stage 9.5	<= 0-5%	1	5	0	75%	Master
Stage 10.1	<= 0-5%	0.5	0	0	75%	Master
Stage 10.2	<= 0-5%	0.5	0	0	75%	Master
Stage 10.3	<= 0-5%	0.5	0	0	75%	Master
Stage 10.4	<= 0-5%	0.5	0	0	75%	Master
Stage 10.5	<= 0-5%	0.5	0	0	75%	Master



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